GEOLOGICAL SURVEY OF MICHIGAN.

# UPPER PENINSULA
**1869-1873**
**ACCOMPANIED BY AN**
# ATLAS OF MAPS.

## VOL. I.
## PART I.
## IRON-BEARING ROCKS (ECONOMIC).

BY
T. B. BROOKS.

MEMORANDUM.—It has been deemed advisable that the Appendices, referred to in this Part, should be issued separately as Vol. II.

PUBLISHED BY AUTHORITY OF THE LEGISLATURE OF MICHIGAN.
UNDER THE DIRECTION OF THE
BOARD OF GEOLOGICAL SURVEY.

NEW YORK
JULIUS BIEN
1873



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Governor J. J. BAGLEY,
Hon. W. J. BAXTER,
Hon. DANL. B. BRIGGS,

*Board of Geological Survey of the State of Michigan.*

GENTLEMEN,

Herewith I transmit a Report, with maps and illustrations, containing in part the results of my economic survey of the Iron Regions of the Upper Peninsula, made in accordance with a plan approved by your predecessors, under the chairmanship of ex-Governor H. P. Baldwin. I have labored diligently to produce "as complete a manual as possible of information relating to the finding, extracting, transporting, and smelting of the iron ores of the Lake Superior Region;" a book that should possess interest and value to the practical man and capitalist interested in our mines, which have for several years produced nearly one-fourth the ore raised in the United States.

Absence in Europe, on account of ill-health, prevents my giving the book that supervision, in passing through the press, which is essential to accuracy and finish in a work of this kind, especially when, as in this case, the author is not accustomed to bookmaking. Your publisher, Mr. Julius Bien, has promised to perform this duty, which is a guarantee that it will be well done.

I hope that the iron trade of the West will find in this a useful, although incomplete, manual, and that the people of Michigan will approve of the manner in which I have expended the money entrusted to me.

Very respectfully and obediently yours,
T. B. BROOKS.

London, May 1st, 1873.


[I. Jackson Mine, looking West in No. I Pit]

# INTRODUCTION.

IT is customary to preface Geological Reports with a history of the surveys on which they are based; in this case, however, it will be impossible to give more than a brief sketch, without omitting some part of die report itself, the limits of the book, for the publication of which funds were provided, having already been considerably exceeded.

The first survey of the State by Dr. Houghton, which was discontinued on account of his death by drowning in Lake Superior in 1845, is noticed in the first chapter in connection with the discovery of iron ore. The present survey was inaugurated by act of the Legislature in 1869, which appropriated $8,000 per year for the work, one-half of which went to the Upper Peninsula. This amount was again divided equally between the Iron and Copper Regions, which gave $2,000 per year for each to coverall expenses, including salaries, supplies, instruments, travelling, etc. To the $8,000 aggregate for four years from this source, the Geological Board added $1,000 for chemical work, making $9,000 in all received by me from the State for the survey of the Iron Region. In addition to this sum I have expended about $2,000 of my own means, and have not received any compensation for my services.

This small sum would have been inadequate to have accomplished anything worthy of the importance of the work undertaken, had not several corporations and individuals generously come to my relief; indeed on this

source of help I counted largely in undertaking the work, and made it an express condition in the arrangement that I should be permitted to avail myself of all the assistance of this kind I could obtain, and also that during the progress of the work I should be free to continue the practice of a profession from which I was sure to obtain further facts bearing on the objects of the survey.

The companies which have contributed valuable data in their possession, or have instituted special surveys at my suggestions, with the view of furthering the object of the survey, are:—The Marquette, Houghton & Ontonagon Railway, The Portage Lake & Lake Superior Ship Canal Co., The Republic, Washington, Lake Superior, Champion, New York, Spurr Mountain, Iron Cliff, Cannon and Magnetic Iron Companies. E. Breitung bore a part of the expense of making Map No. V., and John Fritz, A. Pardee, and Daniel J. Morrell, of Pennsylvania, S. P. Ely, of Marquette, and A. B. Meeker, of Chicago, contributed generously to the chemical fund, the results of the analyses being given in Chapter X.

The law of 1869 established a Board of Survey, consisting of H. P. Baldwin, Governor ; W. J. Baxter, President of the Board of Education, O. Hosford, Superintendent of Public Instruction, with power to select the Geologists, disburse the money appropriated, and perform other necessary duties. Prof. A. Winchell was made Director, who approved the plan for the survey of the Iron Region which I submitted to him, and which is contained in the following letter:

LETTER OF INSTRUCTIONS,

*Referred to in Agreement with* T. B. BROOKS, *dated Negaunee, Mich., June* 5th, 1869.

"*To Major* T. B. BROOKS, *Assistant of the Geological Survey of Michigan.*

"SIR:—You are hereby authorized and requested to make a Survey of the Marquette Iron District, and to draw up a report on the same, substantially in accordance with the following suggestions:

"1. By the Marquette Iron District is meant the region embracing all the deposits of iron ore extending from the shore of Lake Superior on the east, through Townships 46, 47, and 48 north, as far as Range 31 west, inclusive, being the region which for the present finds its outlet by railroads through Marquette and Escanaba.

"Your report on this district would appropriately furnish—

"2. A historical sketch of discovery in the Iron Region of Lake Superior,

"3. A physiographical sketch of the Marquette Iron District; general topography, hydrography, timber, soil, climate, etc.

"4. The general geological structure of the district (not entering into details, nor theoretical discussions); identification of iron range stratification; outline description of the rocks; general description of the ores of iron occurring in the district.

"5. The mines in general; their distribution and grouping.

"6. Special notices of the mines and mining locations of the District; local structural geology, topography, mineralogical specialties pf the ores.

"7. Discovery of ores; geological principles applicable; the use of instruments.

"8. The working of Iron Mines; methods in use here and elsewhere in analogous regions; advantages of each; machinery.

"9. The manufacture of iron and steel; special adaptations of the different varieties of ore in the District; the use of charcoal and mineral coal; resources of charcoal in Michigan ; manufacture of charcoal; fluxes; location of furnaces; construction and operation of furnaces.

"10. Transportation of iron ores, and of iron; market; prices.

"11. Commercial statistics of iron ores, and of iron.

"In the discussion of the above topics, it is intended that you make such reference to other iron regions as may be necessary to thorough treatment and illustration of the general subject.

"It is not intended to lay down any stringent rules for your procedure, but only to furnish a general conception of the ground to be worked over. It is desired to produce as complete a manual as possible of information relating to the finding, extracting, transporting, and smelting of the iron ores of the Lake Superior Region, and it is believed that your own experience and the suggestions which may occur to you in the progress of the work will render it proper to deviate from the letter of the foregoing programme, according to the dictates of your own judgment. Specimens are to be collected according to the requirements and provisions of the law of 1869.

"In the prosecution of your field work, it is obvious that you cannot with the money at your disposal enter into detailed and complete examinations of individual properties, but it will promote the interests of the general work, if proprietors can be induced to defray the expenses of such detailed surveys beyond the limits to which you may be able officially to prosecute them; and it is evident that the interests of proprietors, no less than those of the Slate, will be promoted by committing such detailed surveys to your direction.

"The report, with the requisite maps, plans, and other illustrations, is to be ready for publication by the 31st day of December, 1870.

"(Signed) A. WINCHELL,
"Director Geological Survey,
"Ann Arbor, Mich."

On the completion of this survey of the Marquette Region, the Board decided to extend the work over the Menominee Region as well as further West before publishing, thus embracing all the known Iron-fields of the Upper Peninsula. Professor Winchell having resigned in 1871, this part of the work was done under the direction of the Board.

Prof. R. Pumpelly has been engaged, with interruptions, in the Copper Region during the same period I have been at work in the Iron (see his Report, Part II.), and in the spring of 1871 Dr. C. Rominger commenced work on the Palaeozoic rocks; his Report on the Silurian rocks of the Upper Peninsula is contained in Part III. of this volume.

The sum appropriated ($20,000) for publishing 2,000 copies of the three reports, with Atlas of maps, enabled the Board to contract for no more than a 500 octavo-page volume, which at the time was deemed sufficient space, I have been generously allowed more than one-half this space, but find that it was not sufficient to contain the material which I had accumulated, and which it seemed to me could be advantageously embodied in the proposed report. It was for some time a question with me, whether I should attempt to consider all the points named in the above scheme (giving each its relative space), which plan would have excluded a large amount of valuable material, or whether I should only attempt to treat each subject in order, as fully as my material would admit and its importance seemed to demand, without attempting at this time to cover the whole ground.

I choose the latter plan, and have in consequence been obliged to entirely omit all consideration of the important subjects of the location, construction and operation of furnaces ; of fuels, fluxes, and ore mixtures ; of the resources and manufacture of charcoal in Michigan,* as well as the consideration of the question of steel manufacture. The question of the transportation of ore and iron, of markets and prices, was also forced out for want of space. A proper treatment of these subjects would fill a volume.

I trust those gentlemen, who have favored me with lengthy and carefully prepared replies to my numerous inquiries on these excluded subjects, will feel that no injustice has been done them in withholding their papers, until they can be properly presented.

*The subject of the resources of Michigan in Charcoal and the location of charcoal furnaces both on the Upper arid Lower Peninsulas has been carefully worked up and illustrated by Timber Maps, but there is unfortunately no means provided for their publication.

The following named gentlemen are well acquainted with their respective localities on the Lower Peninsula, and are prepared to give information regarding the timber, etc., which is in many instances unsurpassed:

| | |
|---|---|
| JOSEPH DAME, North Port. | O. W. HART, Torch lake. |
| E. E. BENEDICT, Manistee. | A. G. BUTLER, Frankfort. |
| E. B. MILLS, Mayville. | JAMES LEE, Bingham. |
| GEO. N. SMITH, Bear river. | W. H. HURLBURT, South Haven. |
| W. H. C. MITCHELL, East Traverse bay. | DENNIS T. DOWNING, Little Traverse. |
| LEROY WARREN, Pentwater. | DELOS L. FILER, Ludington. |
| J. S. DIXON, Charlevoix. | WILLIAM H. FREY, West Olive. |

It may be questioned, whether with the purely practical object I have had in view in preparing this report, and the limited space, that so large a place should be given to the subject of Lithology, so ably treated by Mr. Julien, in App. A, Vol. II. The reasons which led to this were my own inability to properly treat this subject, its great relative importance in the study of rocks devoid of fossils, but above all I had collected and catalogued during seven years a more complete suite of specimens from the Azoic of the Upper Peninsula, than had before been got together, which collection I believed worthy the study and paper referred to, and which I saw no better way of utilizing to the public, than as has been done It is open to question whether Mr. Julien's paper should not have been published through some scientific channel, rather than In an Industrial report, where it will stand nearly alone as a contribution to science.

**Grouping Iron Deposits.**—It has been found convenient In this report to disregard such political divisions as counties and towns in designating localities, and to employ instead, either the precise and simple method of U. S. linear surveyors, which can be readily understood by an Inspection of Maps II., III. and IV. of Atlas; or, by the use of what may be termed the mineral or industrial geography of the Upper Peninsula, by which it is conveniently divided Into regions, districts, groups, etc., which, although not sharply defined, may be considered at present to have the following boundaries: The *Marquette Iron Region* (see Map III., Table XIII., and Chap. IV.) embraces all the developed Iron mines of the Upper Peninsula, the ores of which now find their outlets via Marquette, L'Anse and Escanaba by the Marquette, Houghton and Ontonagon and Chicago and Northwestern railroads. This again is subdivided Into the (1) Negaunee, (2) Michigamme, (3) Escanaba, and (4) L'Anse districts. These divisions may be conveniently carried still further by a subdivision of the Negaunee District Into the Cascade Range, Negaunee Hematite Mines, Ishpeming Group, New England and Saginaw Range; and of the Michigamme District Into the Washington, Champion, Spurr and Magnetic Ranges, and Republic Mountain Basin. The S. C. Smith Is the only worked mine in the Escanaba District, and no ore has yet been shipped from the L'Anse District or Range. The *Menominee Iron Region* (see Map IV. and Chap, IV.), which as yet has sent no ore to market, Is divided into (1) The North Belt in south part of T. 42, (2) The South Belt in Ts. 39 and 40, and (3) The Paint River District. The Lake Gogebic and Montreal River Region or Range (Chap. VI.) is so little known that it may be questionable whether it should have a place in this economic grouping; it embraces the country between Lake Gogebic and the west boundary of Michigan, and is 100 miles west of the Marquette Region.

It but remains for me to express my obligations and gratitude to the many gentlemen who have contributed in various ways to the objects of this survey, to officially acknowledge their services and to thank them cordially for myself and on behalf of the Board for what they have done.

To S. P. Ely, of Marquette, the survey is more deeply indebted than to any other person; indeed, I would not have undertaken the work except from assurance of his support, which has been constant and generous from the beginning. To Messrs. H. B. and F. L. Tuttle, of Cleveland, Ohio, I am indebted for a considerable amount of the material embodied on Statistical Tables XII. and XIII. of Atlas, much of which I believe it would have been impossible for me to have procured, except through them; App. J, Vol. II., contains a letter from H. B. Tuttle, who has always, with great promptness and care, answered my various inquiries. To Major Fayette Brown,

Cleveland, the survey is indebted for a most valuable paper on the amount of air required by charcoal furnaces and the mode of applying it, based on his experience with the Jackson Co's furnaces at Fayette, the almost unparalleled success of which gives his statements great value. S. L. Smith, on the part of the Marquette, Houghton & Ontonagon railroad, placed all the results of that company's explorations, made under my direction, at the disposal of the survey. J. J. Hagerman, Milwaukee, furnished a statement regarding the working of Lake Superior and Iron Ridge, Wisconsin, ores with anthracite and coke, and the successful use of the metal in making rails. John L. Agnew has furnished drawings of the new charcoal furnace, superintended by him at Escanaba, 50 feet high and 12 feet bosh, the largest, so far as I know, in the world. M. R. Hunt, Depere, Wis., has given full details of a remarkable long and successful blast of the First National Iron Co.'s furnaces.

The Historical chapter has been made far more complete and reliable than would otherwise have been possible through the contribution of facts and documents by Messrs. William and John Burt, Messrs. Everett, White, Harlow, Hewitt, and Ely, .of Marquette ; also by Messrs. Jacob Houghton and Charles T. Harvey. This chapter was rewritten by Charles D. Lawton.

I am indebted to so many persons for the facts embodied in the chapter on Mining, that I can only mention W. E. Dickinson, J. C. Morse, William Sedgwick, A. Kidder, Peter Pascoe, George and Eugene St. Clair, and D. H. Merritt, of Marquette county, and Prof. R. Akerman, of Stockholm, Sweden.

C. H. V. Cavis, S. H. Selden, and George P. Cummings, civil engineers, have greatly aided in the work by their personal efforts in procuring information which is embodied in the maps. The valuable explorations of C. E. and Frank Brotherton, and of A. M. Brotherton, deceased, made for the C. & N. W. and M. H. & O. roads, has been to a large extent placed at my disposal by the officers of these companies.

The nature of the valuable scientific aid given to this work by Alexis A. Julien, Prof. R. Pumpelly, Dr. T. S. Hunt, Prof. George J. Brush, Dr. H. Credner, and Charles E. Wright, are explained in the text of chapters III., V., VI., and in Appendices A, B, and C, Vol. II.

Edwin Harrison, of St. Louis, has given me full and detailed statements regarding the working of his Irondale furnace, which has one of the best records ever made by a charcoal furnace. Robert Wood has prepared most of the manuscript for the press, and, with Mr. Bien, will take care of the publication and indexing.

The survey is indebted to the University of Michigan, Ann Arbor, for the use of rooms without charge, and for the same courtesy (most cordially extended) to the School of Mines, Columbia College, New York, on which institution the survey had no claim.

The Marquette, Houghton & Ontonagon, Chicago & Northwestern, Michigan Central, the Great Western, and Grand Trunk railways have in every instance, when requested, granted passes to persons connected with the survey.

To the gentlemen and companies above named, as well as to Messrs. J. N. Armstrong, American Iron & Steel Association, S. C. Baldwin, William H. Barnum, J. B. Britton, C. M. Boss, J. R. Case, Mr. Childs, Girard Iron Company, C. H. Hall, A. Heberlein, Alexander L. Holley, E. C. Hungerford, Prof. Hayden, Gilbert D, Johnson, F. B. Jenny, Prof. J. P. Leslie, J. S. Lane, A. W. Maitland, David Morgan, Capt. H. Merry, F. W. Noble, Charles H. Pease, New York Mine, J. R. Orthey, Freiburg Royal School of Mines, James M. Safford, Samuel Thomas, J. M. Wilkinson, H. N. Walker, Walter Williams, Capt. R. D. Weston (deceased), Washington Mine, Dr. White, and Charles R. Westbrook, who have in various ways promoted my work, I am under great obligations. Without their aid this report could not have been prepared. I have forwarded to the Board of Survey a full list of their names and addresses, with the request to furnish each with a copy of this Report and accompanying Atlas.

# CHAPTER I.
# HISTORICAL SKETCH OF DISCOVERY AND DEVELOPMENT.*

NOTE.—Statistical Tables XII. and XIII. of Atlas contain many facts relevant to this subject, which could not well be incorporated in the text.

MINERAL explorations along the south shore of Lake Superior began at a very early period, and the existence of copper was made known to the world as long ago as 1636, by La Garde, in a book published in Paris. During the subsequent portion of the 17th century frequent mention is made in the "Relations" of the Jesuit Fathers of the finding of this metal.

These Relations† extend from 1632 to 1672, and are made up of the reports or simple narratives of these humble but zealous missionaries, scattered as they were all over the region of the great Lakes, then controlled by the French Government, and are necessarily of inestimable value to the historian and archaeologist; and also contain much that is highly interesting to the geologist, as indicating the early discoveries of minerals and the knowledge of their localities and uses, possessed by the natives. In illustration of the allusions to copper found in these reports, we quote simply from one, Claude Allouez, who seems to have been a man of intelligence, as well as one of the most persevering and deserving of these early missionaries. He first visited Lake Superior in 1666, and makes mention of a large mass of copper to be seen near the shore of the lake, with its top rising above the water, giving an opportunity for those who passed that way to cut pieces from it. The writer says, this "rock" has disappeared, having become buried, as he opines, beneath the sands, through the action of the waves. He also states that pieces of

copper weighing from 10 to 20 lbs. are frequently found among the savages, who esteem them as domestic gods, and hold them in superstitious awe, preserving them, in some instances, time out of mind, among their most precious articles.

*C. D. Lawton, Esq., rendered much assistance in the preparation of this chapter.

†These valuable documents have been republished by the Canadian Government.

In 1672, a map was published in Paris of this region, which was made by these early Jesuits, and on which is represented 1,600 miles of coast and many islands, with what may be considered remarkable accuracy.*

In 1689, Baron La Houtan, in a book relating to travels in Canada, mentions that "upon Lake Superior we find copper mines, the metal of which is fine and plentiful; there being not a seventh part base from the ore."

In 1721, P. De Charlevoix described the native copper deposits, and the superstitions which the Indians had in regard to them, in considerable detail. The occurrence of native copper being so frequent, the wonder of the early voyageurs was naturally excited, being increased also by vague rumors (gathered from the savages) of the existence of gold, silver, and diamonds.

In 1765, Captain Jonathan Carver visited Lake Superior, and in his account dwelt so largely on the abundance of native copper, that a copper company was formed in England in 1771, which actually began mining operations on the Ontonagon river, under the direction of Mr. Alexander Henry, who seems to have been a better historian than miner; for he gives a detailed account of the winding-up of his operations in 1772 and concludes, as the result of his unsuccessful experiment in mining, that the country must be cultivated and peopled before the copper can be profitably mined.

In 189, Mr. H. R. Schoolcraft accompanied as mineralogist and geologist a government exploring expedition along the south shore of Lake Superior, having for its object the investigation of the copper mines.

In 1823 another government expedition, under charge of Major Long, passed along the north shore of the Lake, having come from the northwest; and mention is made of their having observed copper boulders in the region of the headwaters of the Mississippi. Steps had been taken with a view to an exploration of this region during the Presidency of John Adams, but nothing was ever effected. The work of systematic, scientific exploration of the Upper Peninsula of Michigan was first undertaken by Dr. Douglas Houghton, the earliest State Geologist. Dr. Houghton had commenced his examination of this region in 1831, and in his first annual report to the Legislature in 1841 presented the results of his labors up to that period in so able a manner, that the attention of the world became directed to the Northern Peninsula with greatly increased interest. In 1840, Dr. Houghton wrote to the Hon. A. S. Porter, under date December 26th, regarding the mineral wealth of the south shore of Lake Superior: "Ores of zinc, iron and manganese occur in the vicinity of the shore, but I doubt whether either of these, unless it be zinc and iron is in sufficient abundance to prove of much importance. Ores of copper are much more abundant than either of those before mentioned, and a sufficient examination of them has been made to satisfy me that they may be made to yield an abundant supply of the metal."

*A fac-simile of this map, and much other interesting matter relating to the early history of the copper region, may be found in Foster and Whitney's Report, Exec. Doc., 1850, Part I.

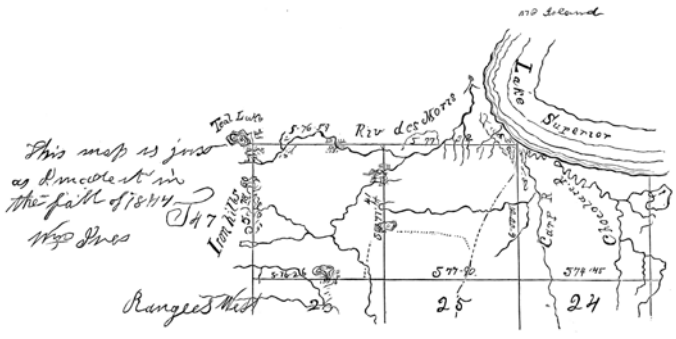
In his Geological Report of 1841 Dr. Houghton says: "Although hematite ore is abundantly disseminated through all the rocks of the metamorphic group, it does not appear in sufficient quantity at any one point that has been examined to be of practical importance." At this date Dr. Houghton had traversed the south shore of Lake Superior five times, in a small-boat or canoe, on geological investigations. It is therefore probable that up to 1841 no Indian traditions worthy of credence, in regard to large deposits of iron ore, had come to his knowledge. As there are, so far as known, no considerable outcrops of iron ore, which come nearer than seven miles to the shore of the Lake, it is plain that investigations, based on observations taken along the shore only, could have determined no more than its probable existence, which is plainly indicated in the extracts given. Dr. Houghton was not aware of the existence of iron ore in quantity, until the return of Mr. Burt's party of surveyors to Detroit in the fall of 1844, his examinations in the interior of the country having been confined to the Copper Region. Attention at that early period was entirely directed to searching for ores of more value than iron, and it is worthy of remark, that the Jackson and Cleveland Iron Companies, which were the first two organized, were formed to mine copper, silver, and gold.

The remarkably rapid development of the mineral resources of the Upper Peninsula is largely due, among other causes, to the fact that the United States Linear Surveyors were required to combine geological and topographical observations with their surveys. The use of Burt's solar compass, which permits of rapid and precise observations of local variations (so important in the economic survey of a primitive iron region), served greatly to enhance the value of the results, by making known the position of rocks containing magnetic ore.

The honesty, skill and enthusiasm with which the field-work was executed resulted in the collection of a large amount of geological data, which at the completion of the survey would have left little to be done save the final report, in which the master-mind should classify, group, and harmonize the facts, and thereby develop nature's law from the mass of material collected. Dr. Houghton's untimely death by drowning in Lake Superior, while in the midst of his labors, prevented him from performing the crowning work. Any one familiar with the geology of the Upper Peninsula, who will peruse the manuscript

notes* left by Dr. Houghton, will be convinced that his views regarding the geology of the older rocks were far in advance of his time, and such only as geologists years afterward arrived at, and those which are but now, thirty years after he recorded them, universally accepted (see Appendix E, Vol. II.). A brief statement of the origin of a work from which such important results have accrued will be given. In 1843 the financial troubles of the State of Michigan arising out of the "Five Million Loan," as it was called, were of such a character as to cause the Legislature to withhold the annual appropriation for the Geological Survey, which then had been for several years in successful operation under the direction of Dr. Houghton. Thoroughly interested in his scientific work, and believing that the best interests of the State and the cause of science demanded the continuance of the survey, Dr. Houghton asked from the General Government the aid which his own State felt unable to grant, and succeeded in obtaining, in the appropriation for the Public Surveys of the Upper Peninsula of Michigan, an additional allowance per mile to cover the cost of the geological work. In order to expedite the work and insure the best scientific results from the adoption of his plan, Dr. Houghton himself took the contract from the Government for completing the surveys on the Upper Peninsula, which had been previously begun in 1840 under the direction of the Hon. William A. Burt, United States Deputy Surveyor. In the spring of 1844 Dr. Houghton commenced operations under his contract, the field-work being in charge of Mr. Burt, who received in compensation therefor the allowance granted by the Government. It is proper to add that Mr. Burt entered with deep interest into Dr. Houghton's plans and had, during his survey in the Lower Peninsula, collected for him many specimens and important geological information not required by his instructions.

*These manuscript notes are now in the University Library at Ann Arbor, having been presented to that Institution by Dr. Houghton's widow. Dr. Houghton, it will be remembered, was at the time of his death a Professor in the University of Michigan as well as State Geologist.




[I. Ives' map showing Iron Hills, 1844]

In 1844 Mr. Burt, with a party consisting of William Ives, compassman, Jacob Houghton, barometer man, H. Mellen, R. S. Mellen, James King, and two Indians named John Taylor and Bonney* was engaged in establishing Township lines and making geological observations, as previously described.

On the 19th September, while running the east line of Town. 47 north, Range 27 west (the great iron Township), they observed by means of the solar compass remarkable variations in the direction of the needle, amounting to 87° from the normal. (See Appendix D, Vol. II.) Ascribing this phenomenon to iron ore, they sought for and found it in the ledges or outcrops at several points. Specimens† were collected and named by Mr. Burt and Dr. Houghton (See Appendix D, Vol. II.), and were described by them in their official returns; the fact of the great variation and large amount of ore being also especially commented upon. (See Appendix and official notes in Land Office, Washington, Lansing and Marquette.) A map made by Mr. Ives at the time, a fac-simile of which is given in PL I., has written along this line the words "Iron Hills." As the Jackson range is not magnetic at this locality, and does not outcrop on the line in question, it is not probable it was seen, but instead one or more of the ranges of flag or soft hematite ore further south. In the month of June following, Dr. Houghton and Mr. Burt, with their party, were engaged in subdividing the Township above mentioned (Town. 47 north, Range 26 west), when the former made a personal examination in reference to iron ore, especially at the corners of Sections 29, 30, 31, 32 (see Appendix D, Vol. II.), now known as the Cascade mines, and remarked to Jacob Houghton and others, who were members of the party, that it would some day be very valuable and the basis of an active industry.

It thus appears that the U.S. surveyors, in the fall of 1844, officially established the fact, that iron ore in considerable quantities existed in the Upper Peninsula of Michigan. It is also undoubtedly true, that Indians had previously observed the ore and were acquainted with locations of it, without, however, being able to identify it.

*Bonney's real name was Michael Doner; himself and Taylor are now dead.

†Mr. R. S. Mellen has still in his possession a piece of the ore found that day, which he brought away with him.

**The Jackson Co.**—The manner in which this, the earliest developed, and one of the most important of the iron properties on Lake Superior, was discovered (although the enterprise was not mainly undertaken with a view of finding iron), is reliably set forth in the following letter, written by P. M. Everett, now of Marquette, to Captain G. D. Johnson, now of the Lake Superior mine. The letter is dated at Jackson, Mich., Nov. loth, 1845, and is as follows:—

"I left here on the 23d of July last and was gone until the 24th of October. . . . . I had considerable difficulty in getting any one to join me in the enterprise, but I at last succeeded in forming a company of thirteen. I was appointed treasurer and agent to explore and make locations, for which last purpose we had secured seven permits from the Secretary of War. I took four men with me from Jackson and hired a guide at the Sault, where I bought a boat and coasted up the lake to Copper Harbor, which is over 300 miles from Sault Ste. Marie. . . . . We made several locations, one of which we called

iron at the time. It is a mountain of solid iron ore, 150 feet high. The ore looks as bright as a bar of iron just broken. Since coming home we have had some of it smelted, and find that it produces iron and something resembling gold—some say it is gold and copper. Our location is one mile square, and we shall send a company of men up in the Spring to begin operations; our company is called the 'Jackson Mining Co.'"

The actual discovery of the Jackson location was made by S. T. Carr and E. S. Rockwell, members of Everett's party, who were guided to the locality by an Indian chief, named Manjekijik.*

The superstition of the savage not allowing him to approach the spot, Mr. Carr continued the search alone, resulting in the discovery of the outcrop, which he describes as indicated in Mr. Everett's letter. Previous to the discovery he was led to suppose from the Indians' description, that he would find silver, lead, copper or some other metal more precious than iron, as it was represented and found to be "bright and shiny."

July 23d, 1845, articles of association of the Jackson Iron Company were executed at Jackson, Mich., and by these articles Abram V. Berry was appointed the first *President*, Frederick W. Kirtland, *Secretary*, Philo M. Everett, *Treasurer*, and George W. Carr and William A. Ernst, *Trustees*.

Mr. Berry gives the following account of the early history of his company, in a letter dated at Jackson, Mich., Oct. 21st, 1870:—

"In the summer of 1845, an association was formed in this city, then a village, for the purpose of exploring the mineral region on the south shore of Lake Superior. The company consisted of P. M. Everett, James Ganson, S. T. Carr, G. W. Carr, F. W. Carr, E. W. Rockwell, F. W. Kirtland, W. H. Munroe, A. W. Ernst, F. Farrand, of Jackson, and S. A. Hastings, of Detroit (John Watkins, of Detroit, was interested with Hastings). Eleven individuals of the association procured permits from the War Department to locate one square mile each of mineral land on the south shore of Lake Superior. John Western, of Jackson, was then added to the company, making thirteen in all. In the fall of 1845 a company of explorers, consisting of S. T. Carr, P. M. Everett, W. H. Munroe, and E. S. Rockwell, visited Lake Superior, when what is now known as the Jackson location was secured by the permit granted to James Ganson, in the unsurveyed district, the section lines not having been run. The location was described by metes and bounds, commencing at a certain large pine-tree, the position of which was fixed by its course and distance from the corner of Teal lake. When the land was surveyed it was bought at $2.50 per acre. * * *

*In reward for the service of the Indian on this occasion, the officers of the Jackson Company subsequently gave him a written stipulation, of which the following is a copy:—

"RIVER DU MORT, LAKE SUPERIOR,
*May* 30, 1846.

This may certify that, in consideration of the services rendered by Manjekijik, a Chippeway Indian, in hunting ores of Location No. 593 of the Jackson Mining Company, that he is entitled to twelve undivided twenty one-hundredths part of the interest of said mining company in said location No. 593.

A. V. BERRY, *Superintendent*.
F. W. KIRTLAND, *Secratary*."

This agreement on the part of the company was never fulfilled, and Manjekijik finally died in poverty; his relatives, now living in Marquette, are in the same miserable condition, without ever having received, as is averred by those who are cognizant of the facts, any compensation for the services mentioned.

"In the spring of 1846, another expedition was fitted out, consisting of F. W. Kirtland, E. S. Rockwell, W. H. Munroe and myself, members of the company and several other adventurers; the object being to make further examinations of the iron and to use the remaining permits, by entering other mineral land. * * * * * I found our location much beyond what I had anticipated. After spending twelve days in the woods, exploring the surrounding country, including what was afterwards known as the Cleveland location and building what we called a house, we returned to the mouth of the Carp with 300 pounds of ore on our backs. We then divided; one party was left to keep possession of the location, another went farther up the Lake to use the remaining permits, while I returned to the Sault with the ore. It was my intention at this time to use another permit on the Cleveland location, but on arriving at the Sault I met Dr. Cassels, of Cleveland, agent of a Cleveland company, and having arranged with him that his company should pay a portion of the expense of keeping possession, making roads, etc., I discovered to him the whereabouts of the Cleveland location. He took my canoe, visited the location, and secured it by a permit. On arriving at Jackson we endeavored on two occasions to smelt the ore which I had brought down, in our common cupola furnaces, but failed entirely. In August of the same year, Mr. Olds, of Cucush Prairie, who owned a forge (in which he was making iron from bog ore), then undergoing repairs, succeeded in making a fine bar of iron from our ore in a blacksmith's fire, the first iron ever made from Lake Superior ore. In the winter of 1846-47 we began to get up at Jackson a bellows and other machinery for constructing a forge on the "Carp;" and in the summer of 1847 a company of men commenced building the same, and continued until March, 1848, when a freshet carried away the dam. * * "—The association was then (1848) merged into an incorporated company, and by some means the pioneers in the enterprise are now all out."

In a book* on the mineral region of Lake Superior, with map by Jacob Houghton, Jr. and T. W. Bristol, published in 1846, only one iron company is mentioned—The Jackson. The description of the company's property is as follows :

Permit No. 593—somewhere in T. 46, N.-R. 27 or 28 W., while on Section 1 of T. 47, R. 27, Permit No. 158 is marked, which was granted to D. Hamilton, of Watervliet, New York. Section 3, same Township, embracing the

New York mine, is covered by Permit No. 160, granted to T. Williams, of Newburg, N. Y. Section 10, same Township, embracing parts of the Cleveland and Lake Superior mines, was covered by Permit No. 177, granted to T. Ricket, of Copper Harbor.

In 1846 Fairchild Farrand explored the Jackson location and mined some ore. The company, under the superintendency of Wm. McNair, began, in 1847, the construction of a forge on the Carp river, three miles east of the mine, the first iron being made Feb. 10th, 1848, by forgeman, now Judge, A. N. Barney. Work was stopped in a few days by a freshet which carried away the dam. Mr. Everett came up in the summer of 1848, had the dam repaired and resumed the manufacture of blooms. The first iron made was sold to E. B. Ward, who employed it in the construction of the steamboat "Ocean." This forge was afterwards carried on under leases by B. F. Eaton, and later by the Clinton Iron Co., subsequently by Peter White and lastly by J. P. Pendill; it made but little iron and no money. The quality varied from the highest (as shown by the experiments of Major Wade, of the U. S. army) to indifferent, the trouble being a lack of uniformity in the blooms. The power was supplied by the Carp river, a dam 18 feet high having been constructed across the stream for this purpose. There were upon either side of the stone arch, and arranged opposite each other, four fires, from each of which a lump was taken every six hours, which was placed under the hammer and forged into blooms four inches square and two feet in length; the daily product being about three tons, requiring two teams of six horses each to convey them over the intervening ten miles of horrible road to Marquette. These teams, when so fortunate as not to break down, on returning brought back supplies for the men and animals. The same difficulties attended the procuring of the supply of ore and charcoal. The power was also found to be insufficient, owing to a scant supply of water occurring at certain seasons of the year. These difficulties were too numerous and serious for the maintenance of the existence of the concern, and resulted in its abandonment in 1856.

*This little volume, (afterwards revised by Mr. Houghton,) thus early issued, contains much interesting and valuable matter relating to the early discoveries and mining operations of Lake Superior, especially regarding the copper region.

On the 6th of June, 1848, a meeting was called to act on the question of the acceptance of an act of incorporation passed at the preceding session of the Legislature, and it was decided to incorporate the company under the act referred to. The organization was completed under the title of the Jackson Mining Co., of Jackson, Michigan—Fairchild Farrand, *President*, W. A. Ernst, *Secretary*, George Foot, *Treasurer*, F. W. Carr, F. W. Kirtland, Lewis Bascom, and John Western, *Directors*. The capital stock of the company, as also that of the New England Mining Co., organized at this time, was fixed at $300,000, in shares of $100 each; the purpose of each being the mining of copper as well as iron. April 2d, 1849, an amendment to the charter of the Jackson Mining Co., of Jackson, was obtained, when the title was changed to its present form—**Jackson Iron Co.** The first officers under this organization were Ezra Jones, *President*, Wm. A. Ernst, *Secretary*, John Watson, *Treasurer*, S. H. Kimball, James A. Dyer, and James Day, *Directors*.

In 1850, Mr. A. L. Crawford, proprietor of the iron works at Newcastle, Pa., took with him from Lake Superior about five tons of the Jackson ore, and there worked it up. Part of the ore having been made into blooms and rolled into bar-iron, was used for special purposes, and part used for lining in the puddling furnaces. The iron was found to be excellent. About the same time, General Curtis, of Sharon, Pa., proprietor of extensive iron-works at that place, came to Lake Superior to inspect the Jackson and Cleveland locations; his object being to secure an interest, with a view to a future supply of ore for his works, of a better quality than he then possessed. Failing to make an arrangement for the Cleveland, he bought up sufficient stock in the Jackson Co. to give him a controlling interest in the management of its affairs; so that for some years the location was known as "Sharon."

It is proper to remark that General Curtis believed, as did also John Western before him, that, as soon as practicable, the best policy for Lake Superior iron mines to follow would be to sell their ore to the furnaces of Ohio, Pennsylvania, and elsewhere; and in 1852 about 70 tons of the company's ore were taken to Sharon, Pa., and there made into pig-iron in the "old Clay Furnace." There were frequent changes of officers and directors in the Jackson Co. up to 1860, and the history of the company was one of disappointment and financial embarrassment. Between 1860 and 1862 the gentlemen who now compose the Board of Directors came into office, and in 1862 the first dividend was made. The great demand for iron occasioned by the war caused the iron interests of Lake Superior, for the first time, to assume a very successful aspect. The first regular shipments of ore from the Jackson mine were made in 1856, which amounted to about 5,000 tons. Up to this time the different forges in the district had consumed about 25,000 tons of ore. (See Table, PL XII. of Atlas.) The Jackson mine, earliest discovered, and first opened and tested, became widely known from the outset, and has ever continued to remain the leading mine in the district. The important village of Negaunee, within whose corporate limits the Jackson mine is situated, dates its origin with the commencement of the company's operations. As the Chicago and Northwestern and the Marquette, Houghton and Ontonagon railroads form a junction in Negaunee, facilities are thus afforded for shipments over either road—that is, by the way of Escanaba or Marquette. The "openings," or pits, are irregular and numerous, and extend from the west edge of the village of Negaunee-west for three-quarters of a mile. The greater portion of the product finds its outlet through a tunnel, which enters the mines from the north side of the hill and is of sufficient size to admit railroad cars and small

locomotive engines. From the main tunnel radiate several branches, which extend to, or are being extended to, the different stopes and shafts. The main shafts are supplied with ample steam-power for pumping and hoisting purposes. For details of workings, geological structure, etc., see accompanying maps, tables, and text.

**The New England Mining Co.** was, like the Jackson, *incorporated* by a special act of the Michigan Legislature passed in 1848. The purpose for which the organization was effected is stated as being the mining and smelting and manufacturing of ores and minerals in the State of Michigan, the language stating the company's objects being identical with that of the Jackson Company; the capital stock was placed at 300,000. It does not appear that anything noticeable was accomplished by this company, thus early organized. The charter came in 1855 into the possession of Capt. E. B, Ward, by whom it is now held.

**The Marquette Iron Co.**—In the summer of 1848, Mr. Edward Clark, of Worcester, Mass., was sent to Lake Superior by Boston parties, to look for copper, but at the Sault he fell in with Robert J. Graveraet, who induced him to stop at the Carp river and see the iron mines. The Jackson Company's forge was at work and had made a little iron. Clark, on his return to Worcester, carried with him abloom and some ore from the Jackson Iron mountain, which, on being drawn into wire at a factory, proved excellent. Clark at once proceeded to form an association for the purpose of building a forge on the far-offshore of Lake Superior, assisted by Graveraet, who also appeared in Worcester at this time (having travelled from Marquette to Saginaw on snow-shoes); he succeeded in organizing a company, March 4th, 1849, consisting of E. B. Clark, W. A. Fisher, A. R. Harlow, of Worcester, Mass., and R. J. Graveraet, of Mackinaw; Clark and Graveraet putting in against the capital of the others leases of iron lands of which they claimed to have possession. These iron lands constitute what subsequently became known as the Lake Superior and Cleveland mines, and over which a long controversy arose as to which party should possess the land, and which was finally decided by the Interior Department at Washington in favor of what was known as the Cleveland Company. Mr. Harlow constructed and purchased the necessary machinery to the value of $8,000, and in the spring of 1849 shipped it to Marquette, starting himself with his family on the 11th of June, and arriving in Marquette on the 6th of July thereafter. Graveraet had reached there on the 17th of May previous, taking with him a small party of men, among whom was Peter White, then a lad, but subsequently largely identified with numerous interests in the Iron Region, and now President of the First National Bank of Marquette. The forge was completed, making the first bloom in just one year from the date of Mr. Harlow's arrival.

The Marquette Iron Co.'s works started with 10 fires, and used Cleveland and Lake Superior ores, mostly the former, making blooms exclusively, which were sold in Pittsburg at prices ranging from $35 to $50. The works were in operation somewhat irregularly until 1853, when the Marquette Company was merged into the Cleveland Company, under the auspices of which the forge continued in operation for a few months longer, and was finally destroyed by fire in 1854. Like all bloomeries started in Marquette County, it was from the first, financially, a failure. The cost of the plant was great, transportation difficult and expensive, and the price of iron during the entire period disproportionately low. There was no dock at Marquette, no canal at the Sault, scarcely a road in the country, no shop for repairs, no skilled labor but what was, together with all supplies, imported "from below," and no regular communication. During the summer of 1849 only three sailing vessels and five propellers arrived at Marquette. The stock of the Marquette Company was bought up by the Cleveland Company, and its property passed to the ownership of the latter.

In 1852 John Downey, Samuel Barney and others began the construction of a forge on the "Little Carp," but after having built some houses, constructed a wheel, etc., permanently abandoned the enterprise.

In 1849 and 1850 a *whetstone quarry* was opened in a bed of novaculite, near the outlet of Teal lake, and Messrs. Smith and Pratt established a factory, for the purpose of sawing these blocks, at the mouth of a small stream near the Marquette landing, and carried on a "thrifty business."

**The Iron Mountain Railroad.**—The question of transporting the rich ores of Marquette county to the coal of Ohio and Pennsylvania, being one that came to be seriously considered, it naturally suggested the necessity of *a railroad* from the mines (those near the present villages of Negaunee and Ishpeming) to Marquette bay. In 1851 Messrs. Heman B. Ely and John Burt strongly advocated the enterprise, and in the following year Mr. Ely caused a survey to be made; at that period the entire population of Marquette county was less than 150 persons. There being no general railroad law In the State at that time, the construction of the railroad was undertaken by Mr. Ely, assisted by his brothers George H. and Samuel P. Ely, of Rochester, New York, as an individual enterprise, he having previously made a contract with the Jackson and Cleveland Iron Mining Companies and Mr. John Burt, as the representative of other companies, for the transportation of their ores. This contract the two first-named iron companies subsequently attempted to break, and sought to defeat the railroad by constructing a plank-road in opposition to it, thus instituting a serious and embarrassing controversy, which continued until 1855, when all matter of dispute then pending between the Railroad Company, under charge of Mr. Ely, and the Plank-road Company, under charge of Mr. S. H. Kimball, were submitted to arbitration and settled to the satisfaction of both parties— Messrs. C. T. Harvey and Austin Burt being arbitrators. Immediately after the

passage of the General Railroad Law of this State in 1855, the Messrs. Ely incorporated the railroad under the title of the Iron Mountain Railroad, and John Burt was first President. A year later the company was strengthened by the addition of Jos. S. Fay, Edwin Parsons, Eewis H. Morgan, and other capitalists; and in 1857 the road was completed and put in operation. Mr. H. B. Ely, to whose foresight and energy the origin and success of the enterprise was largely due, and to whom the interests of Lake Superior became otherwise greatly indebted, died in Marquette, in 1856, before the work upon which he had labored so intently was completed.

The death of his brother, and his own connection with the road, was the occasion of bringing to Marquette Mr. S. P. Ely, who is now more largely identified with the business management of many of the leading enterprises in the Iron Region than any person resident on "Lake Superior." The Iron Mountain Railroad became subsequently a part of the Bay de Noquette and Marquette Railroad, this becoming afterwards, by consolidation, the Marquette and Ontonagon Road, and still later, by further consolidation, a part of the through line of the Marquette, Houghton, and Ontonagon Railroad. The plank-road to which reference is here made was built by the Jackson and Cleveland Companies jointly, but was never used as a plank-road; longitudinal sleepers were laid down and covered with strap-rail, on which horse cars were run. The road was used for two seasons, and cost $120,000, which amount was practically sunk. The cost of transportation was nominally one dollar per ton; each team would make the round trip in a day, bringing four tons of ore. It is proper to add that the rates of transportation fixed by these H. B. Ely contracts, although afterward deemed by the iron companies much too liberal, were lower than any at which ore has ever been carried over the road; the present rates being more than double those agreed upon with Mr. Ely.

Among the most important enterprises early connected with the development of the Lake Superior iron interests was the construction of the **Sault Ste. Marie Ship Canal.** In the St. Mary's river or strait, connecting the waters of Lakes Superior and Huron, occurs, nearly opposite the village of Sault Ste. Marie, a rapid of about one mile in length, and about seventeen feet fall, forming a complete barrier to the communication between the lakes. Some years previous to the construction of the canal this barrier had been overcome partially, by the construction and use of a portage flat-bar railroad, over which all articles of commerce between the lower lakes and Lake Superior were transported and reshipped in both directions. The important and growing interests of Lake Superior demanded more easy and effective means of commercial communication with the lower lakes. The matter being brought before the National Legislature, Congress granted to the State of Michigan, by Act approved Aug. 26th, 1852, 750,000 acres of land for the purpose of aiding in the construction and completion of a ship canal around the falls of Ste. Marie. On the 5th of February following, the State of Michigan, by an Act of its Legislature, accepted the grant of land above mentioned ; and to further the objects thereof, authorized the Governor of the State to appoint Commissioners to let the contract for the construction of the canal, and to enter the lands authorized under the grant.

The Commissioners appointed under this legislative act entered into contract with Joseph P. Fairbanks, Erastus Corning and others for building the canal within two years from date thereof; the consideration being the U. S. Government grant of lands. This contract was soon after duly assigned to the Ste. Marie's Falls Ship Canal Co., which company had been organized in the city of New York on the l4th of May, 1853, under an Act of the Legislature of the State of New York, passed April 12th, immediately preceding. At the organization of the company, the following persons were chosen officers and directors of the company: Erastus Corning, *President*, J. W. Brooks, *Vice-President*, J. V. L. Pruyn, *Treasurer* and *Secretary*. *Directors:* Erastus Corning, J. W. Brooks, J. V. L. Pruyn, Jos. P. Fairbanks, John M. Forbes, John F. Seymour, and James F. Joy.

Subsequent to the passage of the grant by Congress, but previous to the acceptance thereof by the State of Michigan, Mr. Charles T. Harvey was authorized by Messrs. Fairbanks and Corning to cause a survey to be made, which he proceeded to do during the month of November, 1852, having secured the services of an experienced engineer from the Erie Canal, Mr. L. L. N. Davis. After the organization of the company, Mr. Harvey was appointed its general agent, and the supervision of the construction placed under his control.

Early in the season of 1853 Mr. Harvey, with 400 men, proceeded to the Sault, and on the 4th of June broke ground for the canal. The remoteness of the locality, and many other unfavorable circumstances, rendered the construction of a work of such magnitude exceedingly difficult, and necessitated at every step of the operations unusual care and energy in the management as well as heavy pecuniary expenditures. Mr. Harvey remained in control of the construction for one year, when he was relieved and placed in charge of the finance, and also appointed agent for the State to select lands under the grant in the Upper Peninsula. Mr. Harvey selected about 200,000 acres of land, 39,000 of which were taken in Marquette county, and were subsequently sold for $500,000 cash, to the Iron Cliff Co. Among the copper land selected was the quarter section on which the Calumet and Hecla Company's mine is situated, and which was sold by the canal company for $60,000, now worth, on the basis of late sales of stock, $13,000,000. The 750,000 acres granted by the General Government were entered by the company as follows: on the Upper Peninsula, 262,283 acres of iron, copper, and timber land, and 487,717 acres of pine land in the Lower Peninsula. A land agency was established at Detroit for the purpose of locating the lands obtained through the grant.

During the summer of 1854 the difficulties necessarily attendant upon building the canal were very much enhanced by disease among the workmen; some 200 of whom died of the cholera, and among them was Mr. Ward, who had charge of the construction. Mr. Harvey was again placed in charge of the work, which, owing to the panic among the workmen, had become nearly suspended; but by the exercise of much skill and energy he succeeded in reorganizing the force, and pushing the work vigorously forward to final completion. On the 19th of April, 1855, the water was let into the canal, and in the following June the work was opened for public use, under the superintendency of Mr. John Burt.

The total cost of the construction of the canal, which includes also the expense attendant upon the selection of lands, as contained in the report of the company under date of January 1st, 1858, was $999,802.46.

The State of New York, by act passed April 15th, 1858, granted a charter incorporating the **"St. Mary's Canal Mineral Land Co."** Under this act of incorporation, a company was duly organized, and to it was transferred the canal company's lands of the Upper Peninsula. It was soon found that the canal failed to meet the growing wants of the commerce of Lake Superior, owing to the variation in the general level of the Lake Superior becoming somewhat lower than when the canal was completed, thus making a variable difference in the depth of the canal of from one to one and one-half feet; and also that the General Government, by successive appropriations, has caused the channels through Lake George and the St. Clair Flats to be so widened and deepened, that vessels of far heavier tonnage than was originally anticipated could be employed. The Michigan State Legislature adopted a resolution in the session of 1869, offering to cede the canal to the U. S. Government; although Congress has not as yet formally accepted the offer made by the State, nevertheless, under its system of internal improvement, the General Government is now engaged in the enlargement of the canal. The width of the canal is to be increased to 300 feet, and its depth to 16 feet, the locks are to be double, 80 feet in width and 450 feet long. The amount of the government appropriations under which this improvement is being effected is in the aggregate $800,000; and the work, when completed, will be fully adequate to the wants of commerce.

The report of superintendent Guy H. Carleton shows the following to be some of the principal exports and imports through the canal during 1871 and 1872:

| | 1871. | 1872. |
|---|---|---|
| Flour, bbls. | 25,146 | 42,141 |
| Pork, bbls. | 8,887 | 10,306 |
| Beef, bbls. | 3,054 | 4,161 |
| Bacon, lbs. | 163,763 | 242,475 |
| Lards, lbs. | 283,141 | 213,394 |
| Butter, lbs. | 519,545 | 559,137 |
| Cheese, lbs. | 187,340 | 200,994 |
| Tallow, lbs. | 104,354 | 106,170 |
| Soap, boxes. | 21,799 | 18,205 |
| Apples, bbls. | 18,359 | 20,025 |
| Sugar, lbs. | 4,062,087 | 5,454,559 |
| Tea, chests. | 3,864 | 7,980 |
| Coffee, bags | 5,228 | 7,815 |
| Salt, bbls. | 36,199 | 42,690 |
| Tobacco, lbs. | 258,179 | 321,836 |
| Nails, kegs. | 29,843 | 34,984 |
| Dried Fruit, lbs. | 115,366 | 73,230 |
| Vegetables, bush. | 27,619 | 35,263 |
| Lime, bbls. | 2,338 | 6,067 |
| Window Glass, boxes. | 25,226 | 7,492 |
| Cattle, head. | 2,639 | 3,608 |
| Horses and Mules. | 435 | 528 |
| Hogs, head. | 1,625 | 1,567 |
| Brick, M. | 1,225 | 9,067 |
| Furniture, pieces. | 13,616 | 44,768 |
| Machinery, tons. | 1,595 | 10,593 |
| Engines. | 18 | 28 |
| Boilers | 17 | 34 |
| Liquor, bbls. | 4,366 | 7,082 |
| Malt, lbs. | 653,140 | 1,545,875 |
| Coarse Grain, bush. | 283,503 | 444,875 |
| Mdse., tons. | 23,245 | 38,215 |

The following are some of the principal exports from Lake Superior for 1871-72:—

| | 1871. | 1872. |
|---|---|---|
| Mass Copper, tons | 1,091 | 1,709 |
| Ingot Copper, tons | 7,666 | 8,547 |
| Stamped Work Copper, tons | 5,705 | 4,365 |
| Iron Ore, tons | 327,461 | 383,105 |
| Pig Iron, tons | 23,304 | 29,341 |
| Fish, half bbls | 26,041 | 14,529 |
| Wheat, bush | 1,376,705 | 567,134 |
| Tallow, lbs | 59,225 | 64,567 |
| Flour, bbls | 179,093 | 94,270 |
| Barley, bush | 25,320 | 898 |

| | 1871. | 1872. |
|---|---|---|
| Silver Ore | 464 | 306 |
| Stone, building, tons | 5,528 | 5,213 |
| Potatoes, bush | ..... | 636 |
| Copper, manufactured, tons | ..... | 395 |
| Quartz, tons | ..... | 591 |
| Wool, tons | ..... | 30 |

In 1853 the **Lake Superior Iron Company**, one of the three oldest companies in the district, was formed; articles of association were filed March 13th, capital stock $300,000, in 12,000 shares of $25 each. The capital stock was subsequently increased to $500,000, which has all been returned to the stockholders in dividends. The incorporators were Heman B. Ely and Anson Gorton, of Marquette, Mich.; Samuel P. Ely, George H. Ely, and Alvah Strong, of Rochester, New York. The company commenced operations in 1857 on 120 acres of land in Sections 9 and 10, T. 47, R. 27, which was purchased of John Burt, being a part of the Briggs and Graveraet claim spoken of above under the Cleveland Company. Subsequent purchases enlarged the company's estate to 2,000 acres, its present dimensions. The company's principal openings are upon the land originally purchased. The first shipment of ore (4,658 tons) was made in 1858; since which the increase has been so great that its shipments now exceed those of any mine in the district, as will be seen by reference to the tables. This company have recently constructed, in Marquette, the Grace Furnace, which went into blast in December, 1872, using anthracite coal in the manufacture of pig-iron. The furnace is located on the shore of the bay, within the limits of the city, and is the first anthracite furnace built on Lake Superior. A map of the Lake Superior and Barnum mines accompanies this report.

**The Eureka Iron Company** was organized October 29th, 1853, with a capital stock of $500,000 in 20,000 shares. The corporators were Eber B. Ward, Harmon De Graffe, Silas M. Kendrick, M. Tracy Howe, P. Thurber, Elijah Wilson, Thomas W. Lockwood, and Francis Choate, with office in Detroit. The organization was effected with a view of mining ore and of manufacturing charcoal pig-iron from Lake Superior ores; preparations were made to build a furnace in Marquette county, but the location was finally changed and the furnace erected where now stands the flourishing city of Wyandotte, becoming the nucleus of the extensive iron works which have since grown up in that locality. The Eureka Company was also the first iron enterprise in which Captain E. B. Ward, subsequently so widely known as a successful iron master, became engaged. The company was formed by Philip Thurber, and a quarter section of land purchased near Marquette of Mr. A. R. Harlow, on which a few hundred tons of ore were mined; but it becoming evident that the ore did not exist in quantity, the work was abandoned. This land was subsequently sold back to Mr. Harlow for his shares of the company's stock, and is now known as Harlow's Mill.

**The Cleveland Iron Mining Company** filed articles of association March 29th, 1853; capital stock, $500,000, in 20,000 shares. The corporators were John Outhwaite, Morgan L. Hewitt, S. Chamberlain, Samuel L. Mather, Isaac E. Hewitt, Henry F. Brayton, and E. M. Clark, with office in Cleveland, Ohio. The early history of this celebrated mine, one of the oldest and most important in the district, is referred to in connection with that of the Jackson Co.

Dr. J. Lang Cassels, of Cleveland, to whom reference is made in Mr. Berry's letter, visited Lake Superior in 1846, and took, as he expresses it, "squatter's possession" of a square mile for the Dead River Silver and Copper Mining Co. of Cleveland; the property here spoken of includes the mines of the present Cleveland Co. The Jackson Co. had previously taken possession of their lands, and Dr. Cassels obtained guidance thereto from an Indian, there being no white men in the region; the doctor went up from and returned to the Sault in a bark canoe. During the succeeding year, Cassels having left the country, the location was taken possession of by Messrs. Samuel Moody, John Mann and Dr. Edward Rogers. The two former claiming what became the Cleveland mine, and the latter what is known as the Lake Superior. When the Marquette Forge Co. was organized in Worcester, as previously described, Clark had authority from Mann and Moody to lease their location, and Graveraet had similar power from Rogers.

In this manner leases of these lands were put into the organization against $20,000 cash capital, to be paid by Messrs. Harlow and Fisher. Both the Cleveland Co. and Graveraet, representing Messrs. Moody and Mann, claimed priority of right to the land under a "pre-emptor's mining act." These conflicting claims went before the Department at Washington, where a decision was rendered, which gave the right of purchase to the Cleveland Co. The entries which the Cleveland Co. made did not cover the Lake Superior location, Graveraet still claiming it, in behalf of the Marquette Co., on the ground of the Rogers pre-emption. Previously Isaiah Briggs had been on the land, but, leaving it, Rogers had taken possession. Rogers lost his interest, however, by not being present at the Government sale of lands in November, 1850, and establishing his claim, having been detained by a storm on the lake while endeavoring to proceed to the Sault (where the land

office was located) for that purpose. The location was purchased by John Burt, on the basis of the Briggs claim, he having agreed to lease an undivided one-half interest to Graveraet, who was also present in behalf of the Rogers claim. This lease to Graveraet was assigned by him to the Marquette Co., passed with the company's other assets into the possession of the Cleveland Co., and was finally sold for $30,000 to the Lake Superior Iron Co., that company having previously purchased the Briggs title.

The Cleveland association, although formed in 1849, did not do any business in Lake Superior until 1853; at that date the Cleveland and Marquette companies became finally merged by the former company purchasing (including 64 acres of land on which the forge was located) the assets of the latter, and the present Cleveland Iron Co. was formed. The Cleveland Co. continued to run the forge for about two years, until it was burned down. The company mined in 1854, 4,000 tons of ore, which was made into blooms at the different forges in the vicinity. In 1855 they shipped 1,449 tons of ore to the furnaces "below," thus preceding the Jackson Co. one year, and becoming the first to send out of the region any considerable amount of ore. The Jackson Co. had sent a few tons to the World's Fair in New York in 1853, and in 1852 some had been sent to Sharon, as before mentioned. The Cleveland Co. has also an ore dock at Marquette, entirely similar to the docks of the M. H. & O. R. R. Co., of which full descriptions and illustration are given.

On Nov. 8th, 1853, the **Collins Iron Co.** filed articles of association, with a capital stock of $500,000 in 20,000 shares. The corporators were Edward K. Collins, of New York, Solon Farnsworth, Edwin H. Thomson, Robert J. Graveraet, and Charles A. Trowbridge, with office in Detroit.

The company built a forge in 1854, and began to make blooms late in the fall of 1855; Robert J. Graveraet, Supt., and C. A. Trowbridge, Managing Director. E. K. Collins largely interested himself with a view of obtaining a superior quality of iron for the shafts of his ocean steamers. In 1858, about the time the Pioneer Furnace was completed, Mr. S. R. Gay, who had been engaged on that work, leased the Collins Forge and put up a cupola there in which he made some pig-iron. The company immediately thereafter constructed a blast-furnace under the direction of Mr. Gay. This furnace was completed and put in operation December 13th, 1858, with a single stack; all the necessary power being afforded by the Dead river, upon which the furnace is located.

On August 28th, 1854, **the Peninsula Iron Co.** filed articles of association, with a capital stock of $500,000 in 20,000 shares. The corporators were Wm. A. Burt, Austin Burt, Wells Burt, John Burt, Heman B. Ely, Samuel P. Ely, and Geo. H. Ely; the two latter of Rochester, N. Y., the others of Michigan. Office of the company, Marquette, Mich. The company originally owned 800 acres of iron lands, which it sold in 1862 to the Lake Superior Iron Co., and determined on building a blast-furnace at Hamtramck, Detroit, Mich., which furnace was completed in February, 1863, and is still in successful operation. The company also operated a sawmill for a few years, which they built on the Carp river, a short distance from Marquette.

Oct. nth, 1854, the articles of association of the **Chicago and Lake Superior Iron Mining and Manufacturing Co.** were filed. Capital stock, $500,000, in 20,000 shares. The corporators were B. S. Morris, Isaac Shelby, Jr., Geo. Staley, Henry Frink, and Samuel S. Baker, all of Chicago, Ill. ; and Solomon T. Carr and Fairchild Farrand, of Jackson, Mich. No permanent mining work was ever done by this company.

**The Clinton Iron Co.** Organized by forgemen from Clinton Co., New York, Jan. 20th, 1855. Capital stock, $25,000. *Corporators*, Azel Lathrop, Jr., H. Butler, Chas. Parish, and Daniel Brittol.

The object for which the organization was effected was to lease and operate the Jackson Forge. The company being composed of workmen, who at the time were employed in that concern and were locally styled the "Mudchunk." The market price of blooms being much below the cost of their manufacture, they were enabled to operate the forge but a brief period, and having become hopelessly involved in indebtedness, the company permanently suspended.

**The Forest Iron Co.** filed articles of association, September 22d, 1855, with a capital stock of $25,000 in 1,000 shares. The corporators were Matthew McConnell, Wm. G. Butler, Wm. G. Mc-Comber, M. L. Hewitt, and J. G. Butler. This company was organized for the purpose of putting up a bloom forge on Dead river, and the location became known as Forestville. McConnell, Butler and McComber commenced operations at this point as early as 1852 on their own private account, but becoming financially embarrassed, they sought relief by organizing a company as above indicated, who continued the manufacture of what was called half blooms, the production of which cost them from $180 to $200 a ton. These selling in Pittsburg for $35 to $40, on six months' time, it naturally resulted in the ruin of the company.

To the original projectors of the **Pioneer Iron Co.** belongs the credit of having established the first blast-furnace on Lake Superior; previous to that all the iron manufactured had been made in bloomeries. Mr. C. T. Harvey was the mover of the scheme, and the originator and manager of the company. He induced capitalists (chiefly in New York) to embark in the enterprise, Mr. E. C. Hungerford of Chester, Conn., being chosen Secretary and Resident Treasurer. Although the business was unknown to a single man on Lake Superior, the most sanguine views prevailed from the outset, and a two-stack furnace was constructed near the Jackson mine.

The late S. R. Gay and L. D. Harvey, now Superintendent of the Northern Furnace, were the

builders; the work being commenced June, 1857, and completed so as to make the first iron in February of the next year.

Much of the material, including two millions of brick, was brought from Detroit and had to be hauled 13 miles from Marquette by teams; the engines were made at the West Point Foundry. The original stock was $125,000, in 5,000 shares; the articles were filed July 2Oth, 1857, the corporators being Moses A. Hoppock, Wm. Pearsall and Chas. T. Harvey. Most of the parties interested in the concern were totally ignorant of iron-making and as an instance illustrating the fact, it is related that one of the directors, during the period of construction, inquired when the furnace would be completed so that it might be sent up to Lake Superior; he supposing it was being made in Detroit. These unfavorable circumstances, combined with the financial depression of 1857, at which time the company were obliged to sell their iron for $22, while the cost of its production was $24 per ton, gave no return save anxiety and disappointment.

In the spring of 1860, the furnace was leased for four years to Mr. I. B. B. Case, he agreeing to deliver the pig-iron on board the vessels at Marquette for $17.50 per ton, and paying all the expenses of its manufacture; the company furnishing the timber, standing, for the charcoal, and giving him the advantage of a contract with the Jackson Company for the ore, the royalty for which ($1.00 per ton of iron) he paid. This price proved to be less than the iron could be made for. The furnace was burnt down August 9th, 1864; number two stack was at once rebuilt and put in operation in January following, by Mr. Case.

In 1865, Dr. J. C. McKenzie, then President of the Pioneer Iron Company, entered into negotiations with the Iron Cliff Company, which subsequently resulted, largely through the instrumentality of Major T. B. Brooks, Vice-President of the latter company, in an arrangement (ratified by the stockholders of both companies, March 10th, 1866) by which the Iron Cliff Company came into possession of the furnace, on consideration that it pay to its former proprietors one-third of the profits of the business. Soon after the two companies became practically one, through the purchase of the stock of the Pioneer by the Iron Cliff Company.

**The Detroit Iron Mining Company** filed articles 15th August, 1857. Capital, $500,000, in 20,000 shares at $25 each, with office in Detroit. Corporators were Patrick Tregent, Guy Foot, Joseph P. Whittemore, John H. Harmon, John W. Strong, Oville B. Dibble, Nelson P. Stewart, Andrew T. McReynolds, Thornton T. Brodhead, Henry T. Stringham, Henry J. Buckley, Joseph L. Langley, of Detroit, and Edwin H. Thomson, of Flint. The company having ascertained, as they believed, that their lands did not contain sufficient ore for mining purposes, sold them to Mr. J. P. Pendill, and upon them is now built a portion of the village of Negaunee. The McComber mine, which lies at a short distance south of that village, is on this land.

**The Excelsior Iron Company** filed articles October 6th, 1857. Capital stock, $100,000; 4,000 shares, at $25 each. Corporators were: C. T. Harvey, Sarah V. E. Harvey, E. C. Hungerford, George P. Cummings, and Joseph Harvey, all of Marquette. This company did little but organize. It originated with Mr. C. T. Harvey, and some of the land which it owned has since proved to be valuable mining property, as it embraces the Barnum mine, now owned by the Iron Cliff Company; upon it is also situated a portion of the village of Ishpeming.

**The Lake Superior Foundry Company** filed articles of association July 14th, 1858. Capital stock (paid in), $10,000; 400 shares, at $25 each. *Corporators:* John Thorn, Isaac Maynard, Thomas Maynard, Nathan E. Platt, of Utica, N. Y., and Charles T. Harvey, of Marquette, Mich. This establishment, which was started in 1858, is now running on a much enlarged scale, under the name of the **Iron Bay Foundry**, D. H. Merritt, proprietor. The location is near the bay, within the city of Marquette.

**The Grand Island Iron Company** filed articles May 3d, 1859. Capital, $400,000; 16,000 shares, at $25 each; paid in, $110,000. *Corporators:* Thomas Sparks, Henry W. Andrews, William Lippincott, John L. Newbold, John D. Taylor, John R. Wilmer, Samuel Pleasants, William M. Baird, Samuel J, Christian, L. de la Cuesta, William A. Rhodes, Charles Lennig, James C. Fisher, Samuel T. Fisher, Lewis Seal, Coleman Fisher, Henry Maule, William Gaul, J. T. Linnard, Howard Spencer, Caleb Jones, Charles W. Carrigan, of Philadelphia, and Devere Burr, of Washington, D. C., with office in Philadelphia. The property belonging to this company, consisting of 3,000 acres of land, situated on Grand Island harbor, in Munising Township, was sold in 1867 to the Schoolcraft Iron Company, and their operations were confined to some minor improvements in the way of wharves, etc.

**The Northern Iron Company** filed articles May i6th, 1859. Capital stock, $125,000, in 5,000 shares of $25 each. *Corporators:* John C. Tucker, Moses A. Hoppock, of N. Y., and Charles T. Harvey, of Marquette, with office in Marquette. This company was formed through the efforts of C. T. Harvey, and constructed a blast-furnace at the mouth of the Chocolate river, 5 miles south of Marquette, with a view of making pig-iron with bituminous coal, being the first enterprise of this kind inaugurated in this region. After making about 1,000 tons of iron, the furnace was changed into and run as a charcoal furnace up to June, 1867; since which time it has not been working, and it is now being changed back into a bituminous coal furnace. This is the first charcoal furnace on the Upper Peninsula that has been permanently blown out.

1863.—The great financial prostration of 1857, combined with numerous causes which readily suggest themselves, naturally embarrassed and, in instances, extinguished the new and struggling enterprises of Lake Superior to the extent, that comparatively little was done in the manufacture of iron or the mining of ore up to the opening of 1863. During this interval of time no

companies of importance filed articles of association in this region. Very early in the war, however, the greatly increased demand for iron which it occasioned, began to be felt over the country and finally extended its influence to Lake Superior, causing the revival of the languishing enterprises already started and the organization of many new ones. The abundance of ore, together with its surpassing richness in iron and freedom from deleterious substances, the facility with which it could be mined and the greatly improved means of transportation, were becoming generally known, and the strength and exceeding tenacity of the iron manufactured therefrom universally acknowledged. Thus altogether there was opened to the Marquette region an outlook of prosperity, which it had not heretofore experienced, enabling its mining and iron manufacturing companies to assume a basis of more successful operation, and confidently to push forward their improvements.

The articles of association of the **Teal Lake Co.** were filed on the 7th of June, 1863, with a capital stock of $500,000, in 20,000 shares, and an amount paid in of $100,000. The corporators were George A. Fellows, John W. Wheelwright and Charles L. Wright, of New York, with office in New York. Beyond some explorations this company never did any work on Lake Superior, confining its operations chiefly to stock speculations, it being the only iron mining company organized in this region, whose stock was sold at the Brokers' Board in New York.

The articles of association of the **Morgan Iron Co.** were filed on the 1st of July, 1863, with a capital stock of $50,000, in 2,000 shares, and $26,000 paid in. Corporators were Joseph S. Fay, of Boston, Lewis H. Morgan, of New York, Harriet H. Ely, Samuel P. Ely, Ellen S. White and Cornelius Donkersley, of Marquette, with office in Marquette. The capital stock was subsequently increased to $250,000, in 10,000 shares fully paid. The company own 20,000 acres of timber land. In 1863 they constructed the Morgan Furnace, eight miles west of Marquette on the M. H. and O. R. R., and the location has since become known as "Morgan." The furnace was put up under the supervision of Mr. C. Donkersley and has been successful. It went into blast Nov. 27th, 1863, making that year 337 tons of iron, and was the first furnace company in the region to pay a dividend to its stockholders. The extreme high price of iron, created by the war, enabled the company to realize, during the first ten months of the operation of the furnace, a dividend of 100 per cent, over and above the total outlay in its construction. Having exhausted the fuel in the vicinity, the company constructed charcoal kilns upon their lands at a distance of nine miles north from the furnace, and provided for the transportation of the coal by building a wooden railway thereto. The kilns and railway were made in 1869, and most of the coal now used is prepared at these kilns.

In 1867 the Morgan Company built the **Champion Furnace,** which went into blast Dec. 4th of that year. This furnace is located at what is now Champion village, on the line of the M. H. and O. R. R., 31 miles west from Marquette. The ore used is mainly magnetic from the Champion mine, and the record of the furnace is one of gratifying success.

The articles of association of the **Marquette Iron Co.** were filed April 9th, 1864, with a capital of $500,000, in 20,000 shares of $25 each. *Corporators:* George Worthington, Truman P. Handy, Samuel L. Mather, N. B. Hurlbut, Richard C. Parsons, G. D. McMillen, John Outhwaite, of Cleveland, Ohio, and Charles I. Walker, of Detroit, Mich. This company was organized for the purpose of mining iron ore and owns 400 acres of land, lying contiguous to, and south of, the Cleveland mines, 240 acres of which was originally held by the latter company. Its stock is held by stockholders of the Cleveland Company. The year of its organization it shipped 3,922 tons of ore, and has been somewhat regularly in operation since that period.

**The Magnetic Iron Co.** was organized in 1864; the articles of the company were filed May the 6th of that year, with a capital stock of $500,000 in 20,000 shares. *Corporators:* John C. McKenzie, Alex. Campbell, of Marquette, and Edwin Parsons, of New York. Office in Marquette, but now in Philadelphia, Pa. The property owned by this company consists of 520 acres of land on Section 20, T. 47, R. 30. A shaft 60 feet in depth has been sunk, and other explorations made to test the ore-deposit and the company expect to take out ore, as soon as a branch road is built to the mine.

**The Chippewa** mining property comprises Section 22, T. 47, R, 30, W., owned by J. S. Waterman, of Philadelphia, and S. S. Burt, of Marquette; considerable exploring has been done on the property and some fair ore found, but no mining done. This property lies on the east side of Michigamme river and opposite the Magnetic and Cannon properties.

**The Phœnix Iron Co.** filed its articles of association June 7th, 1864. Capital, $500,000, in 20,000 shares, of which $20,000 was paid in. The Corporators were Wm. C. Duncan, Henry J. Buckley and Simon Mandlebaum, of Detroit, with office in Detroit. No mining or manufacturing was ever done in the Marquette Region by this company.

**Washington Iron Company** filed its articles of association July 30th, 1864. Capital stock, $500,000, in 20,000 shares, at $25 per share; amount paid in, $100,000. The Corporators were Edward Breitung, I. B. B. Case and Samuel P. Ely, of Marquette, Joseph S. Fay, of Boston, and Edwin Parsons, of New York.

This company made its first shipments of ore (4,782 tons) in 1865, and has since been in active operation. The land owned by the company comprises 1,000 acres in the northeast part of T. 47, R. 29, which was purchased of Silas C. Smith, J. J. St. Clair, J. C. McKenzie, and Alexander Campbell, who derived their title from the United States Government. The mine is on the M. H. and O. railroad, at a distance by rail from Marquette of 27 miles. All the company's surplus

earnings have been expended in making extensive improvements, of which an adit or tunnel, now over 1,100 feet long, constitutes the chief. Their plans and expenditures have been on an extensive scale, and contemplate operations for a long period to come. The details of the mine, shafts, adit and underground workings, together with the geological structure, are fully shown by the map of the Washington mine, accompanying this report.

**The Bancroft Iron Co.** filed its articles of association September 12th, 1864; capital stock being $250,000 in 10,000 shares, of which $100,000 was paid in. The Corporators were Wm. E. Dodge, of New York, Samuel L. Mather, John Outhwaite and Wm. L. Cutter, of Cleveland, Peter White and Samuel P. Ely, of Marquette, and Henry L. Fisher and L. S. McKnight, of Detroit, with office in Marquette.

The location of this company is the same as that of the Forest Iron Co., heretofore described; the property of the latter having been purchased by Mr. S. R. Gay, in 1860, he erected on the water-power employed by the old forge a blast-furnace, this being the second furnace he had built on Dead river, the one at Collinsville having been constructed by him the winter before.

Mr. Gay* having died in 1863, his furnace at Forestville passed to the ownership of the Bancroft Iron Co., who have since continued to operate it. The furnace is worked by Mr. L. Huillier on contract, the company paying him a certain price per ton for the iron delivered on the dock in Marquette.

*It is a fact worthy of note, in connection with the services rendered by Mr. Gay, that he was the first among the iron men who visited Lake Superior to recognize the value of the hematite ores; while engaged in the construction of the Pioneer Furnace, he observed that the Jackson Co. were wasting their soft hematite in large quantities, they supposing it to be worthless. He at once called their attention to its value.

The articles of **The Iron Cliff Co.** were filed September 15th, 1864, with a capital stock of $1,000,000, in 40,000 shares at $25 each. *Corporators:* William B. Ogden and John W. Foster, of Chicago, and Samuel J. Tilden, of New York. Office at Negaunee, Mich. This company in 1864 purchased of the St. Mary's Ship Canal and Mineral Land Co. the 38,000 acres of land which that company owned in Marquette county. Subsequently, as heretofore mentioned, the Iron Cliff Co. came into possession of the Pioneer Co.'s property, thus increasing its estate to over 40,000 acres. The company soon began the construction of a furnace near the Foster mine, which has never been completed. They own and are working the *Barnum* and the *Foster mines*, the latter of which was opened in the spring of 1865. The product is a soft hematite, which forms a good mixture with hard ores. This mine is situated on Secs. 22 and 23, T. 47, R. 27. The first shipment of ore therefrom was made in 1866, and the mine has since been continually worked.

The **Barnum mine** is situated on Sec. 9, T. 47, R. 27, connecting with the Lake Superior Co.'s principal opening. The first shipments of ore were made during 1868, the ore being specular and of excellent quality. The C. and N. W. R. R. has a branch running into the mine, over which shipments are made. The mine is supplied with pumping and hoisting machinery. The map of the Lake Superior mine, which will be found in the accompanying Atlas, embraces the Barnum mine.

On that portion of the estate purchased of the Excelsior Company, in addition to the Barnum, a deposit of specular ore has been found near the corner of Secs. 5, 6, 7, and 8, T. 47, R. 27, which promises well; a branch railroad has been surveyed to it. Besides those already mentioned the company have several other openings. One on Sec. 15, adjoining the Pittsburgh and Lake Angeline Co., opened during the past season, which gives a fine showing of hematite ore. The Cliff-Parsons, also opened during the past season, adjoins the *Old Parsons*, on Sec. 21, T. 47, R. 27.

Another opening is near the quarter-post between Secs. 17 and 18, T. 47, R. 26, from which ore was shipped during the season. A second opening is being made on this same line, at a point farther north, near the section corner. These openings belong to the Negaunee Hematite Group. In addition to their own mines the company are working the Pioneer opening of the Jackson mine on a lease. Near the Foster mine the company have in operation a sawmill, to which is attached shingle and lath mills.

In 1864 the *Ogden* and *Tilden* mines, situated on Secs. 13, 23, and 24, T. 47, R. 27, were extensively opened, and the branch road, which also extends to the Foster, built to them. The ores, however, proved of too low a percentage to sell in the then existing market, and the work was abandoned. The purchasers of the Iron Cliff estate also controlled the Chicago and Northwestern Railroad, and a short time previous to the purchase effected a consolidation with the Peninsula Road of Michigan, with a view to the future development of iron deposits on this extensive property, and the control of the railroad facilities for transporting the product of these and other mines to Lake Michigan.

**The Iron Mountain Mining Co.** filed its articles of association Nov. 1, 1864, paid in $100,000. *Corporators:* Geo. E. Hall, of Cleveland, O., Richard Hays, Henry A. Laughlin, and Irwin B. Laughlin, of Pittsburgh, and Gilbert D. Johnson, of Ishpeming. The company own 320 acres of land, being the S. ½ of Sec. 14, T. 47, R. 27. The first shipments of ore were made in 1865, a branch of the C. and N. W. R. R. extending into the mine. All work at this mine has been discontinued, owing to the leanness and refractory nature of the ore, its yield being less than 50 per cent, of iron in the furnace. This mine has been recently leased to Messrs. Clark and Colwell, under whose auspices work will be resumed in the spring of 1873, with the view of finding hematite.

**The Michigan Iron Co.** filed its articles of association Dec. 3Oth, 1864. Capital stock, $500,000, in 20,000 shares of $25 each. *Corporators:* Henry J. Colwell,

Andrew G. Clark and Samuel P. Ely, of Marquette, with office there.

This company own a large amount of woodlands, two furnaces and considerable other manufacturing property. The Michigan furnace was built by them in 1866, went into blast June, 1867, and has since been in constant operation; it is on the M. H. and O. R. R., 23 miles west of Marquette, and is surrounded by the village of Clarksburgh.

The remaining furnace owned by this company, known as the Greenwood, went into blast in June, 1865, and was purchased by the Michigan Co., together with about 8,000 acres of land of the M. and O. Rd., in 1868. Greenwood is 27 miles from Marquette, on the line of the M. H. and O. R. R., and the furnace has continued in blast since the time of its purchase by the present owners.

In 1864 **The Peninsula Railroad,** from its junction with the Marquette and Ontonagon Railroad at Negaunee to Escanaba (a distance of 62 miles), was completed and put in operation. The project which has resulted in opening this important outlet to the great iron mines was first definitely broached in 1855. In that year meetings were held at Ontonagon, Marquette, and all important points to Milwaukee, with a view to the united action of the people along the route, in the endeavor to obtain governmental aid in the construction of the railroad. These meetings were chiefly initiated by Mr. C. T. Harvey and H. B. Ely. Mr. Harvey, John Burt and others, immediately proceeded to Washington and were instrumental in obtaining from Congress the passage of an act, June, 1856, which donated a large amount of land in aid of railroad enterprises.

Among the projects for which provision was thus made in this grant were the building of a railroad from Marquette to Little Bay de Noquette, and also from thence to Menominee, as well as for the extension of a road from Fond du Lac to this latter point. In 1859, the Chicago, St. Paul and Fond du Lac Railroad Co. (which company had received from Wisconsin the congressional grant), through the agents of its bond-holders, organized under the name of the Chicago and Northwestern Railway Company, and in 1861, under a law of the State of Wisconsin, proceeded to locate a line by the way of Fort Howard to the Menominee river. In 1862 the State of Wisconsin conferred upon the C. and N. W. R. R. Co. all the franchises and rights heretofore granted to the several companies of which it had become the successor; and in the same year the road was extended to Green bay, a distance of 242 miles from Chicago.

The Iron Mountain road was completed and became consolidated with the Bay de Noquette railroad in 1858. The location of the Marquette and State line grant was changed by act of Congress in 1860, so as to extend from Menominee northward along the shore of Green Bay, and thence to Negaunee; and in 1863 the Marquette and State line grant, with the remainder of the Bay de Noquette grant (being coincident with it from Negaunee to Escanaba) having been suffered to lapse, were, by agreement between the grantees, conferred by the State upon the Peninsula Railroad Co., of Michigan. Surveys were made in 1862 (the enterprise being set on foot by C. T. Harvey, who subsequently transferred it to S. J. Tilden, of New York), and work began in the summer of 1863, and in December of the following year the road was opened to the public. During the preceding October, however, the Peninsula road had consolidated with the Chicago and Northwestern, and the line from Marquette to Menominee became known as the Peninsula division of the C. and N. W. R. R. The lands owned by the Peninsula division embrace in the aggregate 1,200,000 acres.

An extensive ore dock was constructed at Escanaba, upwards of 1,300 feet in length, 32 feet in height, and 37 feet in width, capable of receiving in the pockets 20,000 tons of ore at a time, and of shuting it thence into the holds of vessels. This dock was built at an expense of about $200,000. Communication to this excellent and accessible harbor being thus opened, and such ample facilities afforded for the transmission and shipment, large and increasing amounts of ore have since been carried yearly over this route.

**Corning Iron Co.** filed articles of association March 23d, 1865. Capital stock, $200,000—8,000 shares of $25. *Corporators:* G. C. Davidson, S. Churchill and Chas. T. Harvey, with office in Marquette. This company did nothing worthy of note.

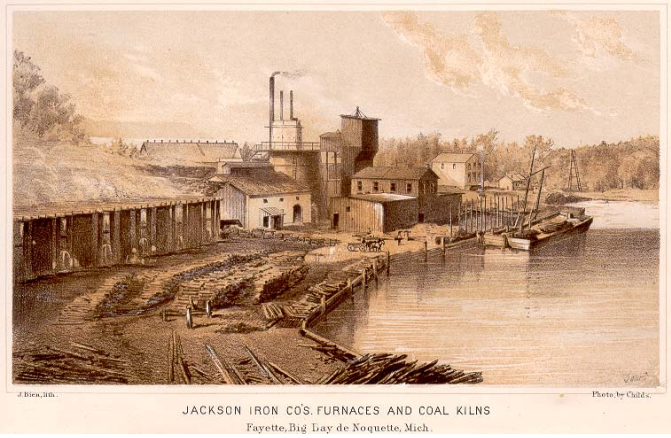
**The New York Iron Mining Co.** Incorporated April 8th, 1865. Capital stock, $250,000, in 10,000 shares of $25 each. *Corporators:* Samuel J. Tilden, J. P. Sinnett and J. Rankin, of New York.

The mining operations of this company are conducted in the southeast ¼ of southeast ¼, Sect. 3, T. 47, R. 27, being 16 miles west from Marquette and adjoining the Cleveland. The mine is worked under a lease from Mr. A. R. Harlow and the stock is all held by Mr. S. J. Tilden and Messrs. W. L. and F. W. Wetmore. Operations were commenced in the mine in 1864, during which year 8,000 tons of ore were shipped. The statement of its yearly product and other details will be found by reference to the tables in this work; the workings and geological structure are shown by a map. This company is identical with the New York and Boston Iron Mining Co., and also with the New York iron mine, incorporated March 3ist, 1865; it soon after changed to the New York Iron Mining Co., as above described.

**The Pittsburgh and Lake Angeline Iron Co.** was incorporated Nov. 11th, 1865. Capital stock, $500,000, in 20,000 shares of $25 each. James Laughlin, *President*, T. Dwight Eels, *Secretary* and *Treasurer*. The company own 1,376 acres of land, situated in T. 47 and 48, R. 27 and 28, of the former Town., and R. 31 of the latter. They also hold a lease of about 300 acres, on which is located the Edwards mine. The company's mines consist of the Lake Angeline and Edwards ; the

Lake Angeline mine is situated on the south shore of Lake Angeline and on the line of the M. H. and O. and C. and N. W. R. Rs., 17 miles from Marquette and 66 miles from Escanaba, and, produces both specular and hematite ore, the latter of first quality.

The **Edwards mine** lying contiguous to the Washington, is also on the line of the M. H. and O. R. R., distant from Marquette 28 miles, and produces only magnetic ore. Work was commenced in 1865. the first shipments being made in the following year. The mining is all conducted underground, the ore being raised to the surface through shafts and is the only mine in the Iron Region which has been exclusively worked in this way. The results of this company's operations are shown in the accompanying tables and the mine workings by maps and illustrations.




[II. Jackson Iron Co.'s Furnaces and Coal Kilns, Fayette]

**The Schoolcraft Iron Co.** filed articles of association April 8th, 1866. Capital stock, $500,000, in 20,000 shares of $25 each. Paid in, $250,000; the remaining 10,000 shares being held by the company. *Corporators:* Hiram A. Burt, Peter White and H. R. Mather, of Marquette; office at Marquette, Michigan.

A furnace was constructed by this company at Munising, Schoolcraft county, on Grand Island bay, which went into blast in June, 1868, and was blown out in about six months thereafter. The furnace continued "in and out" of blast somewhat irregularly, until the company went into bankruptcy. In 1871 the furnace and other property, including 40,000 acres of hard wood land, which had belonged to them, passed into the hands of Peter White, Esq., by whom it was transferred to the Munising Iron Co., an organization effected for the purpose of owning and operating this estate, which is now being successfully done. Mr. Peter White, of Marquette, is managing director.

**The Marquette and Pacific Rolling-Mill Co.** filed its articles of association Oct. 1st, 1866. Capital stock, $500,000, in 20,000 shares of $25 each. The corporators were John Burt, Samuel P. Ely, Wm. Burt, Edward Breitung, Timothy T. Hurley, Cornelius Donkersley, W. L. Wetmore, Peter White and Alvin C. Burt, of Marquette. Office in Marquette, Mich.

The company has constructed at Marquette a bituminous blastfurnace, with rolling-mill connected therewith. The works are located near the lake shore, at a short distance south from the city, went into operation in the summer of 1871, and are connected with the M. H. and O. R. R. by a branch track. Upon their land at Negaunee, the company have opened a mine of manganiferous hematite ore, to which a side track has been extended, connecting it with both railroads; from this mine the company's furnace at Marquette is in part supplied. This rolling mill is the first erected on Lake Superior, and the furnace the first which has continually used bituminous coal. H. A. Burt is superintendent.

The *Fayette Furnace* was constructed and put in operation in December, 1867, the enterprise originating with Major Fayette Brown, general agent of **The Jackson Iron Co.** It is located at "Snail Shell Harbor," in Big Bay de Noquette, 20 miles east of Escanaba, and about it has grown up the beautiful village of Fayette. It is owned by the Jackson Iron Co., with general office in Cleveland, Ohio. The company own 16,000 acres of land, excellently well timbered with hard wood, and generally adapted to agricultural purposes, the soil being of limestone formation. From the ledges of limestone, which exist in the immediate neighborhood, material for the necessary flux is obtained, as well as for the manufacture of all the lime used by the company. They possess a full complement of charcoal kilns, and a large portion of the necessary wood is purchased, the company preferring to save their own timber as long as possible. This wood is delivered by the parties of whom it is bought at the furnace, or along the line of the company's railroad, of which they have constructed for this purpose six miles, laid with T-rail, and operated with two small locomotive engines, it being the only furnace on the Upper Peninsula that operates a locomotive railway for the exclusive purpose of transporting fuel. The company have also a saw-mill, machine-shop, etc. The furnace, as originally started, consisted of a single stack, which is shown in the accompanying illustration. A second one was subsequently erected, and both stacks have since been in operation with results more favorable, than any other charcoal furnaces using Lake Superior ore. The extraordinary favorable working of these furnaces will be fully realized from the following statements, furnished from the company's reports: During the 73 days immediately preceding April 13th, 1872, there were made in the No. 1 stack an average of $27^{6}/_{10}$ tons per day, using 94 bushels of charcoal and 125 lbs. of limestone per ton, the ore being from the Jackson mine and yielding from 62½ to 64½%. On August 4th following, the same stack again went into blast, making, during the first quarter, a period of 91 days, 2,258 tons of iron, an average of $27^{8}$ tons per day, using by measure 92 bushels of charcoal per ton. No. 2 was also in blast during a portion of the same period with corresponding results. On December 14th No. 2 stack had produced, during the previous four weeks, an average of $26^{39}/_{100}$ tons per day, and on January 18th, 1873, had produced, during the previous five weeks, an

average of $29^{34}/_{100}$ tons per day; the charge used during this time was 26½ (called 30) bushels of charcoal, 1,000 lbs. of ore (⅓ soft and ⅔ hard specular Jackson), 35 lbs. of limestone and 10 lbs. of clay.

These results require no comment relative to the efficiency of the management. The coal is of the best quality, kept dry under shelter, as is also the ore, which is crushed finer than is customary. The stacks are each 42 feet high inside and 9 feet 6 inches bosh; 4 feet 8 inches, and 5 feet 8 inches diameter, 3 feet below the top, and 4 feet and 5 feet at the top respectively. The hearths are 4 feet diameter battering from the bottom; the tuyeres, three in number, with 3½ inch nozzle, are placed 40 inches above the bottom of the hearth. Two blowing engines are used, the cylinders respectively 36 and 48 inches in length, with diameter of 50 and 44 inches. The engines make from 24 to 28 revolutions per minute, and both of them are only run when the two stacks are in operation. The temperature of the hot blast averages in one about 600° and in the other 750°. Originally No, 2 stack had a five-foot cone, but did not make as much iron, nor as cheaply, as the other, until the cone was reduced in height to 4 feet 4 inches, since which time it has worked equally well with the other. The total product of these furnaces during 1871 and '72 was 19,117 tons, which were used as follows:

| | | |
|---|---|---|
| For Bessemer Steel..... | 17,465 | tons. |
| " Malleable Iron ..... | 88 | " |
| " Wheels..... | 787 | " |
| " Foundry, etc..... | 400 | " |
| " Forge purposes..... | 377 | " |

Genl. Agt., Major Fayette Brown, Cleveland, Ohio. Local Agt., C. L. Rhodes, Fayette, Mich. Founder, Jos. Harris, Fayette, Mich.

**The Deer Lake Iron Company.**—Articles of association were filed July 9th, 1868. Capital, $75,000—3,000 shares at $25 each. *Corporators:* George P. Cummings, of Marquette, Edward C. Hungerford, of Chester, Conn., Gardner Green, Caleb B. Rogers, Moses Pierce, Samuel B. Case, Theodore T. McCurdy, John E. Ward, James Lloyd Greene, James C. Colby (Ex'r), Daniel T. Gulliver, William R. Potter and Enoch F. Chapman, of Norwich, Conn.; Giles Blague, Jr., New York, Geo. Smith, New York, G. F. Ward, E. R. Ward, Old Saybrook, Conn., and James H. Mainwaring, of Montville, Conn., with office at Marquette, Mich.

This company organized for the purpose of smelting iron ore, and immediately constructed a furnace, which went into operation in Sept., 1868. This furnace, the smallest in the district, is located at Deer lake on the Carp river, two miles north from the village of Ishpeming on the M. H. and O. R. R., with which place it is connected by a tram railway. The stack is 33 feet high and 7 feet 8 inches bosh, thus making it perhaps the smallest furnace which has been built in the United States during the past 7 years. Another peculiarity of this furnace is the comparatively enormous size of its hot-blast oven, to which is doubtless due in part the favorable results, which, considering its small size and peculiar management, the furnace has accomplished. The oven, on the Pleyer plan, contains 45 tons of metal, which is 50 per cent, more than that contained in the ovens of our largest charcoal furnaces; having twice the capacity of the Deer lake stack. The furnace is driven by water, employing an 18-inch turbine wheel under 35 feet head, thus leaving all the gas available for heating the blast, which is brought to an extremely high temperature. It runs but six days in the week, "banking up" Saturday night and starting again on Sunday night. Notwithstanding an arrangement necessarily disadvantageous to the greatest production, the furnace has averaged during several consecutive weeks n tons of pig-iron per day, using no bushels of charcoal to the ton, one-half of which is made from pine slabs,—the ore used being hard ore from the New York mine, averaging 66 per cent. The origin of this enterprise is due to Mr. E. C. Hungerford, who also determined its unusual size and the peculiar policy under which the furnace has been managed. Near the present one the company are now building a new iron shell furnace, 9 feet bosh.

**The Cannon Iron Company.**—Articles filed July, 1869. Capital, $500,000; 20,000 shares, $25 each. *Corporators:* Bernard A. Hoppes and Wm. H. Berry, of Philadelphia, and Samuel S. Burt, of Marquette, with office in Philadelphia. This company organized for the purpose of mining iron ore, but beyond making explorations on their lands with this view, nothing has as yet been done.

**Bay Furnace Company.**—Articles filed July 19th, 1869. Capital stock, $150,000; 6,000 shares at $25 each. *Corporators:* William Shea, of Munising, Mich., George Wagner, Jay C. Morse, Frank B. Spear and James Pickands, of Marquette, John Outhwaite, of Cleveland, and John P. Outhwaite, of Ishpeming, Mich., with office in Marquette.

This concern organized for the purpose of smelting iron ore, and immediately proceeded to the construction of a blast-furnace for that purpose. This furnace was completed and went into operation on the 6th of March, 1870. It is located at Onota, in Schoolcraft county, on Grand Island bay, 40 miles from Marquette. But one stack was originally constructed; a second one, however, has since been erected and put in readiness for the blast. The ore used is from the Cleveland and McComber mines, received by the way of Marquette. This company own about 20,000 acres of land, mostly hard wood timber, from which the fuel for the furnace is obtained.

**The Whetstone Iron Company.**—Organized Aug. 20th, 1869. Capital stock, $150,000, in 6,000 shares of $25 each. Office at Marquette. This company have not commenced operations. Corporators were William Burts, Samuel Peck, A. A. Cole, Thomas O. Hampton, Clark Stratton, A. S. Harvey and A. G. Benedict.

**Champion Iron Company.**—Organized August 23d, 1869, with a capital stock of $500,000, in 20,000 shares

of $25 each. *Corporators:* Joseph S. Fay, of Boston, Edwin Parsons, of New York, Thomas C. Foster, of Cambridge, Mass., and Samuel P. Ely and Peter White, of Marquette. The company own about 1,600 acres of land, but their mining operations are conducted on that portion of their land comprising the south half of Sec. 31, T. 48, R. 29, being 32 miles by railroad from Marquette. The ore is principally magnetic, though a large amount of slate ore is obtained. The Champion mine is upon the south outcrop of the magnetic ore basin, which underlies Lake Michigamme, and near the village of Champion, about half a mile distant from the furnace of that name. The company are now working chiefly underground, as is fully shown in Map VIL of Atlas, where the geological structure and all other important details will also be found.

**The Lake Superior Foundry Company** filed their articles of association Sept. 2d, 1869, with a capital stock of $50,000—2,000 shares at $25 each. *Corporators:* Daniel H. Merritt, Lotan E. Osborn, Henry J. Colwell, William L. Wetmore, Jay C. Morse, Alfred Kidder, James Pickands and Thomas Fitzgerald, of Marquette, Mich.; Gilbert D. Johnson, Seymour Johnson, Harvey Diamond and Robert Nelson, of Ishpeming. The works (located at Ishpeming) are quite extensive and adapted to general and particular foundry and machine work. (See Iron Bay Foundry, p. 33.)

**Silas C. Smith Iron Company.**—Articles of association filed Jan., 1970. Capital, $500,000, in 20,000 shares at $25 each. *Corporators:* Silas C. Smith, of Ashtabula, O., Oliver F. Forsyth and Wm. H. Lyons, of Flint, Mich., with office at Ashtabula, O.

The property of this company consists of 703 acres of land in Sections 18, 20, and 28, T. 45, R. 25, upon which have been made numerous openings, showing soft hematite ore in quantity, the main one being near the E. ¼ post of Sect. 18. A tunnel is being driven into the deposit, of sufficient size for the admission of railway cars from a branch road five miles in length, which connects with the Chicago and Northwestern railroad. The ore at present is loaded into the cars from temporary docks, provided with pockets for that purpose. The principal stockholders are Silas C. Smith, the discoverer, General James Pierce, of Sharpsville, Pa., and Henry Fassett, of Ashtabula, O. The shipments of ore and other details will be seen by reference to the mining tables.

**The Pittsburgh and Lake Superior Iron Co.** filed articles of association June 28th, 1870. Capital stock, $500,000, in 20,000 shares of $25 each. *Corporators:* James McAuley, C. T. Spang, C. G. Hussy, Thos. M. Howe and James M. Cooper, of Pittsburgh; Sherman J. Bacon, of New York, Joseph G. Hussy, of Cleveland and W. M. Sinclair, of Philadelphia; with office at Pittsburgh, Pa. The company own 2,691 acres of land in Towns. 47 and 48, Ranges 25 and 26, their title to which was derived direct from the United States Government. Work was commenced on their property near the Cascade mines in Sept., 1872, houses, etc., were erected, a railroad side track built and a pit opened on Sec. 32, which is called the Hussy mine, and from which about 2,000 tons have been shipped.

**The Republic Iron Co.** was organized Oct. 2Oth, 1870. Capital stock, $500,000, in 20,000 shares. Office in Marquette. *Corporators:* E. Breitung, S. P. Ely and Ed. Parsons. This company own 1,328 acres of land, being in part in Sections 6, 7, and 18, T. 46, R. 29, comprising what was formerly known as Smith mountain, which is unquestionably one of the largest deposits of pure specular and magnetic ore on the Upper Peninsula, if not in the United States. The great extent and value of this deposit was observed and commented on by the early United States surveyors, when engaged in running the township lines in that locality in 1846. The property was explored and selected by Silas C. Smith, of Marquette, and entered in the name of Dr. James St. Clair, in 1854 and 1855. A branch from the M. H. and O. R. R. has been constructed to the mine, over which the shipments of ore are now being made. See Tables, Pits. XII. and XIII. of Atlas. A complete map of this property, based upon careful surveys, exhibiting the topography, geological structure, magnetism and other important details, will be found in the Atlas accompanying this work, together with full descriptions.

**The Cascade Iron Co.** is an association of Pittsburgh men, owning 3,120 acres of land in Sections 19, 20, 29, 30, 31, and 25, T. 47, Ranges 26 and 27. These lands were entered by Waterman Palmer and purchased by the present company in 1869. An examination of the iron deposits in this locality was made by Dr. Douglas Houghton, in 1845, while engaged in running the interior section lines. (See Appendix D., Vol. II.)

The company's mines are provided with side tracks, connecting with a branch road of six miles in length to the C. and N. W. R. R. Mining operations commenced in 1871, and the openings (including the leased mines) are seven in number. There are other improvements, such as a saw-mill run by water, a store, sufficient number of dwellings, barns, repair-shop, etc. The expenditure which these improvements (including the branch railroad and side tracks) have necessitated has been very large, and future operations are contemplated upon a scale of considerable magnitude. (See Statistical Tables.)

The Cascade Company, under another organization, to wit, **The Escanaba Iron Co.,** are constructing a blast-furnace at Escanaba, to consist of two stacks, one of which will go into operation in January, 1873; the height of stack, 56 feet; diameter of bosh, 12 feet. The entire structure is built in the most complete and substantial manner, and when finished, will probably not be surpassed, if equalled, in capacity, durability, or beauty, by any similar furnace in the United States. The principal owners are Joseph Kirkpatrick, William Bagaley, James Lyon, William Smith, Samuel Riddle and Samuel Hartman; Joseph Kirkpatrick, *President*, James Lyon, *Treasurer*, and John L. Agnew, *General Superintendent*.

**The Emma Mine,** one of the Cascade openings, is on the E. ½ of E. ½ of N. E. ¼, Sec. 31, and is being worked under a lease from the Cascade Company by an association of Pittsburgh gentlemen, who are represented at the mine by Mr. James E. Clark. They commenced shipping ore in 1872.

**The Bagaley Mine,** likewise one of the Cascade openings, is also worked under a lease from the Cascade Company, by Messrs. Wilcox & Bagaley, and its total product is about 6,000 tons.

**The Gribben Iron Co.,** having a capital stock of $500,000, in 20,000 shares of $25 each, was organized 1872. The mining property comprises a lease on the S. E. ¼, Sec. 28, T. 47, R. 26, being on the Cascade range. Mining and exploring operations during the season have resulted in taking out considerable ore, some of which has been shipped for testing. The company have built a side track, which connects with the Cascade branch of the C. and N. W. R. R. Officers of the company are: W. C. McComber, *President*, C. H. Hopkins, *Secretary*, and James Mathews, *Treasurer*; all of Negaunee, Mich.

**The Carr Iron Co.** was also organized in the summer of 1872, with a capital stock of $250,000. Its real estate comprises forty acres of land, situated on Sec. 33, T. 47, R. 26, being also in the Cascade range. The officers are Amos Root, *President*, Jackson, Mich.; E.W. Barber, *Secretary*, Jackson, Mich.; and W. H. Maynard, *Managing Director*, Marquette.

**Negaunee Hematite Mines.** A large number of new companies have recently been organized for the purpose of mining hematite ore in the vicinity of Negaunee. These new locations, which have been and are in process of being developed, are situated in Sections 6, 7, 8, and 18, T. 47, R. 26, and comprise what are known as the Me-Comber, Grand Central, Rolling Mill, Himrod, Ada, Negaunee, Calhoun and Spurr, Green Bay, Allen, the Iron Cliff "Sec. 18," and other mines. The McComber mine, opened by William C. McComber in 1870, is worked on a lease from J. P. Pendill, of Negaunee, at a royalty of fifty cents per ton for ore. he mine has been worked for the past three seasons, and in the spring of 1872 the lease was sold to parties interested in the Cleveland mine, who in July organized a company. The Rolling Mill mine, heretofore spoken of, is worked in part under a lease from A. L. Crawford. The company, however, own the greater portion of the land.

All these workings, except Sec. 18 and the McComber, are worked on leases from Edward Breitung, at 75 cents per ton royalty, he having leased from the owners, Messrs. Harvey and Reynolds, at 50 cents per ton royalty. Some of these pits have been worked during the past season, and nearly all of them are prepared for active operations during the coming year. Railroad side tracks are either completed, or in process of construction, to the several mines; dwellings and other improvements have been made, or are contemplated at each, and several of the locations bid fair to be the scene of active mining operations. The product is for the most part a soft hematite, containing usually from one to five per cent, of manganese, which renders the ore more easily worked in the furnace and is probably beneficial to the iron. The yield of metallic iron of the best of these ores is 50 percent, and upwards, the average, however, is below that. See Map No. V. and Table PL XII. of Atlas.

Among the promising iron properties upon which work has been commenced during the present season, and from which large shipments may be reasonably anticipated, are the Michigamme and Spurr Mountain mines, at both of which work has actively commenced; side tracks are being constructed at both places, connecting with the M. H. and O. R. R. The mines are situated upon the same magnetic range and are about two miles apart.

The property of the **Spurr Mountain Co.** (which company was organized in September last) comprises 160 acres of land, and the point at which mining operations have been commenced is at what is known as Spurr mountain. The preliminary work has uncovered the south side of a very large mass of magnetic ore of a great degree of purity; rising at the highest point to a height of 60 feet above the surface of the ground at the base of the hill. This remarkable outcrop of ore is situated (as will be seen by reference to the accompanying map) 900 feet east and 700 feet north from the west and south boundaries respectively of the company's property. It was first discovered to the public in 1868. The examinations which have been made, established beyond any reasonable doubt the presence of the ore in a very large quantity and of a uniform purity and quality. The natural facilities afforded at Spurr mountain for commencing mining operations are excellent, and with the exception of Republic mountain there is, so far as known, no other locality in Marquette county where occurs so large an exposure of pure ore, rising at so great an elevation above the general level and at which there is apparently so little preliminary work necessary.

This range has been explored to a considerable extent in either direction; westerly, across the east half of Sec. 23, owned by the M. H. and O. R. R. Co., the examinations show the presence of the ore, but to how great an extent the deposit exists future workings alone can determine; easterly, as is elsewhere more fully related, the range has been traced along the north side of Lake Michigamme for several miles. The officers of the Spurr Mountain Co. are: H. N. Walker, Esq., of Detroit, *Prest.;* Col. Freeman Norvell, *Supt.* and *Sec.* The distances from the mine to the ports of L'Anse and Marquette are respectively, by rail, about 24 and 39 miles.

**The Michigamme Co.** was organized in the winter of 1870-71, the organization being effected mainly by persons already largely identified with Lake Superior iron interests. The land owned by the company comprises 1,400 acres, situated on the north side of Lake Michigamme. Preliminary work was begun in the spring

of 1872, and prosecuted during the summer. The point selected for the commencement of mining operations is near the shore of the lake, and upon each side of the line between Sections 19 and 20, the developments resulting from this work thus far being of the most promising character. Improvements, not previously indicated, consist of a large, substantial steam saw-mill, with other machinery attached thereto, an office, dwellings, etc. At a short distance south and west from this location the company have laid out a village plat, to be called "Michigamme," and which promises to be built up with considerable rapidity. The distance to L'Anse is about 26 miles, and to Marquette 37, by rail. The officers of the company are: William H. Barnum, of Lime Rock, Conn., *Prest.;* James Rood, of Chicago, *Sec*. and *Treas.;* and Jacob Houghton, *Supt*.

**The Keystone Iron Co.** also organized in the fall of 1872, with capital stock of $500,000, in 20,000 shares of $25 each. The property comprises the southeast ¼ of southwest ¼, Sec. 32, T. 48, R. 29, distant from Marquette, by rail, 29 miles, from Escanaba 77, and from L'Anse 35. The company are at work preparing for mining the ensuing season. A. P. Swineford, Marquette, General Agent.

A number of mining enterprises, comprising **The Albion, Saginaw, Lake Superior Company's new openings. The New England, Winthrop, Shenango, and Parsons,** in Secs. 19, 20, 21, 16, T. 47, R. 27, are situated east and west, parallel and contiguous ranges of specular and hematite ore, are all connected by branches with the M. H. and O. R. R., and soon to be with the C. and N. W. Road.

**The Albion mine,** opened in 1871 by the brothers St. Clair, who hold the property comprising the northeast ¼ of the northwest ¼, Sec. 19, on a lease from Messrs. E. Breitung and S. L. Smith; at a royalty of 75c. per ton; up to the present time but a small amount of ore has been mined. The opening is immediately west of the Saginaw mine and on the same ore belt.

**The Saginaw Mine,** situated on the northwest ¼ of the northeast 2*5 of Sec. 19, T. 47, R. 27, was opened in 1872, and during the same season shipped (via M. H. and O. R. R.) 19,000 tons of specular ore. The mine was worked on a lease by Messrs. Maas, Lonstorf and Mitchell, of Negaunee, on a royalty of 5cc. per ton for the ore. During the fall of 1872 the lessees sold out to parties representing the Cleveland Rolling Mill Co. for $300,000, and immediately thereafter the Saginaw Mining Co. was organized with a capital stock of $500,000 in 20,000 shares. A. B. Stone, of Cleveland, *Prest.*, and A. G. Stone, of Cleveland, *Sec*. and *Treas*. Aside track has been surveyed, to connect with the Chicago and N. W. Railroad, and the grading finished to the Winthrop mine. The land on which the Saginaw mine is located was purchased of the State of Michigan, with four other contiguous "40's" situated about the centre of same section, seven years ago, by Messrs. Heater, Elison and Conrad ; the latter having made the selections.

Between the Saginaw and New England mines, on Sec. 20, the Lake Superior Iron Co. have a very promising opening, from which a considerable shipment of specular slate ore was made in 1872.

**The New England Mine,** on same range, is situated on the east ½, northeast ¼, Sec. 20, T. 47, Range 27. The shipments from this mine commenced in 1866, and up to the present time about 60,000 tons of ore have been mined and shipped via Marquette. The property is mainly owned by Captain E. B. Ward, of Detroit, and the mining operations are conducted by H. G. Williams under a contract. The principal part of the product is a hematite ore. A very narrow bed of excellent specular slate ore was worked several years, but not proving sufficiently profitable, work was discontinued. The ore is chiefly consumed at the extensive works controlled by Capt. Ward at Chicago, Milwaukee, and Wyandotte.

Adjoining the New England is the **Winthrop Mine,** situated in the southwest ¼, Sec. 21, T. 47, R. 47, owned by A. B. Meeker and A. G. Clark, of Chicago, and H. J. Colwell, of Marquette, and opened in 1870 by Messrs. Richardson and Wood, who work the mine on contract. Up to the close of 1872 about 25,000 tons of ore have been shipped, and the indications are favorable for increased shipments during the coming year. The product is a hematite ore, one of the richest of the class in the district. A, B. Meeker, of Chicago, is *Prest.*, A. G. Clark, *Sec*. and *Treas*., and H. G. Colwell, Clarksburgh, *Gen'l Agt*.

**The Shenango Iron Co.** was organized in September, 1872, with a capital stock of $500,000, in 20,000 shares of $25 each. The land worked by the company comprises the north-west ¼ of south-east ¼ of Sec. 21, T. 47, R. 27, and adjoins the Winthrop, the deposit being a continuation of that mine.

The officers are C. Donkersley, of Appleton, Wis., *Prest*., and H. D. Smith, *Sec.* and *Treas.;* in addition to these, E. Decker, Charles Reis and George L. Hutchinson, constitute the Board of Directors. A small amount of ore was shipped during the fall of 1872, and the company are erecting machinery, including the sinking of a shaft 60 feet in depth, with the view of doing considerable mining the coming season. The land is leased of the Williams Iron Co., who in turn lease of the Pittsburgh and Lake Angeline Co., who are the owners of land. The ore is mined by Messrs. Hurd and Orthey, part owners, on contract.

**The Boston Mine,** situated on the southwest ¼ of the northeast ¼ of Sec. 28, was organized in 1872, and a lease of the property above described secured by Messrs. Day, Anderson and others, with a view of mining operations. The lease of these parties is the same as that of the Shenango.

**The Parsons,** or **"Old Parsons,"** mine is located between the New England and the Lake Superior Companies' opening on Section 16, northeast of the Winthrop. Several thousand tons of specular slate ore

were shipped from each of these mines, but work has been discontinued.

**The Kloman Iron Co.** was organized in December, 1872, with a capital stock of $500,000, in 20,000 shares. The corporators were Andrew Kloman, William Coleman, Thomas M. Carnegie, Jacob Houghton and T. B. Brooks. The company own 437 acres of land adjoining and northwest of the Republican mountain, being in part in Sec. 6, T. 46, R. 29, on the west side of the Michigamme river. The company have commenced mining on the continuation of the Republic mountain deposit and are building a short railroad to connect the mine with the Republic branch.

**The Howell Hoppock Iron Mining Co.** filed articles of association January 13th, 1873. *Corporators:* Lewis J. Day, Wm. R. Bourne, Wm. Rice, James S. Ward and Frank Austin. Office in Ishpeming, Mich. Organized to mine on the northwest ¼ of northeast ¼ of Sec. 28, T. 47, R. 27. Capital stock, $500,000, in 20,000 shares.

**The Watson Iron Co.** filed articles of association January 16th, 1873, with capital stock fixed at $500,000, in 20,000 shares of $25 each. *Corporators:* C. J. Hussey, E. T. Daro, Thomas M. Howe, M. K. Moorhead, George F. McLeane, W. J. Moorhead, Charles F. Spang, John W. Chalfant, Campbell B. Herron and James W. Brown, all of Pittsburgh, Pa., and James W. Watson, of Marquette county, Mich. The property of this company comprises the northwest ¼ of Sec. 32, T. 47, R. 26 and which constitutes $325,000 of the capital stock. This ¼ section is a part of the estate of the Pittsburgh and Lake Superior Iron Co. and is on the Cascade range. Operations were commenced in September last by this latter company, of which mention has already been made under the Hussey mine.

In the **Menominee Iron Region** two companies, called respectively the Breen and Ingalls Iron Mining Companies, have been organized and are engaged in explorations, and in addition to the operations inaugurated by these companies, explorations are being made by private parties. The completion of the Peninsula railroad from Escanaba to Menominee, affording better promises for transportation, will stimulate operations of this character, which have heretofore been deferred from want of railroad communications.

**The Breen Mining Co.** owns 120 acres of land in Sec. 22, T. 39, R. 28, distant from Escanaba by proposed road 35 miles, from Menominee 55 miles and from Deer river 28 miles. The ore is chiefly flag, with some hematite. The property is being explored by Capt. E. B. Ward, J. J. Hagerman and J. W. Vandyke, who have an option of leasing or purchasing the mine. The officers are E. S. Ingalls, *Pres*., T. B. Breen, *Sec*., S. P. Saxton, *Treas*., Thomas Breen, Bently Breen, and S. P. Saxton, *Directors*—all of Menominee, Mich.

**The Ingalls Mining Co.'s** property constituted 240 acres of land situated in Sections 8 and 9, T. 39, R. 29. The distance from Escanaba by proposed road is 44 miles and from Menominee 64 miles. The officers are E. S. Ingalls, *Pres*., C. L. Ingalls, *Sec*., and F. S. Mullburg, *Treas*.

An effort has been made to manufacture pig-iron by using *peat as a fuel*, but has not as yet proved in the requisite degree successful. A peat furnaces was constructed at Ishpeming and went into operation early in the year 1872, but very soon went out of blast; subsequently it started again and made about 200 tons of iron and again stopped, it being the intention to alter and enlarge the stack, the better, it is thought, to adapt it to the peculiarities of the fuel. The peat is prepared from a bed of the material which exists in proximity to the furnace.

**The Ericson Manufacturing Co.** was organized in April, 1872, to conduct general manufacturing operations, with a nominal capital of $150,000. *Corporators:* Peter E. Ericson, John Carlson, A. J. Burt and Wm. Burt.

The company are operating a foundry and machine-shop, which they have built on Whetstone brook, within the city of Marquette. The machinery is driven by water-power.

Mr. Jno. Burt commenced, in September, 1872, the construction of a charcoal furnace, on the lake shore, at the mouth of the Carp river, south of Marquette. The stack is being built of stone, with a nine-foot bosh, and the whole is to be completed and put in operation in the spring of 1873. It is intended to supply the fuel from points along the lake shore, transporting it to the furnace in boats in the same manner that the wood for the Burt furnaces in Detroit is obtained, of which latter furnaces the one being built at the Carp will be a duplicate, and will be the first built on the Upper Peninsula based on this plan of obtaining fuel.

Very recently **The Carp River Iron Co.** has been organized, and own the furnace and about 500 acres of land at that point, including the water-power on the Carp, etc. The business office will be in Marquette.

## SANDSTONES.

The Lake Superior sandstones are very carefully described by Dr. Rominger in his accompanying report, commencing with page 80, and the results of his observations, as therein described, are of great practical and scientific interest. There are two organized companies now engaged in quarrying and marketing sandstone within the limits of the city of Marquette, the locations being contiguous.

**The Marquette Brown Stone Co.** was organized in August, 1872, with a capital stock of $500,000, in 20,000 shares. The corporators were Peter White, Wm. Burt, F. P. Wetmore, S. P. Ely, Sidney Adams, J. H. Jacobs, H. R. Mather and Alfred Green. In addition to quarrying stone, the company's franchises include the mining and smelting of ore, etc. Office in Marquette, Mich.

This company's property was previously known as the Wolf Quarry, located on the farm formerly owned by J. P.

Pendill, and has been worked for some time past, the stone being principally used in Chicago. It is of a uniform dark-brown color, free from pebbles and clay holes. It apparently exists in great quantity, and is readily quarried and transferred to vessels. Mr. Peter White is constructing in Marquette a fine business block with a variety of stone from this quarry, which is variegated and striped with different colors, giving to the building a unique and pleasing appearance.

The articles of association of The **Burt Free Stone Co.** were filed Oct. 3d, 1872. Capital stock $500,000, in 20,000 shares of $25 each. The corporators were John Burt, William Burt, Hiram A. Burt, A. Judson Burt and Wm. A. Burt. Office in Marquette.

This company have opened a quarry of sandstone adjoining the one described above and the deposit is similar, the stone being lighter colored.

Both companies are prepared to furnish stone in large quantities. For full description of the sandstone found in these quarries, see Dr. Rominger's report, pages 90 and 91.

In addition to the above. **The Lake Superior Stone Co.** has been more recently formed with the amount of capital stock and number of shares as the preceding. The company own and hold in lease about 296 acres of land, situated on the west side of Keweenaw bay and on the north side of Portage Entry. The stone outcrops horizontally in a bluff, which rises from the water of the bay and is thus readily accessible for removal from the bed to vessels.

It is intended to begin operations in the spring. The corporators are H. H. Stafford, V. B. Cochran, W. S. Dalliba, E. J. Mapes and A. Kidder. Office, Marquette, Mich. See Dr. Rominger's report, page 95.

The fine new Court-House at Milwaukee is built with sandstone obtained from Bass island, near Bayfield, on Lake Superior, at which point stones have been quarried for several years.

The quarry described by Dr. Rominger, page 89 of his report, is now owned by Messrs. Winty and Mossinger, of Chicago, and Thomas Craig, of Marquette.

## ROOFING SLATE.

There are three companies which were organized for the purpose of quarrying and selling roofing slate; but one of them, however, has actually commenced operations and is now at work on explorations.

**The Huron Bay Iron and Slate Co.** filed articles of association January 19th, 1872. Capital stock, $500,000, in 20,000 shares. The corporators wrere Peter White, W. L. Wetmore, F. P. Wetmore, J. C. Morse, James Pickands, A. R. Harlow, M. H. Maynard, D. H. Ball, Wm. Burt, D. H. Merritt, Sidney Adams and H. R. Mather. Office, Marquette, Michigan. The company own 2,000 acres of land in T. 51, R. 31.

**The Huron Bay Slate and Iron Co.** was organized subsequently, with same capital stock and number of shares. The corporators are W. L. Wetmore, Peter White, M. H. Maynard, Wm. Burt, Thomas Brown, J. J. Williams, S. L. Smith, Alex. McDonald, John H. Knight, W. C. Wheeler, H. R. Mather, Jas. D. Reid, F. P. Wetmore and R. C. Wetmore. Office in Marquette. The company own 1,100 acres of land in T. 51, R. 31, and have commenced work near Slate river, about four miles south of Huron bay, on the northeast quarter of section 33 in the above town. The slate apparently exists in very large quantities.

**The Stafford Slate Co.,** an association comprising H. H. Stafford, V. B, Cochran, E. J. Mapes, A. Kidder, J. M. Wilkinson, Wm. Burt A. J. Burt and W. S. Dalliba, own 1,900 acres in T. 51, R. 31. The operations of this company thus far consist in having cut out a road from L'Anse to their property on Section 27, in the above town, a distance of 15 miles.

The color of the slate found in T. 51, R. 31, is somewhat varied, the green, purple and gray are found on Sections 14, 15, and 16. South of this are found large deposits of black slate, extending several miles east and west, with an apparent thickness of several hundred feet, the cleavage planes dipping to the south.

## SAW-MILLS.

The following saw-mills are now in operation, all of which, with the exception of the ones at Whitefish Point, at Onota and Fayette (the two former of which are in Schoolcraft county and the latter in Delta), are in Marquette county:

| Name of Firm. | Location. |
|---|---|
| Decker and Steele | Eagle Mills. |
| Edward Fraser | Cherry Creek. |
| George Wagner | Laughing Whitefish Pt. |
| A. R. Harlow | Little Presque Isle. |
| H. A. Stone | Bancroft. |
| Jackson Iron Co | Negaunee. |
| Iron Cliffs Co | " |
| Mr. Jackson | Palmer Falls (Cascade). |
| Hartman and Connelly | Little Lake. |
| Cleveland Iron Co | Ishpeming. |
| Lake Superior Iron Co | " |
| Deer Lake Iron Co | Deer Lake. |
| Michigan Iron Co | Clarksburg. |
| Michigamme Iron Co | Michigamme. |
| Edward Breitung | Republic Mt. |
| C. T. Harvey | Chocolate. |
| Bay Iron Co | Onota. |

These mills produced in the aggregate, during the year 1872 (besides shingles, laths and a small amount of hard wood), thirteen and a half million feet of pine lumber, all of which, excepting the product of the three mills above designated, was, or will be, consumed in Marquette county. The total product during the coming

year, if the winter is favorable, will be much greater, as most of these companies are preparing to get in a larger amount of logs. The Michigamme mill, which has a nominal capacity of 4,000,000 feet, has but recently started, and thus did not contribute to the total product of 1872.

COMPLETION OF THE RAILWAY SYSTEM.

### Marquette, Houghton and Ontonagon R. R.

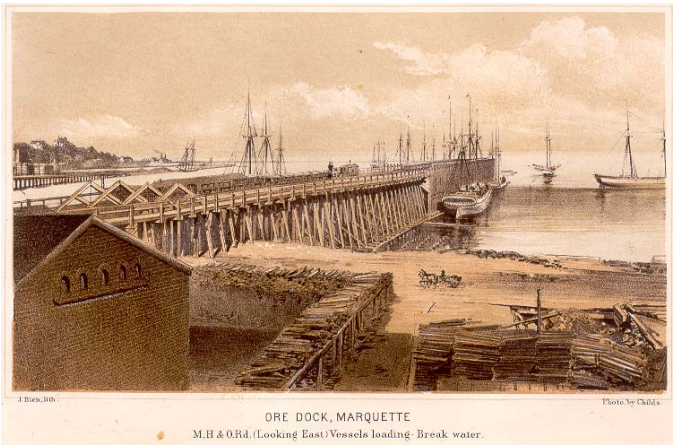
Among the most important events affecting the interests of this portion of our State, which transpired during the year 1872, was the extension of the C. and N. W. R. R. from Menominee to Escanaba, the consolidation of Marquette and Ontonagon Railroad with the Houghton and Ontonagon, and the completion of the line to L'Anse, thus making complete railroad communication from the head of Keweenaw bay to Chicago, a distance of 462 miles.

The development of .the mineral resources of a country are so intimately blended with the improvement of its facilities for transportation, as to render it essential in considering the progress of the former, to give due credit to the latter. Iron ores having a low value per ton must be reached by rail or water before their value can be realized; differing in this particular from the ores of the precious metals, which will bear wagon or even pack-mule transportation. Especially is this true with reference to an isolated region like the Upper Peninsula, which is as yet a comparative wilderness, possessing but a small population, a rigorous climate, few thoroughfares and with a surface so rough and rocky in portions of its territory, as to render their construction a matter of much difficulty. It naturally follows, that the addition of two so important avenues of communication to the railroad facilities of the Peninsula becomes in a pre-eminent degree a matter of congratulation and importance. The history of the enterprise, which has thus resulted in the connection of the bays of Marquette and Keweenaw, is in brief as follows:

As has been previously related in speaking of the Peninsula road, the United States granted to the State of Michigan, by an act passed on the 3d of June, 1856, every alternate section of land for six sections in width, designated in odd numbers, to aid in constructing a railroad from Little Bay de Noquette to Marquette and thence to Ontonagon, and from the two last places to the Wisconsin State line. The State, by an act passed Feb. 14th, 1857, conferred this grant upon the Little Bay de Noquette and Ontonagon Railway Co., and two other railroad corporations, all of which lines were required to be completed within ten years, a condition with which neither of the companies complied.

In 1863 the State conferred the forfeited franchises and grant previously given to the Marquette and Ontonagon *Railway* Co., upon the Marquette and Ontonagon *Railroad* Co., under certain conditions. Congress in 1864 extended the grant five years, in the subsequent year added four sections per mile thereto, and in 1868 fixed the time for a full compliance with the conditions of the grant until Dec. 3ist, 1872. During the period of its existence, the company built twenty miles of main line of railroad, commencing near the Lake Superior mine at the terminus of what was formerly the Bay de Noquette road, and extending to a point on the south side of Lake Michigamme.

In 1870 the State decided that the company, by reason of its failure to complete any extension of their lines, had forfeited the greater portion of the grant. On the 24th of Jan., 1871, the Legislature confirmed the action taken by the State Board of Control during the month of April previous, which conferred the forfeited or unearned lands upon the Houghton and Ontonagon Railroad Company, a new organization, incorporated Jan. 15th, 1870, and of which the following Michigan men were among the principal stockholders: H. N. Walker, *President*, S. L. Smith, Chas. H. Palmer, Geo. Jerome and S. F. Seager. The conditions of the act of Congress required the completion of thirty miles of road before the close of the year 1872, which fortunately this company have succeeded in accomplishing. Jacob Houghton was chosen Chief Engineer; and having located the line from Champion to L'Anse during the winter, the construction was begun in the spring of 1871 at the L'Anse terminus, and on the 16th of Dec., 1872, the first train passed over the entire line to Marquette, sixty-four miles; the whole having been placed under one management by the consolidation of the two companies effected during the previous summer. The completion of the road to L'Anse, exclusive of innumerable other advantages, opens to market the products of several iron mines, among the most promising of the region.




[III. Ore Dock, Marquette]

In anticipation of future shipments of ore from L'Anse, the company have constructed at this terminus of the road an extensive dock, a full representation of which from careful drawings is herewith presented.* They have also built, at this point, in a very substantial manner, a round-house, turn-table, machine-shop, etc.

The charter of the company and the grant of lands provide for the extension of the road to Ontonagon, and it is but reasonable to assume that the energy, which

has characterized the prosecution of the enterprise thus far under its present efficient management, will result in the accomplishment of the work before the expiration of the time fixed by law. The length of the main line is 62 miles, of branches 20 miles and of sidings 18 miles, making 100 miles of road now constructed and in operation.

The dimensions and capacity of the company's railroad dock at Marquette, a representation of which is given in the accompanying view, are as follows:—Total length, 1,222½ feet; working length, 720 feet ; height above water, 38 feet, and width of top, 53 feet, on which are four tracks for cars. Whole number of pockets, situated on both sides, 136, of which 120 have a capacity of 55 tons each, and 16 (steamboat-pockets) of 100 tons each. From both sides 8 vessels can be loading at the same time, and 6,000 tons have been loaded in a single day. Three vessels arrived on Saturday, after 8 o'clock in the evening, and were loaded and gone early Sunday morning. Vessels with a capacity of 476 tons may be loaded in one hour and fifteen minutes; vessels of 683 tons, in one hour and thirty-five minutes; the average time is three hours. The average capacity of vessels is about 650 tons, ranging from 400 for the smallest to 1,100 for the largest. Total amount of ore shipped over the dock from May 12th, 1872, to the following Nov. 25th, 301,210 tons, of which 75,000 tons were taken by steam, and 225,-ooo by sail-vessels; the estimated capacity of the dock, with a sufficient number of vessels to receive the ore, is 500,000 tons.

The working capacity is indicated by the amount of rolling stock, which at the opening of navigation, 1873, will consist of 1,600 ore-cars, 50 box and platform-cars, 7 passenger and baggage-cars and 28 locomotives. The present officers are: H. N. Walker, of Detroit, *President*, S. P. Ely, Marquette, *Vice-President*, Moses Taylor, New York, *Treasurer*, Freeman Norvell, Detroit, *Secretary*, Jacob Houghton, Michigamme, *Chief Engineer*.

*Directors:* H. N, Walker, Detroit, C. H. Palmer, Pontiac, S, P. Ely, Marquette, John Steward, New York, Alexander Agassiz, Boston, S. L. Smith, Lansing, George Jerome, Detroit, Moses Taylor, New York, C. Francis Adams, Jr., Boston.

By the Peninsula division of the **Chicago and Northwestern Railway** the distance from Escanaba to Lake Angeline is $67^{30}/_{100}$ miles, and the branches completed and in course of construction, $37^{90}/_{100}$ miles; sidings, $15^{90}/_{100}$ miles; making a total length of track between these points of $121^{10}/_{100}$ miles.

The total amount of track between Escanaba and Menominee is $65^{70}/_{100}$ miles, of which $2^{30}/_{100}$ are side-track, making a total amount of track between Menominee and Lake Angeline, inclusive of sidings and lurches, $186^{80}/_{100}$ miles.

Estimated amount of rolling stock, which will be necessary and available for the business of 1873, between Escanaba and Negaunee:

| | |
|---|---|
| Number of locomotives | 33 |
| " ore-cars (750 of them 6-wheeled) | 3,000 |
| " other cars | 100 |

For the estimated business between Escanaba and Menominee:

| | |
|---|---|
| Number of locomotives | 6 |
| " cars (exclusive of ore-cars) | 100 |

S. C. Baldwin, *Div. Supt.*
Marvin Hughitt, *Gen. Supt.* } C. & N. W. R. R.

Statistics showing past production, with present condition and capacity of the mines and furnaces of the Upper Peninsula, might properly follow this historical sketch, thus bringing it to date and supplying facts, which could not well have been incorporated into the text. It was thought better, however, to arrange such information in tabular form, which has been done on Plates XII. and XIII. of Atlas, to which attention is here again called.

The Marquette Mining Journal, of Marquette, Mich., publishes an interesting yearly exhibit of the product and condition of the mines and furnaces.

In Appendix G, Vol. II., will be found statistics of population for the whole Upper Peninsula, from the United States Census for 1870,

*Appendix F., Vol. II.

# CHAPTER II.
# GEOLOGICAL SKETCH OF THE UPPER PENINSULA.
## (Where to Explore.)

### I. GEOGRAPHICAL DISTRIBUTION OF THE ROCK SYSTEMS.

IN prospecting for valuable minerals the intelligent explorer should constantly observe several kinds of phenomena. If his search degenerates into a simple blind hunt for ore, he would deserve the success of a hunter who went into a gameless region, or who hunted for game whose habits he did not understand. The following general geological facts and laws will possess value to the explorer in enabling him to wisely select his field of labor and in prosecuting his work.

As all the *sandstone* suitable for building, which has yet been found in the Lake Superior region, belongs to a system of rocks named by geologists Lower Silurian, and all the workable deposits of *iron ore* have been found in another system called the Huronian, while all the *copper* and workable *silver*, in a third system appears known as the Copper-Bearing Rocks; and as no workable deposits of useful minerals have yet been found in the fourth and oldest system, the Laurentian or granitic rocks, it follows, that it is of the utmost importance to the explorer that he be acquainted with the boundaries of these several fields and not waste his energies on unproductive ground. I do not mean to assert that iron ore will not be found in the Silurian

sandstones, for in St. Lawrence County, N. Y., and in the Maramec district, Missouri, valuable deposits of ore exist in rocks of this age. Large deposits of iron ore also occur in the Laurentian (granite) rocks of Canada and Northern New York, and again, the iron ores of Thunder bay are contained in rocks which the Canadian geologists declare to be the equivalents of our Copper series; but at this date it is a fact, that no workable deposits of iron ore have been found in the Upper Peninsula in rocks of these systems, and an explorer or miner would not be considered wise, who should search for Iron outside the Huronian limits. It is not only important that he be acquainted with the boundaries of the four great rock systems, but also with their leading characteristics. We will therefore first sketch in some detail the geographical distribution of these systems, as developed on the south shore of Lake Superior, beginning with the youngest and uppermost. The reader should have before him the map of the Upper Peninsula Pl. I. of the Atlas. The boundaries marked are not always exact, but embody the best information available and are not far wrong.

I. *Lower Silurian.*—The Lower Silurian system, the youngest or lowest division of the Palaeozoic rocks represented on the Upper Peninsula, is made up of various sandstones and limestones which are fully described in Dr. Rominger's Report, Part III. The entire Peninsula, east of the meridian of Marquette, is underlaid by Silurian rocks and the "Copper range" is flanked by a Silurian flat on the south side, which separates it from the iron series, until the two, together with the South copper range, come together west of Lake Gogebic.

About two-thirds of the whole area of the Upper Peninsula, or 9,982 square miles, is underlaid by this system.

II. *The Copper-bearing Rocks*, corresponding with the upper copper-bearing rocks of the Canadian geologists, occupy a narrow belt on the northwestern edge of the Upper Peninsula. These rocks have less superficial extent than either of the other formations, underlying only about 1,186 square miles, or, say 7 per cent, of the whole surface. For descriptions of them see Prof. Pumpelly's Report, Part II.

III. *The Iron-bearing Rocks*, corresponding, it is assumed, with the Huronian system of Canada, consist of a series of extensively folded beds of diorite, quartzite, chloritic schists, clay and mica slates, and graphitic shales, among which are intercalated extensive beds of several varieties of iron ore. The same rocks occur on the east and north shores of Lake Superior, where they also contain iron. The Huronian area represented on the map equals about 1,992 square miles, or nearly one-eighth of the whole area of the Upper Peninsula.

IV. *The Granitic Rocks*, which so far have produced no useful minerals, and which are believed to be the equivalents of the Laurentian of Canada, are represented as underlaying about 1,839 square miles, equal to 12 per cent, of the total area.

As our examinations in the southwestern part adjoining the Wisconsin lime have not been thorough, there is considerable uncertainty regarding some of the lines dividing the Huronian and Laurentian rocks, and a portion of this region, equal to about 668 square miles, or 4 per cent, of the whole area, is left blank on the map.

While, as has been stated, it is not proven that iron ore may not exist in the other great systems in workable quantities, there is every reason to believe, that by far the greater part, if not all the workable deposits, are contained in the Huronian area above described. It must not, however, by any means be understood, that all of this area is iron-bearing. The several iron districts, which have been more or less explored, will be described in another place; they will be found to cover not more than about one-fifth part of the Huronian area, or, say one-fortieth of the whole area of the Upper Peninsula, and on less than one-half of this area have the ores been proven to have commercial value.

*Recapitulation.*

| | | |
|---|---|---|
| I. | Lower Silurian area, about..... 9,982 | square miles. |
| II. | Copper-bearing area, about..... 1,186 | " |
| III. | Huronian or Iron-bearing area, about.. 1,992 | " |
| IV. | Laurentian area, about..... 1,839 | " |
| | Unknown area, about..... 668 | " |
| | Total area of Upper Peninsula, exclusive of islands, about..... 15,667 | " |

In a complete and systematically arranged geological sketch the lithology of the four systems would properly belong here, but what is written on this subject necessarily pertains almost entirely to the Huronian, the whole matter will therefore be considered in Chapter III., following, and in Appendices A, B and C, Vol. II.

## II.—TOPOGRAPHY.

It is of importance to the prospecter to carefully observe the topography or form of the surface, for it is well known that useful minerals generally occur in corresponding topographical positions over considerable areas; again, the topography is the very best key to the nature of the underlying rocks, if these be concealed by earth, as is often the case. As the human physiognomy indicates the fundamental characteristics of the man, so the earth's physiognomy suggests the forces and materials lying beneath. It is safe to assert that within certain limits an experienced topographical geologist can, from a correct topographical map, judge of the nature of the rock underlying the surface represented; and conversely, from a geological map, he can predict the general form of the surface. In the same way, an experienced explorer does not hesitate to express an opinion as to whether he is on the "mineral range," from the form of the ground. We will now sketch in some detail the characteristic topography of the four great systems.

I. *Silurian.*—The prevailing surface characteristic of the Silurian region is a nearly level plain, underlaid by horizontal sandstones and limestones, often swampy and sometimes, where fire has destroyed the timber, a desert. The tame, flat, sandy and swampy country along the line of the Chicago and Northwestern Railroad, between Escanaba and Negaunee, is underlaid by Silurian rocks, but is far below the average in the value of its timber. Where rivers or water-courses have cut into these rocks, or waves wasted them, perpendicular bluffs are presented, which afford an excellent opportunity to explore and study the formation. The famous "Pictured Rocks" are bluffs of this character, from 50 to 200 feet high. From the top of these bluffs the country is flat, proving that they are the results of the action of water cutting its way into a horizontal plane, and are not, so to speak, built up and completed hills like those of the older rocks.

There is one apparent exception to this general flatness of the Silurian topography. Many of the highest hills and mountains in the Menominee iron region are capped with horizontal sandstone and limestone, which is never found in the valleys; the base, however, embracing the great mass of these elevations is always an old rock, and in the iron fields always Huronian. There is no doubt but that the sandstone once filled the valleys, extending in an unbroken bed of irregular thickness across the whole of the Menominee region, covering the older rocks, just as it now covers them further east. Since its formation it has here been mostly eroded, but still caps the elevations as described. If it were all gone, the hills, made as they are, largely of highly inclined beds of quartzite, marble and ferruginous rocks, would remain, but with somewhat diminished heights.

Should the eastern part of the Upper Peninsula be elevated at any future time, so as to bring the underlying azoic rocks above the lake level, the Silurian rocks may there also become so eroded as to only cap the Huronian hills, as they now do in the region described. That the older rocks extend eastward under the Silurian, is, I suppose, a geological necessity, and is, I think, directly proven by the existence of local magnetic attractions in this Silurian area, which are undoubtedly due to the existence of beds of iron ore in the underlying Huronian. The explorer in the Menominee region finds these beds of sandstone much in his way, covering, as they do, in some instances, the ores.

Small lakes of clear water, with sandy bottoms but no outlets, are a characteristic feature of the Silurian area. The U. S. Survey maps represent about one-half of the whole surface of these rocks, which underlie the central and eastern portion of the Upper Peninsula, as swamp ; the solid rock has often been found within a few feet of the surface in the swamp region. The western Silurian area being the prolongation of the Keweenaw Bay valley west, and embracing in part the Sturgeon, Ontonagon, Presquisle and Black rivers, has fewer lakes, much less swamp, and is more broken, than the eastern part already described.

Soft woods, including pine, are more prevalent on the Silurian rocks than on the older series; but on the other hand, some of the finest bodies of sugar-maple and beech found on the Upper Peninsula, are on these rocks. Beech has not, so far as I know, been found growing on the older rocks; whether this be due to climatic or soil influence has not been determined.*

The water divide, or height of land, of the central and east part of the Peninsula, is much nearer Lake Superior than Lake Michigan. It is an irregular line, approximately parallel with the shore of the lake, having an elevation where it crosses the Peninsula railroad of about 650 feet. See Map, PL I.

*A timber map has been prepared, but could not be published for want of means.

II. *Copper-bearing Rocks.*—There is probably no more striking topographical feature in Michigan, than the “Mineral" or Copper range, including Keweenaw Peninsula, of which it is the backbone. Ranges would better express the fact, for west of the Ontonagon river there are three; the Main or central Range which extends from Keweenaw Point far into Wisconsin, being flanked on the north by the Porcupine mountain range and on the south by the South copper range, each separated from the other by broad Silurian flats. The general trend of the three ranges is north, 60° east, and south 60° west, but they are not quite straight, as may be seen on the map. The ridge is broad, generally more than three miles, and the crest quite even, but is cut down to lake level at Portage lake, and further west is deeply eroded by the Fire steel, Flint steel, Ontonagon and other rivers. The surface of the ridge or plateau is from 500 to 600 feet high in the vicinity of Portage lake, and rises to a height of 884 feet at Mount Houghton, near Keweenaw Point. Between the Ontonagon river and Lake Gogebic the Central range attains, in isolated peaks, an elevation of 1,100 feet, and the Porcupine mountain range is over 900 feet high; the range is more broken towards the west, and in the vicinity of Rockland presents a series of oval mammillary hills with steep escarpments on the south side. This is also the character of the South copper range, between Lake Gogebic and Montreal river.

The iron range immediately south of the South copper range, and west of Gogebic, is lower, the hills having more gentle slopes; the range being in places obscured by low ground. As this is the only part of the Upper Peninsula, so far as I know, where the iron explorer may come in contact with copper rocks, it is important to observe the topographical differences above noted, especially as the copper traps in some places resemble the diorites or greenstones of the iron region, Lakes and swamps, so numerous in the iron and granite regions, are infrequent on the copper belt, as must follow from the form of the surface. The reason for the striking regularity in the leading topographical features of the copper range is to be found in the great uniformity in the strike and dip of the rocks, as is explained under Stratigraphy. The timber of the copper range is

generally sugar-maple, is abundant and of excellent quality; very little pine or other soft wood occurs here.

III. *Iron-bearing Rocks.*—The topography of the Huronian rocks differs essentially from that of either the Silurian, or the copper series. It is almost everywhere hilly and often mountainous, forming peaks higher than any in the copper range; but instead of a continuous range, or series of parallel ranges, it is rather a broad belt or irregular area of mountains, hills, swamps and lakes. It may be said, that the ruling topographical features, especially the mountains, have a general east and west trend, but there are numerous exceptions to this law; for example, the Michigamme river, from the lake to Republic mountain, runs northwest to southeast; and Michigamme lake itself has a north-south arm, nearly as long as the main lake, which runs east-west. The ridges west of Paint river, in T. 42, R. 33, run north-south, conforming with the bedding of the rocks.

Probably one of the most persistent ridges in the Marquette region is formed by the "lower quartzite," which outcrops on the shore of Lake Superior just south of Marquette, and rising rapidly from the lake it forms Mt. Mesnard on Sec. 34, T. 48, R. 25; from this peak it extends westerly, crossing the railroad at the Morgan furnace, then by way of the old Jackson Forge and along north side of Teal lake to south side of Deer lake, it holds its westerly course for a total aggregate distance of over 15 miles. The Chocolate and Morgan flux quarries and the Teal lake whetstone quarry are in this range. More persistent and conspicuous, and nearly as long, is the Greenstone ridge, which skirts the north side of the Michigamme and the Three lakes extending from the Bijiki river to the west end of the First lake, a distance of eleven miles:—points on this range are three hundred feet above Michigamme lake, which is 950 feet above Lake Superior. Summit mountain, one mile easterly from the Foster Mine, is one of the prominent landmarks of the region, looking as it does from an elevation of about 1,300 feet over the flat granite and Silurian region to the south. It forms one of a chain of hills which extend from the south end of Lake Fairbanks westerly for about 10 miles, but which form in no sense a ridge.

The mountains, or hill ranges, above described are exceptional in their regularity and continuity. Broken chains of irregular hills and short ridges of various sizes, separated by lakes and swamps, is the prevailing character; the highest hills are seldom over 300 feet above the low grounds at their base and about 1,300 feet above Lake Superior. Outcrops of rock, forming often perpendicular ledges of moderate height, are more numerous in the iron-bearing rocks, than in either of the systems described, except in the westerly part of the copper range. Although the relief of the surface is considerably modified by drift, it is generally plain that the strike, dip, and texture of the underlying rock has determined the general outline or contour; we should therefore expect that the great variation in these rocks, hereafter to be described, would produce this varied topography.

The topography of the Marquette region is very like the iron region of southern New York and northern New Jersey, except in its smaller elevations; a profile running north and south through the Jackson Mine, Marquette, would closely resemble a profile running northwest and southeast through the Sterling Mine, New York, platted say to half the scale.

Passing to the Menominee iron region, we find greater simplicity in the geological structure and a correspondingly less varied surface.

Obeying the influences of the great rock beds beneath, the elevations there have a tolerably uniform east-west trend and consequent parallelism. The south iron range, of which the Breen Mine is the east end so far as known, can be traced through a greater part of its course by a ridge, often bold, which crosses Town. 39, R. 29, and T. 40, R. 30, for a distance of over 15 miles, the bearing being west-northwest. The north iron range, about 12 miles from the other in the south part of Town. 42, Ranges 28, 29 and 30, is in places a prominent topographical feature. The capping of horizontal sandstones, which has already been mentioned as characterizing the Menominee hills, gives a somewhat more even character to the crest lines, and in places produces a strikingly different profile.

The Gogebic and Montreal river range, above referred to, is better marked by its running parallel with and lying south of the South copper range, than by any essential character of its own.

IV. *Laurentian*.—The surface of the granite country south of the Marquette region, at the same time the most extensive and best known, is not unlike that of the iron-bearing rocks on a much smaller scale. There are no mountains, the hills are lower, being usually mere knobs, seldom exceeding 50 feet in height; the ridges shorter and swamps more numerous. A coarse pitting of the surface, or promiscuous sprinkling of little hills, and low, short ridges may convey the idea. Sometimes the knobs range themselves in lines constituting low ridges, with jagged crest line ; these ridges, when near the Huronian rocks, are usually parallel with them; if they have any prevailing direction, it is east and west.

Perpendicular walls of granitic gneiss 15 to 40 feet in height sometimes face the ridges for several hundred feet in length, constituting the most regular topographical feature within the Laurentian area.

Small beaver meadows are common here as in the other rocks, and sometimes a succession of dams, one above the other, forms a long narrow meadow, which produces considerable quantities of wild hay.

This region was once heavily timbered, largely with pine, which has been prostrated by a hurricane, and since burned over several times. The soil, naturally light, has burned up and so washed away, as to expose the white-gray, pink and dark-green rocks in every direction, affording an unsurpassed opportunity to study this series; the boulders are very numerous and often of

great size. The light colors of the rock, scarcity of vegetation and an abundance of standing trunks of dead trees give the landscape a peculiar aspect; but a second growth of poplar and wild cherry is rapidly changing this dismal character.

The fallen timber, swamps, steep bluffs and ledges, and numerous boulders, make travelling through the Laurentian area difficult and laborious in the highest degree. Florida swamps have denser vegetation and are much larger; sea-coast marshes often have more mud; the highlands of the Hudson present more formidable elevations, but, all in all, the writer believes it requires more physical exertion to travel 5 miles per day (all a man can accomplish with a pack) through Lake Superior granite windfall, than in any other region east of the Mississippi. The trees were prostrated by northwesterly winds, judging by the direction in which they lie; persons have travelled in a southeasterly direction on the trunks of fallen trees (mostly pine) for over a mile without once touching the ground.

## III.—STRATIGRAPHY.

Scarcely second to the two classes of phenomena already mentioned is the observance of the rock masses, or strata, as to their direction or strike, and inclination or dip; the order of their superposition and thickness; but more important than either is to ascertain between what rocks the mineral sought for occurs. Useful minerals which occur in beds, like the iron ores of Lake Superior, will usually be overlaid and underlayed by rocks, having different characters and which maintain those characters for considerable distances. Next to finding the ore itself, it is desirable to find the hanging or footwall rock. Whoever identifies the upper quartzite in the Marquette region, or the upper marble in the Menominee region, has a sure key to the discovery of any ore that may exist in the vicinity.

With few exceptions, all the rocks in the region we are describing are stratified—that is, arranged in more or less regular beds or layers, which are sometimes horizontal, but usually highly inclined. This stratification or *bedding* is generally indicated by a difference in color of the several layers, oftentimes by a difference in the material itself, but occasionally the only difference is in the texture or size and arrangement of the minerals, making up the rock. Thus, rocks made of quartz, sand and pebbles, may vary from a fine sandstone to a coarse conglomerate. In general, a *striped rock*, whether the stripes be broad or narrow, plain or obscure, on fresh fracture or weathered surface, is a stratified rock. Usually rocks split easier on the bedding planes, than in any other direction; but the converse is true in the case of most clay slates and in some other rocks, which split more easily on their *joints* and *cleavage* planes, the direction of which seldom coincides with the bedding and is often at right angles with it. If a rock splits most easily along its striping, it is always safe to assume, the true bedding planes have been found. Such planes are supposed to have had their origin in the original deposition of the mud and sand, of which most rocks are made. Similar marks can be seen in excavations in sand and clay, which may be regarded as unconsolidated rocks. The cleavage and joint planes above indicated, which are always more regular in strike and dip, than the others, are supposed to have originated from pressure, subsequent to the formation of the rock.

The term plane, as used in describing bedding, must not be understood to signify a straight-line surface; on the contrary, they are usually curved planes, sometimes folding and doubling on each other, so as to produce a very intricate structure. Not only do these plicatures take place on the small scale, as shown in hand specimens, but precisely similar folds exist in masses of rock, which may be hundreds of feet thick. The resulting curved strata take the name of troughs or basins, if the convexity is downward, the general term *synclinal* structure being applied to this form. Connecting the synclinal troughs and basins are *anticlinal* domes and saddles. The whole may be described as rolling or wave-like forms. Sometimes the power which produced the *folds* seemed greater than the rocks could bear, and cracks or breaks, and *faults* or throws, are the result, though these are not numerous in the Lake Superior region. Cracks so produced and filled with material, other than that constituting the adjacent rocks, are called *dykes;* or if the material be crystalline and metalliferous, *veins*. As iron ore in workable quantities does not occur in this form in this region, vein phenomena will not be considered here.

An examination of the four great rock systems will illustrate and prove the above remarks on stratification.

I. Beginning, as before, with the uppermost or youngest, which is at the same time the softest and lightest rock, the *Silurian* brown and gray sandstones and limestones, so well exposed on the south shore of Lake Superior, we have a perfect illustration of the regular and horizontal bedding, without folds, faults, or dykes. An inspection of the Marquette quarry, or any of the numerous natural exposures, will convince any one that these rocks are but consolidated sandbanks.

II. *The Copper-bearing Rocks.*—Some beds of this series are sandstones nearly or quite identical with the Silurian in appearance, but the great mass is made up of different varieties of copper trap, which are often amygdaloidal; interstratified are beds of a peculiar conglomerate. The stratification of these rocks, considered in large masses, is nearly as regular as the sandstones, and differs only in the fact that the layers are inclined, dipping northwest and north toward Lake Superior at a varying angle, which seems to be greatest on the south side of the range, and is there often vertical. It is least at Keweenaw Point, where it is as low as 23°.

III. *The Iron-bearing* or *Huronian Rocks* are immediately beneath, and are exposed to the south of the copper rocks. This series are, on the average, heavier and

harder, than either of the others and folded to a far greater degree. The prevailing rock is a greenstone or diorite, in which, like the copper traps, the bedding is usually obscure; but the intercalated schists and slates which usually bear strong marks of stratification, make it usually not difficult to determine the dip of the beds at any point. This dip varies both in amount and direction, but is generally at a high angle, and is more apt to be to the north or south than in any other direction.

IV. Descending to the oldest or bottom rocks of the Lake Superior country, the granites and associated beds (*Laurentian*), we find the bedding indications still more obscure and often entirely wanting. Here there is, if possible, more irregularity in strike and dip, than in the Huronian.

## IV.—BOULDERS (FLOAT ORE).

Fragments of iron ore which have been detached from the parent ledge and are found loose on the surface, or in the drift beneath, possess great interest to the explorer, and are among his most important helps and guides. The same remarks are applicable, but to a less extent, to boulders of other rocks. As a rule, in the iron region of Lake Superior, it is safe to assume, that when boulders of a particular variety of rock are abundant on the surface, a ledge of the same will be found in place very near—if not immediately under the boulders, then up hill from them, or perhaps a little to the north or east; the more angular or sharp-cornered the boulders, the nearer we would expect to find the ledge.

In the Menominee region it may almost be said, that this rule is invariable, as there seems to have been less movement of the drift material here than farther to the north.

In the Michigamme district a large amount of float ore is found some distance south of the iron range, part of the fragments being very large and containing at least 100 tons of ore. Sections 19, 29, and 30 of T. 48, R. 30, and Sections 25, 36, and 35 of T. 48, R. 31, contain many such boulders, which were probably derived from the Michigamme range. Considerable digging has been done at several of the larger boulders, which has failed to find the ore in place, and the magnetic attractions are of a character which indicate detached boulders and not a continuous ledge. For mode of distinguishing boulders of magnetic ore, see chapter on use of the magnetic needle.

These Michigamme ore boulders are all found south of the iron range which produced them, and but few at a greater distance than two and one-half miles, most of them being much nearer. This southerly and westerly direction of the drift is, so far as I know, universal in the iron region of the Upper Peninsula, and it is fully confirmed by the direction of the drift scratches in the solid rock, which vary from north to east, averaging about northeast and southwest.

Therefore, if iron boulders be found in considerable abundance, the explorer may assume, especially if they are angular, that he has iron underneath the surface; if rounded or abraded, the ledge may be to the north or east. If the boulders be magnetic, the place of the ledge should be found, with comparative ease, by means of the needle; but if specular, it may be an expensive and difficult work. Soft hematite, from its nature, can never occur in the form of boulders, as it would weather into a reddish soil. Iron boulders are often met with in digging test-pits and shafts; in such instances, if near the ledge, I have generally found the ore in place very near; if considerably above it in the drift, the same rules would apply as to surface boulders.

Attention should be given to the character of boulders other than iron, which may be associated with it, or found where there is no iron. Occasional granite boulders occur everywhere in the Lake Superior iron region and have no economic significance. I have never seen an abundance of granite boulders, however, except over granitic rocks, and so far, these rocks have not produced workable deposits of iron.

Boulders of quartzite, diorite and slate usually accompany those of iron in the Marquette region, and marble boulders, as well as quartzite, are most significant in the Menominee region.

The above laws, regarding the occurrence of *iron boulders*, give the facts regarding their geographical distribution great importance in iron explorations. If, where there are iron boulders, we may confidently look for iron, then conversely, where there are none, we should not expect to find iron. I do not assert that every deposit of hard ore is marked by float or boulders, but, so far as the facts have come to my knowledge, this Is the case in the region under consideration.

Except in one or two instances, which have not been verified, I have heard of no iron boulders in the so-called silver-lead region, which extends north from the Marquette iron region to Lake Superior, which would lead one to believe, that merchantable hard ores will be found there. And except the L'Anse range in north part of T. 49, R. 33, this is true of the belt of country, west from the so-called silver-lead region. The region, without iron boulders, may be briefly described by saying, that it is bounded west and south by the line of the Peninsula division of the Chicago and Northwestern, and by the Marquette, Houghton, and Ontonagon railways. In other words, a person travelling by rail from Escanaba through Negaunee to L'Anse would have the region of iron boulders on the left, and the boulderless region on the right hand, or towards the lake.

Limiting their distribution still further, we may say, that iron boulders have only been found in quantity and quality, which would point toward economic importance in (1.) T. 45, R. 25, in the vicinity of the S. C. Smith mine, which is the most easterly locality in which they have been observed on the Upper Peninsula of Michigan; (2.) the Negaunee and Michigamme iron districts, extending

in belts of irregular width from Negaunee west to the First lake in S. 17, T. 48, R. 31; (3.) the L'Anse iron range, in north part of T. 49, R. 33; (4.) south and southwest from Michigamme lake, embracing wholly or in part Towns. 44 to 47 north, and Ranges 39 to 32 west; (5.) the Menominee iron region, embracing wholly or in part Towns. 39 to 42 north, and from Range 28 west to the Menominee and Brule rivers, but not west of Range 33; (6.) the Lake Gogebic and Montreal river iron belt, south of the South copper range.

Hunting for boulders is something like hunting game; when on the ground the best woodsman, the most active and observant will be the most successful, assuming, of course, that he knows at sight what he is looking for. (See chapter on Explorations.) I have found Indians good help in this kind of work, and believe that the incentive of a bonus in money for boulders or outcrops is often good policy. The best places in which to observe boulder phenomena is in the beds of rapid streams and under the roots of trees, the latter, probably, having been the most fruitful field. A windfall is as good as five thousand dollars' worth of test-pits to the section.

With boulder phenomena may be classed the reddish or *brownish earth*, which comes from the disintegration of iron ore rocks of a hematitic character, and *magnetic sand*, which is very generally distributed, and which comes from the disintegration of magnetic ore. Such material may, for our purposes, be regarded as made up of minute boulders and the same remarks will apply, except that I should not expect to find red earth far removed from the ferruginous rock which produced it. Minute quantities of magnetic sand can be found almost everywhere in this region.

## CHAPTER III.
## LITHOLOGY.* (*Mineral Composition and Classification of Rocks.*)

IN the preceding sketch the terms sandstone, limestone, conglomerate, trap, diorite, granite, etc., occur. It is evident that no satisfactory and useful progress can be made in geological field-work, which includes prospecting, until one has learned to recognize and name the more common varieties of rock. For this purpose we have to give attention to their mineral composition, that is, we must ascertain of what simple mineral or minerals the rock in question is chiefly made up and to observe, whether such minerals are angular, presenting bright facets (crystalline), or whether they are rounded like sand and gravel (fragmental). Not only must the prospector be able to recognize at sight the mineral he is seeking, but in case it is not exposed, which often happens, then those rocks, which are known to indicate its presence or absence. Experienced prospectors will not spend much time in looking for iron among granite rocks, nor in the copper traps, nor yet in the region of horizontal sandstones and limestones.

The mineral composition of rocks, by which they are identified, described and named, constitutes the science of Lithology, one of the most abstruse departments of Geology. A high authority on this subject has remarked:—"In all attempts to define and classify rocks, it should be borne in mind that they are not definite lithological species, but admixtures of two or more mineralogical species, and can only be arbitrarily defined and limited." When rocks present recognizable crystalline minerals, the task of describing and naming is comparatively easy; but when the constituent minerals are obscure, as is often the case in the rocks we are considering, the attempt to employ specific names, which shall define such vaguely compounded aggregates, will be exceedingly difficult.

*The stratigraphical order of the rocks here considered will be found in the succeeding chapter.

The difficulty may be illustrated by supposing, were an attempt made, to give such name to a common brick, as will designate its composition and structure. Bricks are made in general of sand and clay, but several varieties of sand, and as many of clay, are employed in different localities, which, being mixed in various proportions and differently burned, give rise to a wide variation in composition and appearance and could not be expressed by a single word or term. In the case of rocks we have, of course, no previous knowledge of the numerous ingredients employed in their composition, by which the difficulty is greatly increased. It may seem at first sight, as if chemical analysis should form a reliable basis for rock nomenclature, but this is not the case. Van Cotta asserts, that a rock containing 72 silica, 11 alumina, 2.8 oxide of iron, 1 lime, 1.2 magnesia, 1.2 potash, 2 soda and 0.4 water, may be either a granite or a gneiss, protogine, granulite, quartz-porphyry, felsite, petrosilex, pitch-stone, trachyte-porphyry, obsidian, or pearlstone; and by giving a little range in the percentages of some of the constituents, half a dozen other rock names could be added. Here we have eleven different rocks, having precisely the same chemical composition, but widely different in physical character.

It must be borne in mind, in studying this subject, that the solid crust of the globe is almost entirely made up of ten or eleven simple *chemical elements*, which variously combined, according to the laws of chemistry, produce the few *minerals* which in turn, mechanically mixed, constitute ordinary *rocks*; hence we should expect, that the average chemical composition of a series of rocks, wherever found and of whatever character, would nearly agree.

The materials of the first formed rocks, whatever their origin, have been worked over and over by rains and waves and chemical forces, distributed over sea-bottoms, consolidated and elevated, to pass again through the same process by just such means, as are now at work in producing similar results.

The reader who may not be familiar with the physical characters and composition of the minerals—quartz,

feldspar, hornblende, chlorite, talc, argillite, mica and the oxides of iron and manganese, which make up the great bulk of the rocks herein described, is advised to refer to some elementary work on geology or mineralogy.

Extensive rock formations are now generally named after the locality, where they were first thoroughly studied, or are best exposed, and their minor beds and layers are often named according to their peculiar mineral composition, or with reference to their relative age, that is, order of superposition. The names Laurentian, Huronian and Silurian are geographical names of the first class. No attempt will here be made to describe the lithological character of either the Copper bearing traps, conglomerates and sandstones, nor the Silurian sandstones and limestones; these will be fully treated by Prof. Pumpelly and Dr. Rominger, respectively. What has been and will hereafter be said of the geographical distribution and topographical and stratigraphical character of these rocks was considered necessary, to acquaint the prospector and explorer with those general principles of geology, which lie at the foundation of intelligent and successful work. Whoever would become thoroughly acquainted with these systems is referred to Parts II. and III. of this volume. A number of specimens from the Laurentian are described in Appendix A, Vol. II. (see descriptions 252 to 299); but they do not cover all the lithological families represented in that system.

In subdividing the Huronian or iron-bearing series, which we have particularly to study, the rocks have been grouped (1) *lithologically, i.e.*, according to their mineral composition, and (2) *stratigraphically, i.e.*, according to relative age. As this system was first described and named by the Canadian geologists, their names have been employed as far as possible in the body of this report; the identity in composition of many of our rocks with theirs, having been established by an examination of a large number of Marquette specimens by Dr. T. Sterry Hunt.

Alexis A. Julien, A.M., of the School of Mines, New York, has made careful studies, both in the field and laboratory, of a large number of specimens from the Lake Superior region, his results being in part given in Appendix A, Vol. II. As his paper was not obtained in time to modify this chapter and the geological descriptions which follow, in accordance with Mr. Julien's nomenclature and orthography, what follows may be regarded as an independent and popular presentation of this subject, which is scientifically and more fully treated in the Appendix, the practical needs of the explorer and miner being here chiefly considered.

The specimens examined by Mr. Julien are in part from the Marquette region; the L'Anse, Menominee, and Gogebic districts are also well represented, thus embracing an area over 125 miles long and having an extreme width of 60 miles. The specimens described belong to a catalogued collection, numbering over 2,500 specimens, being probably the most complete suite of rocks from the Azoic of the Upper Peninsula yet collected. Those from the Montreal river and Gogebic district were collected by Prof. R. Pumpelly and myself, and are believed to be the first described from that region. Prof. Pumpelly took very full lithological notes in the field, but has not yet, so far as I know, made them public. Dr. H. Credner's publications are very full on the lithology of the Menominee region, he having spent two seasons in that field.

Appendix B, Vol. II., contains a list (named by Mr. Julien) of the specimens constituting the State collection, over thirty duplicate suites of which were collected and have been distributed among the incorporated colleges of Michigan and other leading institutions and cabinets, of this country and Europe.

Appendix C, Vol. II., contains a list of 76 specimens, number 1,001 to 1,076, determined by the microscope by Chas. E. Wright, under the direction of the Faculty of the School of Mines, Freiberg, Saxony. A suite of these rocks is at Freiberg and others in Michigan. The several beds or layers of the Huronian system, as developed in the Marquette region, are numbered upwards from I. to XIX., always written in Roman numerals. These strata being particularly described as to thickness, geographical extent, etc., in following chapters, it need here only be said in general that I., II., III., IV. are composed of beds of silicious ferruginous schist, alternating with chloritic schists and diorites, the relations of which have not been fully made out; V. is a quartzite, sometimes containing marble and beds of argillite and novaculite; VI., VIII. and X. are silicious ferruginous schists; VII., IX. and XL are dioritic rocks, varying much in character; XIII. is the bed which contains all the rich specular and magnetic ore, associated with mixed ore and magnesian schist; XIV. is a quartzite, often conglomeritic; XV. is argillite or clay slate; XVI. is uncertain, it contains some soft hematite; XVII. is anthophyllitic schist, containing iron and manganese; XVIII. is doubtful; XIX. is mica schist, containing staurolite, andalusite and garnets. This classification, it will be borne in mind, applies only to the Marquette region, the equivalency of the rocks of the Menominee and other regions not having been fully made out.

These beds appear to be metamorphosed sedimentary strata, having many folds or corrugations, thereby forming in the Marquette region an irregular trough or basin, which, commencing on the shore of Lake Superior, extends west more than forty miles. The upturned edges of these rocks are quite irregular in their trend and present numerous outcrops. While some of the beds present lithological characters so constant, that they can be identified wherever seen, others undergo great changes. Marble passes into quartzite, which in turn graduates into novaculite; diorites, almost porphyritic, are the equivalents of soft magnesian schists. In this fact is found the objection to designating beds by their lithological character, while to numbers or geographical names no such objection exists. The total thickness of the whole series in the Marquette region is least at Lake Superior, where only the lower beds exist,

and greatest at Lake Michigamme, where the whole nineteen are apparently present, and may have an aggregate thickness of 5,000 feet.

Near the junction of the Huronian and Laurentian systems, in the Marquette region, are several varieties of gneissic rocks, composed in the main of crystalline feldspar, with glassy quartz and much chlorite. Intersecting these are beds of hornblendic schist, argillite and sometimes chloritic schist. These rocks are entirely beneath all of the iron beds, seem to contain no useful minerals or ores and are of uncertain age. No attempt is here made to describe or classify them.

The following description and classification has resulted from an examination of a large number of specimens of "ore and rock," collected with the view of embracing all varieties found in the iron-bearing series of the Marquette region, together with a study of the parent masses in the field, which latter is of great importance on account of the variations in composition of the same bed, to which attention has been directed.

The *specific gravity* of over five hundred specimens, weighing from 3,000 to 10,000 grains, was determined by a balance, which turned when loaded, by the addition of two grains. The magnetic properties were carefully examined and are given in part in the chapter on the magnetism of rocks. Most of the specimens examined were arranged into ten *lithological groups* (having no reference to age), which are designated in what follows by the first ten letters of the alphabet. When a specimen represented a very small and unimportant layer, it was thrown out as exceptional and not important to the object of this report.

It must be constantly borne in mind, that the divisions between these ten lithological groups or families are not sharply marked; one passes into the other by insensible gradations, thus producing many intermediate varieties, which it was difficult, if not impossible, to classify or describe. The first family, A, will include all valuable iron ores, the remaining nine (B to J) will include "rocks." But as iron ore, in large masses, has all the geological characters of the associated rocks, the popular general classification of minerals into "ores" and "rocks" will be disregarded except as above mentioned. Except in a few instances, where Mr. Julien's collection was incomplete, all minute lithological descriptions have been omitted, for such, frequent reference will be made to his paper ; and for the reason that he had not access to maps and sections, which gave the stratigraphical distribution of the various rocks, this part has been made quite full in that respect.

In a few instances reference is made to the full suite of Marquette rocks, numbered 6,000 to 6,222, deposited by me in the cabinet of the University of Michigan, at Ann Arbor.

## A. IRON ORES.

(Occurring in formations X., XII., XIII. and below V.)

Only such ores as are now employed in the manufacture of iron will be described under this head. They are in order of present supply, the (a) specular hematite or *red specular ore*, as this class is designated in the iron trade; (b) *the magnetic*; (c) the "mixed" or *second-class ore*, which may be either specular or magnetic;(d) the *soft hematite*, and (e) *the flag ores*. Another variety, the magnetic specular, might be added, which, as the name implies, is a mixture of the black and red oxides, which gives a purple streak. The local terms "hard," embracing both the magnetic and specular ores, and "soft," for the soft hematites, are convenient.

The commercial statistics, modes of mining, and composition will be considered under their proper heads,* attention being directed here chiefly to the mineralogical and physical character of each ore. Under Woodcraft and Surface Explorations, Chapter VII., are given some brief practical rules for distinguishing iron ores, for the benefit of those, who know little or nothing of rocks.

*See Chapters IX. and X., Plate XIII. of Atlas, and Appendix J, Vol. II.

All the specular, magnetic, and mixed ores, and apart of the soft hematites, are found in one formation; bed XIII. of my arrangement, which has its most easterly exposure near the Jackson mine and extends irregularly and indefinitely westward, embracing all the mines now producing rich hard ore.

It may be said of these ores in general, that they are essentially oxides of iron, with a few per cent, of silica added, and generally contain minute quantities of sulphur and phosphorus, but no titanium. Alumina in quantity not exceeding two and one-half per cent., with one-fourth as much manganese, is sometimes found, together with alkalies, which seldom aggregate over one and one-half per cent. The soft hematites are in part hydrated sesqui-oxides, hence contain water and usually more silica, than the hard ores; traces of organic matter are sometimes found, and manganese is almost exclusively confined, to the soft ores. Many specimens of specular and magnetic ore have been analyzed, which gave ninety-eight per cent, of oxide of iron, the balance being nearly pure silica. For numerous analyses of all the ores, see Chapter X., Appendix J, Vol. II., and Plate XIII. of Atlas. Weathering has no appreciable effect on the hard ores, except to crumble and cover with soil the more granular varieties. The exposed surfaces of the compact ores (by far the most prevalent variety) are of almost as high lustre as fresh fractures, and are often highly polished, showing no weathered coating like almost all other rocks. In the "mixed ores" the jasper bands are sometimes slightly elevated on the weathered surface, due to their greater hardness.

*a. Red Specular Ores.*—Miners divide these into *slate* and *granular*. The former resembles closely in its structure the soft greenish chloritic schists, commonly associated with it. The slabs, into which the slate ore easily splits, are not uniform in thickness like roofing-

slate, but taper always in one and often in three ways, producing elongated pieces often resembling in form a short, stout, two-edged sword-blade, with surfaces as bright as polished steel, but striated and uneven. See Specimens 46, 47, 48, State Collection, Appendix B, Vol. II., and 1,050 Appendix C, Vol. II. Thin edges of such slates can be pulverized into a bright scaly powder by the finger-nail, and occasionally the whole mass is too friable for economic handling. The magnet will generally lift one or two per cent, of the powdered ore, and occasionally one-fourth of the whole, in which case the streak is purple. These last, constituting magnetic slates, are more friable than the pure red specular slates, due in some way to the larger admixture of magnetite. See Specimen 49, State Collection, Appendix B, Vol. II.

The *granular* or massive specular ore shows no tendency to split in slabs, and is made up usually of minute crystalline grains, which are sometimes, however, so large that their octahedral form can be easily recognized without the aid of a lens; fine specimens of this variety occur at the Cleveland and New York Mines. Mineralogists apply the name *martite* to the red oxide of iron, when it has the crystalline form of the octahedron, which belongs to magnetic ore. See Specimens 2, 43, 44 and 45, State Collection, Appendix B, Vol. II. It is not improbable, that all of the granular specular ores under consideration may have once been magnetic and in some way have gained the two per cent, of oxygen necessary to change them from black to red oxides. See Dana's System of Mineralogy, 5th ed., p. 142.

The granular ore is generally firm in texture and never friable, like the granular magnetic. Some highly compacted varieties, which contain a little silica, are very hard, constituting the hardest rock to drill which the miner encounters. This variety is called the "fine-grained steely ore;" some specimens of it possess almost the highest specific gravity observed, 5.23, while the rich softer ores of the same class averaged about 4.85. See Spec. 45, State Collection, Appendix B, Vol. II.

From the examination of a considerable number of specimens of red ore, it was found that the magnet would usually lift an appreciable portion of the powder. In the case of one coarse-grained specimen of pure ore from the New York mine, one-third of the pulverized ore was removed by the magnet. Spec. 1060, App. C, Vol. II. The percentage of powder lifted by a magnet in twenty-one specimens, together with color of powder, is given in Table, App. H, Vol. II. Numerous specific-gravity determinations of this variety of ore will be found in App. B, Vol. II.

*b. Magnetic Ore*.—The description given above of the granular specular ore applies with equal force to this class, except that the latter is more of granular and often friable, has the magnetic property and gives a black or purple powder instead of red. Sometimes the rich magnetites crumble easily into grains, like some Lake Champlain ores, to which the term "shot ore" is applied; again, it is very hard, as in Pit No. 8 of the Washington mine. See Specs. 39, 40, 41 and 42, State Coll., App. B, Vol. II. The compact tabular form so frequent in the magnetic ores of New Jersey and Southern New York is not common in the best ores of the Marquette region, nor are the latter ores as highly magnetic as the former, or at least good loadstones are not so common; the ore from the Magnetic mine (see Spec. 17, State Coll.) has most of this tabular character.

Typical *slate* ores occur with the magnetites, but they are of the character already described, that is, mixtures of the two oxides, the magnet not removing over one-fourth of the powder, while it takes all in the case of the granular variety. The specific gravity of the granular magnetic ores, as will be seen in Appendix B, Vol. II., varied from 4-59 to 5.01, the average of many specimens being 4.81. Specs. 1,054 and 1,059 of Appendix C, Vol. II., are also varieties of this ore.

The following minerals and rocks are most commonly associated with hard ores: a soft grayish-green *chloritic schist*, which sometimes, owing to bad sorting, goes to market in sufficient quantity to perceptibly reduce the furnace yield. The magnesia it contains might tend to stiffen the slag, otherwise it can have no effect in the furnace further, than what is mentioned above. This rock is described under Group D. See Specs. 53, 54, and 55, State Coll., App. B, Vol. II.

*Micaceous red oxide of iron* often occurs in scales and bunches, particularly in proximity to jasper. It has been improperly called plumbago, but is in reality in no way related to it, being chemically pure oxide of iron, having the crystalline structure of mica. A soft whitish mineral, often called *magnesia*, and appearing not unlike flour, occurs occasionally in specular ore and frequently in "soft hematite." This substance is usually most abundant in the more jaspery varieties of specular ore; an examination by Prof. Brush determined it to be *kaolinite*, a hydrated silicate of alumina (clay) in minute crystalline scales. The presence of this clay in small quantity could not but help the working of the furnace, by forming a more fusible slag, but it would of course diminish the yield of iron, if in quantity.

The needle and velvety forms of the mineral *Göethite* (a hydrated oxide of iron) are not uncommon at the Jackson mine, and "*Grape ore*" (botryoidal limonite), sometimes finely colored with yellow ochre, is found at several of the mines, but always in soft hematite. Fine specimens of crystallized quartz are rare, and no form of lime has been observed, although analyses show minute quantities. Bunches of *iron pyrites* are occasionally found, especially in the magnetic mines. At the Champion mine a thin layer containing this mineral occurs next the hanging wall, but it is easily separated from the ore, and is not sent to market. Hornblende, so generally present in the magnetic mines of New York, New Jersey and Sweden, is rare in the Marquette mines, of XII. and XIII.

*c. Second-class Ore*.—By far the most abundant, and commercially objectionable ingredient in the Marquette ores of all kinds, is the so-called jasper, a reddish ferruginous quartz, which is invariably found associated with the best ores, usually in thin seams or lamina conforming to the bedding, but sometimes in a form approaching a breccia. In the hard ores this impurity can usually be readily distinguished, but in the soft hematites it is often only found by analyses. As this rock possesses considerable scientific as well as commercial interest (the better varieties constituting the second-class ores), I will attempt to describe and illustrate it somewhat minutely. It consists of jasper, varying from bright red to dull reddish-brown, with occasional seams of white quartz, and usually pure specular or magnetic ore of high lustre. These materials are arranged in alternating lamina, varying in thickness up to one inch. These lamina are often highly contorted, zigzagging, and turning sometimes in opposite directions within a few inches. The jasper bands are in places broken up into little rectangular fragments, which are slightly thrown out of place, as it were, by tiny faults; the ore fills the break, so that the whole mass has the appearance of a breccia. There can be little doubt, but that the true breccia at the east end of the Jackson mine has this origin, and it would be interesting to consider whether this idea might not be extended to other conglomerates in the Huronian series. The contorted laminated structure, with the striking contrast of colors, is beautiful, and affords fine miniature examples of the anticlinal and synclinal folding and faulting of large rock masses. Sometimes the lamina are very irregular and indistinct, and one or the other of the minerals greatly preponderates. When the jasper layers all thin out (as they usually do somewhere), the ore becomes first class. Some phases of this interesting rock, with descriptions, are given in Appendix K, Vol. II., Figures 19 to 29. See Specs. 36 and 37, State Coll., Appendix B, Vol. II.

The miners call this material "mixed ore;" and those varieties in which the jasper does not constitute over 20 per cent, of the whole, are sold as second-class ore, yielding about fifty per cent, in the furnace; for rail-heads and some other uses requiring a hard iron, the presence of silica in the ore is not objectionable. The quantity of "mixed ore" is greatly in excess of the pure ore, and it will some time undoubtedly have considerable commercial value. Its nature is such, as to admit of the ready mechanical separation of the pulverized ore from the jasper by jigging, a process now employed in separating ores in the Lake Champlain region. For fixing puddling furnaces, or for any branch of iron industry which may demand pulverized ore (as the Elerhausen process promised to), it is very probable that this method may advantageously be employed, and a cheap ore produced.

"Mixed ore" is seen in outcrops far oftener than the purer ores, the softer character of which has caused their erosion, whereby they had become covered with soil; but as the mixed ores are usually associated with the pure varieties, their outcrops possess great significance in prospecting. It is important in this connection not to confound the "flag ores," (e) to be described, which they sometimes closely resemble, with this variety. The quartz of the magnetic mixed ore is usually white, or lighter colored than the red mixed ore.

*d.* The *soft hematites* of the Marquette region differ entirely from the ores above described, and are closely related to the brown hematites of Eastern Pennsylvania and Connecticut. In color they are various shades of brown, red and yellow, earthy in form, and generally so slightly compacted, as to be easily mined with pick and shovel. They are invariably associated with, or rather occur in, a limonitic silicious schist, from which they seem to have been derived by decomposition and disintegration. These ores occur in two distinct formations, X. and XII., and probably mothers, in irregular bunches or pockets, surrounded by the schist and passing by gradations, often abrupt, into it. Scattered through the ore, and conforming in their positions with the original bedding of the rock, are fragments of the schist. When the ore shows stratification, which it often does not, it also conforms with the bedding of the schist. The specific gravity of the soft hematite ore varied from 3.50 to 3.81, the average of five specimens being 3.59, and specimens of the schist varied from 2.80 to 3.38. Strictly this schist should be described under the next group of rocks, B, to which it belongs, but its assumed parentage of the hematite ore, here considered, has led to the digression. See Specs. of soft hematite 1,067, 1,077, 1,079, and of schist 1,040, 1,065, and 1,069, Appendix C, Vol. II.; also, Specs. 25 and 26, State Coll., App. B., Vol. II.

The following analyses of the schist and ore, from the Foster mine, by Dr. C. F. Chandler, will help to make their relations better understood:—

| | Schist. | Ore. |
|---|---|---|
| Sesquioxide of iron | 44.33 | 79.49 |
| Alumina | 2.14 | 1.19 |
| Oxide of Manganese | .16 | .25 |
| Lime | .36 | .27 |
| Magnesia | .13 | .33 |
| Silica | 47.10 | 9.28 |
| Phosphoric Acid | 0.13 | 0.19 |
| Sulphuric Acid | 0.17 | 0.17 |
| Water | 5.19 | 8.74 |
| | 99.71 | 99.91 |
| Equivalent to .... Iron | 31.03 | 55.64 |
| Sulphur | .068 | .068 |
| Phosphorus | .057 | .083 |

It will be observed that the essential difference is in the amount of silica, of which the schist has over 47 per cent., while the ore has less than 10 per cent., and again the ore has 25 per cent. more metallic iron than the rock. The one would evidently be converted into the other, both as to its chemical and physical characters, by the abstraction of the greater part of its silica. It is not at all improbable, that this change may have been brought

about by the alkaline waters of former thermal springs, such as are now producing similar results in other parts of the world. There seems to be very little sand or clay in this ore, and washing has not appeared to improve its quality, as is the case with the eastern ores which it resembles. If the fragments of silicious rock, which are scattered through it, are carefully picked out by the miner, an ore uniform in character is obtained. Except the ever-present silica, there are only two minerals, which it is necessary to mention as being generally associated with this variety of ore. 1st. The *white clay* (kaolinite), above described, which is far more abundant in this ore than the hard ores; bunches as large as a hen's egg being sometimes seen. There can be no doubt but that the kindly working of the furnace usually obtained by using the best quality of this ore, is due in part to this clay as well as to the porous character of the ore. (Calcining the ore would expel the water, of which it contains from 2 to 9 per cent., and should also cause it to reduce more easily in the furnace.) The second and most important mineral to be mentioned is the *oxide of manganese*, usually if not always in the form of Pyrolusite; minute quantities of this metal, always less than one per cent., are sometimes found in the hard ores, but from 1 to 4 per cent. is constantly present in several of the hematite deposits, which is so important an element in their value, as to almost warrant the subdivision of the soft hematites into two classes, the *manganiferous* and *non-manganiferous*.

The recently developed hematite mines near Negaunee, belonging to formation X., contain most manganese; others contain little or none. Scarcely enough of the ore has been worked to determine its place in the market; but there can be no doubt, that when equally rich in metallic iron, the manganese would give this ore the advantage, as a mixture for the furnace, over the non-manganiferous varieties. See Spec. 25, State Coll., App. B, Vol. II.

The hematite ores now in the market, as a class, vary greatly in richness, from an average of not exceeding 40 per cent, of metallic iron for some deposits, to at least 55 Per cent, in the case of others. This difference is in part brought out in Chapter X.

Passing from the Marquette region to the undeveloped districts, we find on the L'Anse range, at the Taylor mine, a large deposit of hematite of excellent quality. At the Breen mine, on the south belt of the Menominee region, is also a good "show" of hematite. Promising indications of this ore were also found between Lake Gogebic and Montreal river; all of these localities and their ores will be described hereafter.

*e.* The last variety of merchantable ore, to be described in this report and designated *Flag*, has been in use so short a time, that but little can be said of its metallurgical character. It corresponds more nearly with the second-class ores (*c*), than with either variety described, differing from it more in structure than in composition. The ores embraced under this head are abundant and have received various local names, which will be found significant and convenient, as lean ores, iron slates, magnetic slates and silicious ores. They have also been called "lower ores," in reference to their subordinate geological position, being older than the rich ores of formation XIII., already described. Flag ores are in reality only varieties of the ferruginous schists, constituting Group B, next to be described, which are sufficiently rich in iron, to possess market value. The percentage of metallic iron in these ores and the associated schists varies from say 5 to nearly 60, those above 50 now constituting a merchantable ore. The remaining material is generally silica, always silicious, but sometimes contains more or less chlorite, manganese, argillite, mica, garnet, or hornblende added. This ore is always flaggy in structure, the layers being occasionally thin enough, to warrant the application of the term slate. All forms of the oxide of iron can be observed, a mixture of the black and red prevailing. The hydrated oxide, producing limonitic silicious schist, has been described above, as the rock from which the soft hematite ore seems to have been derived, and an analysis is there given, to which nothing need be added here.

Stratigraphically these rocks are older than the ores described under *a* and *b*, and constitute at least four beds, X., VIII., VI., and below V., separated by diorites, chloritic schists, quartzites and argillites. Like the mixed ores (c) they are banded, but the marking is seldom bright and often obscure, produced by the interlamination of a dull reddish or whitish quartz, with dull *silicious* instead of *pure* ore. There are exceptions to this rule, but they are not numerous in this region. As this is a point of much importance to iron prospectors, it may be asserted, that when white or red quartz (jasper) is found banded with an ore which can be scratched with the knife, it is in all probability the " mixed ore," which accompanies the pure ores of bed XIII.; but if the quartz be dull and not sharply defined in its layers, and particularly if the knife marks the ore layers like a pencil, instead of cutting them, then we probably have one of the flag-ore formations. It is difficult to say, whether the red or black oxides prevail in many flag ores; hence whether particular varieties should be described as hematitic or magnetic.

All ores and ferruginous rocks become more magnetic as they are followed west in the Marquette region, the maximum amount of magnetite occurring in the Michigamme district. The ferruginous schists of the Republic Mountain series are among the most highly magnetic rocks in the whole region. At the Ogden mine, Section 13, T. 47, R. 27, the abrupt transition of the hematitic into the magnetic variety can be plainly observed, by following the *strike* of the beds less than 200 feet. This transition probably often occurs in the same bed, and, of course, might occur still oftener in crossing the formations, that is, in passing from one bed to another.

Several varieties of *flag ore* will now be described, showing a wide range in lithological character, which we

should not be warranted in grouping together in a strictly scientific classification; but our arrangement of rocks, as has been stated, is rather economic and for the use of practical men.

(1) A showy, granular, chloride, specular ore was found in a small pocket-like mass at the north ¼ post of Sec. 26, T. 47, R. 26, at locality known as the Gillmore mine. A specimen having a specific gravity of 4.28 gave Dr. C. F. Chandler metallic iron 60.46, alumina 3.49, lime 0.60, magnesia 1.33, silica 7.05, sulphur 0.30, phosphoric acid 0.08, water and alkalies not determined 0.77.

A similar ore, but containing some magnetite and peculiar white glistening spots, which appear to be mica scales, is found at the Chippewa location, Sec. 22, T. 47, R. 30. A specimen of this gave Prof. A. B. Prescott metallic iron 53.17, and insoluble silicious matter 20.20. Neither of these varieties are flaggy. See Specs. 6,156 and 6,206, University of Michigan cabinet.

(2) A specular slate ore, holding reddish specks on freshly fractured surfaces, is found at the Cascade location, bedded with layers of jasper, having the local significant name of "Bird's-eye Slate." A specimen of this gave J. B. Britton metallic iron 59.65, insoluble silicious matter 12.24, alumina 0.88, lime 0.14, magnesia 0.08, oxide of manganese 0.02, water 1.08, with traces of sulphur and phosphorus. See Spec. 6,190, University of Michigan cabinet, and Spec. 6, State Coll., App. B, Vol. II.

(3) South of the Cascade range is a flag ore, beautifully banded with red jasper and silicious iron ore, closely resembling some of the mixed ores of Bed XIII. above described, and interesting on this account.

(4) Northeast of the Cascade location, and near the centre of Sec. 29, T. 47, R. 26, is a granular slate ore showing on fresh fracture a peculiar fine reticulated appearance and indistinct octahedral forms. A specimen of this gave Mr. Britton 59.42 per cent, of metallic iron. See Spec. 6,191, University of Mich. cabinet. Since the foregoing was written, shipments of flag ore have been made from the Cascade mines (see Plate XII. of Atlas), and with it a considerable amount of a good quality of specular ore.

(5) At the Tilden mine, while the prevailing ore is a 40 per cent, ordinary red flag ore, there are seams or layers of bright steely ore, very hard and heavy, which yield, according to analyses made by Dr. Draper, 62 per cent, metallic iron. This ore possesses particular interest from its close resemblance to the Pilot Knob ore, Mo.

(6) While the most abundant ore at the Iron Mountain mine, Sec. 14, T. 47, R. 27, is much like the Tilden and Ogden ores already mentioned, there is a peculiar variety, containing manganese, which is also found on the hills south of Negaunee and on the lands of the Deer Lake Company, north of the New York mine. This ore is a very dark-colored silicious hematitic schist, containing on the average several per cent, of manganese, single specimens of which have proved to be nearly pure oxide of manganese. Some of this ore from Iron Mountain was tested in the furnace as a mixture, but was found to be silicious. The need of ferro-manganese in steel-making would make ores of this character a legitimate object of exploration. An experienced iron-master recently expressed the opinion that a 30 per cent, iron ore, with 12 to 20 per cent, of manganese, would soon have commercial value. It is possible that such a variety may exist in some of the beds under consideration. The soft or hematitic variety of this ore has already been mentioned.

(7) Passing from the Negaunee to the Michigamme district, we find two flag ores worth noticing. On the Magnetic Company's property, Sec. 20, T. 47, R. 30, is a large amount of a very compact, hard, heavy, highly magnetic ore, laminated with a greenish horn-blendic mineral, producing an unusual banded structure. A piece of one of the layers of ore gave Mr. Britton 56.78 metallic iron, 19.44 insoluble silicious matter, less than one per cent, of alumina, lime and magnesia, and a trace of phosphorus. See Spec. 18, State Coll., App. B, Vol. II.; also Chapter X. Recent explorations have developed a workable deposit of this ore.

(8) Adjoining this property, to the southeast is Sec. 28, owned by the Cannon Iron Co., on the north side of which is a thin layer of micaceous specular ore, closely resembling that described above under A, but containing more silica. A specimen of this afforded Professor Prescott 55.12 metallic iron, 19.80 insoluble silicious matter; with traces of sulphur and phosphorus. This and the banded ore associated with it, has a closer resemblance to the slate and "mixed ore" of some of the old mines, than any place I have seen in the flag-ore series, to which it seems to me geologically to belong; its relation to the associated mica schist is interesting. See Group H below. The Chippewa ore, near the Cannon, has already been mentioned above in connection with the Gillmore.

The foregoing brief descriptions of several varieties of flag ore embrace all those, which have come under my notice in the Marquette region and give promise of having early commercial value.

As will be elsewhere (Chapter V.) more fully described, the hard ores found in the Menominee region up to October, 1872, are more nearly allied to flag ores than to either of the first-class ores of the Marquette region. Flag ores of a low grade have also been found in the L'Anse and Gogebic districts, as will be mentioned hereafter.

A very limited experience in working these ores, together with the little I have been able to learn from others, leads me to believe, that they require more limestone and coal and produce a harder metal, having comparatively little strength, but which is probably well adapted to making rail-heads. I think a large mixture of manganiferous hematite might help the working of a furnace consuming flag ore. Precisely the same remarks may be made of the second-class ores (*c*); indeed, these two classes are

to all intents and purposes identical in their metallurgical character, and are only separated here because of their different geological occurrence. The second-class ores are, it will be remembered, simply inferior grades of the rich hard ores of XIII.

The flag ores have here received relatively far more attention, than their present commercial importance warrants, for the following reasons:—1st, Their quantity, so far as can now be judged, is greater by tenfold than the first-class hard ores, and for this reason they must, at some future time, constitute a large part of the total production of the region. 2d. Very serious disappointments and losses have occurred in the past, and are likely to be repeated in the future, from mistaking flag ore for first-class ore. This arises from the fact, that the better varieties of flag ore closely resemble the poorer varieties of the rich ore. So close is this resemblance, that the best judges of ore in the Marquette region have erred. It is doubtful, if the matter can be settled definitely, except by thorough explorations, aided by the well-known laws of the geological occurrence of the two ores, which will be more fully brought out in succeeding chapters.

It is not asserted that first-class hard ores may not be found associated with the flag ores, hence below and older than formation XIII.; but it is a fact, that over one million dollars have been sunk in such search, and excepting the West End mine of the Cascade range (if that is an exception), no workable deposit of strictly high grade hard ore has been found in the flag-ore series.

### B. Ferruginous, Silicious, and Jaspery Schists.

(Occurring in formations XII., X., VIII., VI., and below V.)

The best general idea of the character of the rocks embraced here can be conveyed by saying, that they are identical with the flag ores last described, except in containing less iron and usually more silicious matter. On geological grounds, as has been remarked, the flag ores should be embraced under this head and described as a subclass, rich in iron. It remains therefore for me to mention briefly, a few of the remaining varieties of this series, which are so poor in iron as to render it highly improbable that they will ever possess value as ores: I design to embrace in this group Mr. Julien's quartz schist, silicious schist, and jasper schist, Appendix A, Vol. II. For minute lithological descriptions of numerous varieties see Specs. 154 to 173, App. A, Vol. II.

At Republic Mountain are three highly magnetic beds of silicious, chloride and hornblendic schists, numbers VI., VIII., and X. See Map No. VI. of Atlas. The peculiar striping—whitish, greenish, brownish, and yellowish—exhibited in the large outcrops suggested the name "rag-carpet schist." A specimen made up of numerous chippings of this rock gave 31 per cent, of metallic iron; this is believed to be above the average. Both the red and black oxides are present, and some of the layers hold an ore, which, if it could be separated, might yield 50 per cent.

South of the Washington mine these rocks contain the minimum amount of iron, a specimen of which gave Charles E. Wright less than 5 per cent. Garnets and anthophyllite, or mica, seem to replace the iron, producing a grayish and brownish schist, the mineralogical character of which is obscure. See Group I. The old Michigan mine ore, Section 18, T. 47, R. 28, seems to be a variety of this peculiar schist, but much more highly charged with metal, specimens of which, I should judge, would afford 30 to 40 per cent, of metallic iron.

Passing to the Negaunee district we find in the railroad cut at the northwest end of Lake Fairbanks a chloritic, magnetic, silicious schist of a brownish gray color, faintly banded and very hard; it is aphanitic in character, and shows no disposition to split on the planes of bedding. In the railroad cut near the centre of Section 8, one mile and a half southeast of Negaunee, is a soft variety of ferruginous rock, affording some good red chalk. The rock seems to be chloritic, layers of which are impregnated with red oxide of iron. A similar material was found in numerous test pits in the east part of Section 18, T. 47, R. 26. Recent explorations In this vicinity prove this rock to be associated with the Negaunee hematites, which are fully described in Chapter IV.*

One of the best characterized and abundant varieties of this group Is the banded ferruginous jaspery schist, which constitutes in the Michigamme district the whole of formation XII., and is also abundant in parts of ore formation XIII. Such varieties of "mixed ore," as contain too little iron to give them commercial value (unfortunately the greater part), would be classed here. The full descriptions and illustrations already given of "mixed ore" under A, will make any further description unnecessary, for this is a similar rock with little or no iron. See Spec. 32, State Coll., App. B, Vol. II., and for several other varieties of this group see Specs. 1,026, 1,034, 1,061, and 1,064, Appendix C, Vol. II. The Felch mountain series contain a large amount of a similar rock.

*It is questionable whether this rock should be classed under D or G.

### C. Diorites, Dioritic Schists and Related Rocks (*Greenstones*,) *

(constituting formations XI., IX,, VII., and one or more beds below them.)

These obscurely bedded rocks, locally designated greenstones and sometimes traps, are co-extensive with the ferruginous rocks A and B, very abundant, outcropping throughout the Huronian region, and present much variety in appearance. They range in structure from very fine-grained or compact (almost aphanite) to coarsely granular and crystalline, being sometimes porphyritic in character. The color of the fresh fracture is from dull-light to dark or blackish green, the weathered surface being usually lighter and of a grayish green or brownish color, not unfrequently spotted or mottled, showing a dark-green, or black, lamellar mineral

(hornblende), set in a whitish, and sometimes reddish, softer mineral (feldspar). The rock is exceedingly tough, powdering under blows of the hammer rather than break. It can be scratched by the knife, giving a light grayish-green powder, and is fused without difficulty before the blow-pipe. On the one hand, it graduates into a heavier, tougher, blacker variety, which is unquestionably hornblende rock, with some feldspar, well shown at the Greenwood Furnace quarry, on Sec. 15, T. 47, R. 28. See Specs. 1,018 and 1,020, App. C, Vol. II. On the other hand, it passes into a softer, lighter colored rock of lower specific gravity, which, while it has the same streak, weathers similar to the true diorite, is eminently schistose in character, splitting easily, and appearing more like chloritic schist than any other rock. The Pioneer Furnace quarry at Negaunee contains this schist and several transition varieties, some of which approach the granular massive rock. See Specs. 1,001, 1,005, 1,006, and 1,015, App. C, Vol. II. On the north side of Lake Michigamme, and west, varieties occur having a true slaty structure in appearance, although not splitting easily. See Spec. 1,028, Apps C, Vol. II.

*See Dr. Houghton's Notes on Diorites, Appendix E, Vol. II.

At several points dioritic schists, semi-amygdaloidal in character. were observed, and in one instance the rock had a strong resemblance to a conglomerate. See Spec. 1,024, App. C, Vol. II.; and Spec. 71, State Coll., App. B, Vol. II. It is of much practical importance to distinguish between the schist of this group and the true chloritic schist to be described under the next head, D, which is usually found associated with the pure ores of Bed XIII.*

At Republic mountain a dioritic schist graduates into black mica schist, and large garnets are there found in typical diorite. Iron pyrites are usually seen sprinkled through the rock, and epidote is sometimes observed. Dr. Hunt found chromium in two specimens. South of the Old Washington mine, in Bed XL, occurs a variety, which in places may almost be described as hornblendic schist; that in other parts of the same bed, near at hand, graduates into the above-described dioritic schist.

In the railroad cut at the foot of Moss Mt., west of Negaunee, is an exposure of soft dioritic schist, in which are imbedded rounded lumps of diorite, which, when broken, show a crystalline reddish feldspar. See Specs. 1,001 and 1,002, App. C, Vol. II. Spec. 77, App. B, Vol. II., is another beautiful and rare variety, in which the feldspar is red. On the south side of Sec. 9, T. 49, R. 33, is a heavy bed of coarse-grained friable diorite, which has in places disintegrated into sand. Mr. Julien regards this and the associated dioritic rocks of the L'Anse range as possessing such distinctive characteristic as to warrant him in describing them as a distinct variety. See Specs. 342 to 353, App. A, Vol. II. He also classes the well-known peculiar serpentine rock of Presque isle with the diorites. See Spec. 321, App. A, Vol. II, also App. E.

The magnet usually lifts less than one per cent, of a powdered diorite, but in one case it took nearly all, and the specimen attracted the needle. This piece was from the ridge south of the New England mine; it had the essential character of a compact, perhaps hornblendic diorite, but its magnetic property and very high specific gravity, 3.29, prove that it is exceptionally rich in iron. It will be shown below, that in addition to the magnetite, seventeen per cent of metallic iron exists in some diorites in the form of combined protoxide, which does not attract the needle. The specific gravity of the typical rock varied from 2.84 to 2.96, the average of six specimens being 2.91. The hornblendic varieties ranged as high as 3.01, while the schistose variety fell as low as 2.70, averaging 2.82. A garnetiferous specimen, from Smith Mountain, gave 3.02, while a peculiar variety from north of Greenwood Furnace, which appeared to be feldspathic in character, gave but 2.71. Numerous additional specific gravity determinations are given in App. B, Vol. II. The precise character of the constituent minerals of this rock is obscure. Mr. Julien has minutely described numerous varieties in App. A, Vol. II., Specs. 302 to 353.

*See Julien's remarks under Chloritic schist, App. A, Vol. II.

The following analysis of a specimen from bed XL is from Foster & Whitney's Report, Part 2d, p. 92. The specimen was from Sect. 10, T. 47, R. 27, on south side of the Cleveland and Lake Superior ore deposits:—

| | | OXYGEN. |
|---|---|---|
| Silica | 46.31 | 24.06 |
| Alumina | 11.14 | 5.21 |
| Protoxide of iron | 21.69 | 4.82 |
| Lime | 9.68 | 2.76 |
| Soda | 6.91 | 1.78 |
| Water | 4.44 | |
| Magnesia | trace. | |
| | 100.17 | |

From this it is deduced that the rock is a mixture of labradorite feldspar with hornblende or pyroxene. Regarding the presence of water, numerous analysis of similar rocks in Canada show the same result. See Geology of Canada, pages 469, 604, 605, and 612. Dr. Hunt expresses the opinion, that in the case of the Marquette diorites, the hornblendic mineral often becomes softened and hydrated, passing into a degenerate form more nearly allied to chlorite or delessite (in which water is an essential constituent), than to a true hornblende. This chloritic mineral is sometimes seen scattered through the body of the rock, and very often near the weathered surface.

The absence of *magnesia*, which is regarded as an essential ingredient of chlorite and delessite, and as very rarely absent from hornblende, as shown by the above analysis, deserves notice. Dr. Hunt remarks that the hornblendic element may very likely be the iron hornblende described by Dana, System of Mineralogy,

5th ed. p. 234, under the name grünerite. The unusually large amount of iron shown by Whitney's analysis and the high specific gravity observed would favor this view. The conversion of this non-magnesian diorite into a magnesian schist (chloritic or delessitic) would require the introduction of the magnesian element under some law of pseudomorphism, the possibility of which is proven by chemical geology.

Magnesia is not, however, absent from all varieties of the diorite. A chromiferous specimen from near the centre of Sec. 36, T. 48, R. 28, was found by Dr. Hunt to be rich in magnesia, containing more of this element than of lime; the specimen was not a typical one, but showed a tendency to pass into a steatitic rock, which might be expected to contain magnesia. Until, however, the presence of magnesia in the schists and its absence from the diorites is proven by more analyses, it is not worth while to conjecture in the matter, and I here digress only to record a few facts, bearing on an interesting and unsettled question in chemical geology. In the absence of any additional light, we adopt the hypothesis that the Marquette "greenstones" are diorites, composed essentially of a non-magnesian iron hornblende and some feldspar other than orthoclase.

It is of great importance that the prospector should have a good practical acquaintance with this rock, for it is everywhere associated with iron ores in the Upper Peninsula. He should be able to recognize it at sight, to distinguish its varieties, and especially he must not confound the Huronian diorite with a similar rock, found in the Laurentian, nor with Copper trap. More than one piece of land has been bought for iron on the Laurentian area, because "greenstone" was found on it.

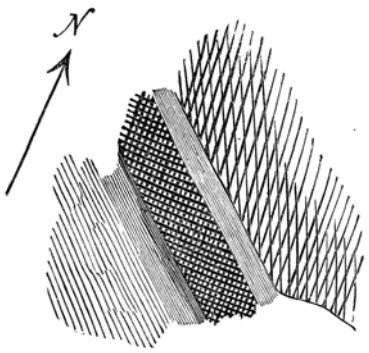
The bedding of these rocks is generally obscure, and in the granular varieties entirely wanting. It is usually only after a full study of the rock in mass, and after its relations with the under and overlaying beds are fully made out, that one becomes convinced, whatever its origin, it presents in mass precisely the same phenomenon as regards stratification, as do the accompanying schists and quartzites.

I have nowhere seen the granular diorites show more unmistakable evidence of bedding than on the small knob southwest of Bear Lake, Republic Mountain, shown in Fig. 1, scale $^1/_{50}$th. The cross shading represents massive diorite, and the parallel shading a slaty silicious iron ore.

No reference is here made to the false stratification or joints, which are numerous and interesting, but which, unfortunately, for want of space, can receive no other attention here, than to warn the observer against mistaking *joint* planes for *bedding* planes, which is sometimes done, even by experienced observers.

Fig. 1.

Stratification of Diorite.




[1. Stratification of diorite—Republic Mountain]

This description, as has been stated, is intended to apply to the diorites of the iron-bearing or Huronian series, and more especially to the Marquette region; but a similar rock, as has been observed, occurs abundantly in dykes or veins, and probably in beds in the Laurentian rocks. A fine example of such a dyke can be seen penetrating a granitic gneiss, near the northeast corner of Sec. 7, T. 46, R. 29. At other points in the Laurentian area immense masses of a dioritic rock were observed, the stratigraphical relations of which to the gneiss and granites was not made out. The average specific gravity of the dyke diorite was 3.03. Mr. Julien describes some specimens of diorite from the Laurentian in App. A, Vol. II.

The following designated specimens, in addition to those already referred to, constitute a tolerably full collection of the more important varieties:—Granular diorites, 1,007, 1,008, 1,009, 1,010, 1,011, 1,012, 1,014, and 1,016; Dioritic schists, 1,001, 1,019, and 1,023 of App. C, Vol. II. The State Collection, App. B, Vol. II., also contains a large number of specimens of diorite of several varieties.

The distribution of this rock in the Huronian of the Upper Peninsula is interesting. It is far more abundant in the Marquette region and contiguous to the ore deposits, than elsewhere. The related rocks in the L'Anse region are abundant; but in the West iron district, and on its prolongation into Wisconsin, where it forms the Penokie range, diorites are rare. In the Menominee region they seem to be replaced to a great extent by chloritic schists and hornblendic schists, as described in Chapter V. Whether future explorations will prove that the best ores are always associated with the typical diorite, remains to be seen.

### D. Magnesian Schists (*mostly chloritic*).

(See Mr. Julien's description, Specs. 179 to 188, App. A, Vol. II.)

Intercalated with the pure hard and mixed ores, at all the mines worked in formation XIII., are layers of a soft schistose rock, of some shade of grayish green, and often talcy in feeling. The Cleveland, Lake Superior and Champion mines are good localities for an examination of this rock. It is unquestionably a magnesian schist,

varying from chloritic to talcose in character, and sometimes apparently containing a large percentage of argillite. In places, as at the Old Washington, its character is unmistakably talcose. Specimens obtained there held 4.2 per cent, of water, and had a specific gravity of 2.81, with light grayish-green color, and other characteristics of talcose schist. See Specs. 1,046, App. C, Vol. II. The corresponding schist at the Champion mine is also decidedly talcy. On the same magnetic range, but further west, at the Spurr Mountain, the equivalent schist is unmistakably chloritic. See Specs. 179 to 181, App. A, Vol. II. A rare variety of talc schist is represented by Spec. 74, App. B, Vol. II., obtained at the Grace furnace, Marquette.

In the Lake Superior and Barnum mines this rock is, in places, of a light green color, less soapy in feel, has a higher specific gravity and is of uncertain composition. See Spec. 55, State Coll., App. B, Vol. II. At this locality it has a marked cleavage structure, the planes of which trend east and west, and are nearly vertical, being distinct from its bedding, which latter is very obscure. Its structure bears a striking resemblance to that of the specular slate ores, noticed under A, even to the presence in both of minute octahedral crystals. Prof. Pumpelly has suggested, that one may be a pseudomorph after the other. In this connection it may be remarked, that no gradual transition of one into the other was observed, the division planes being in each instance sharply defined.

Specimen No, 1,043, App. C, Vol. II., from the Washington mine, is grayish, less schistose in structure than the last described variety, and gave up, when pulverized, one-third its bulk to the magnet. A similar massive variety from the same mine, which contained three per cent, of water, held black hard scales, which Prof. Brush decided had the character of ottrelite.

A reddish gray variety of this rock (see Spec. 6,164, University of Mich. Cabinet), holding grains of vitreous quartz, is from a heavy bed on the northeast side of the S. C. Smith soft hematite ore deposit, on Sections 17, 18, and 20, T. 45, R. 25.

South of the Edwards mine, at the Republic Mountain, and at other places in the ferruginous schists, occur bunches and thin irregular beds of a pure chlorite, often micaceous, which always contain garnets. See Spec. 6,097, University of Mich. Cabinet. This specimen shows, under the lens, minute elongated crystalline faces, closely resembling those seen in the diorite. Spec. 184, App. A, Vol. II., is garnetiferous. The "keal" or red chalk, found at several mines, is a variety of this schist impregnated with oxide of iron. See Spec. 6,183, University of Mich. Cabinet.

A very peculiar occurrence of this rock are the so-called "slate-dykes," which can be seen at the New England, Lake Superior and Jackson mines, but still better in the quartzite ridge, just north of the outlet of Teal lake. These dykes are often several feet in width, cut across the stratification, and are filled with a magnesian schist. If space permits, this subject will be more fully considered elsewhere. See Specs. 1,053, 1,068, App. C, Vol. II.

The Lower Quartzite bed V. often contains talc in bunches, small beds and disseminated, producing in places a talcy rock. The *novaculite* of that formation is due to the presence of talc and argillite. These rocks will, on account of their association, be more fully described in the Quartzite group.

It would be difficult for a skilled lithologist, and impossible for me, to draw the line between the chloritic schists here considered and the dioritic schists mentioned under Group C. So far I have chiefly noted occurrences of the magnesian schists, in formations XIII. and V., where they are not associated with true diorites. But at the Marquette quarries we find what may be called typical chloritic schists, bedded with granular diorites. See Specs. 182 and 183, App. A, Vol. II, At this locality the planes separating the two kinds of rock are well defined; at others, which have been designated, the transition is gradual.

Along the north border of the Laurentian area, which lies south of Lake Gogebic (see Map I.), are numerous exposures of a chloritic schist (see Specs. 187 and 188, App. A, Vol. II.), which in places becomes massive and granular, a form designated "greenstone" by the United States Linear Surveyors, and so marked on their maps. See Specs, of Diorite, 309 and 212, App. A, Vol. II.

The specimens of Laurentian Gneiss, 275 and 299, App. A, Vol. II., contain chlorite as an essential ingredient, proving this mineral to be as widely disseminated in the Laurentian as Huronian. An examination of Prof. Pumpelly's very exhaustive chapters on the lithology of the copper-bearing rocks, will show chlorite to be of frequent occurrence in that system; demonstrating it to be next to feldspar and quartz, one of the most universally diffused minerals in the Azoic of the Upper Peninsula.

### E. QUARTZITE—*Conglomerates, Breccias, and Sandstones.*

(Principal development in Formations V. and XIV. See Mr. Julien's descriptions, 126 to 140, and also 358 and 359, App. A, Vol. II.)

After diorite and the ferruginous schists, no rock is more abundant in the Marquette region, and none more frequently found in outcrops, than the different varieties of this group. Two extensive beds exist—XIV, lies immediately over the ore formation, and V. near the base of the series. The last appears to be the most persistent and wide-spread member of the Huronian system. It can be traced from the shore of Lake Superior, near Chocolate river, westward for 40 miles, and possesses unusually economic interest from its affording the marble, used to a limited extent as furnace flux, and the whetstone rock (novaculite), which was at one time quarried for market. This quartzite has also

recently been successfully employed as lining for Bessemer converters.

The Upper Quartzite (XIV.) is co-extensive with the ore formation XIII.; it is seen as the hanging wall of the most easterly point, at which rich hard ore is mined, and overlays the most westerly deposit yet explored. Between these is a third bed, seen in the railroad cut near the west end of Lake Fairbanks, the extent of which has not been made out. See Spec. 21, App. B, Vol. II.

At the west end of Lake Michigamme, near the centre of Sec. 25, T. 48, R. 31, is a large mass of quartzite, which appears to be a ledge, but if so, the bed is concealed to a greater extent than usual, for it has not been observed elsewhere. No. XVIII. is assigned for this quartzite, or for whatever rock may be found in the gap between Beds XVII. and XIX. The Cascade iron range is divided by a thin bed of quartzose rock, which varies from a quartzite to the coarsest conglomerate I have observed in the region, but which, like the two last-mentioned beds, seems to be local. At the Greenwood furnace is a heavy and persistent bed of quartzite, in which are intercalated layers of clay slate; its age has not been determined; it resembles the lower quartzite.

The extreme hardness of quartzite (the knife makes no impression on it, and it will readily scratch glass), and its general dissimilarity to the other members of the series, renders its recognition easy and much description unnecessary.

Vein quartz, occurring in bunches, seams and veins, in nearly all rocks, is not embraced in this description; nor are those slightly ferruginous quartz schists, already described in Group B, which a strictly scientific classification would place under this head. Quartzite is seldom white, often light-gray, or dark-gray and sometimes reddish or greenish. The effect of weathering does not penetrate the rock beyond a mere film, dulling the lustre and color of a fresh fracture rather, than changing it; but the latter effect is sometimes produced in the impure varieties. Broken pieces often show grains of glassy quartz; and the arenaceous character is sometimes so plain, as to leave no doubt in the mind, that the rock is a metamorphosed sandstone or conglomerate (see Fig. 2). Again, the whole mass is compact, having much the appearance of vein-quartz. In structure it is usually massive, and the bedding obscure; but in places, as at the northeast corner of Teal lake, it is banded, presenting a flaggy structure, like the ferruginous schists. The mean specific gravity of a large number of specimens was 2.69. See App. B, Vol. II.

The foregoing description applies in general to all the beds; but as it is often of importance to the explorer to distinguish the Upper bed on account of its relation to the ore formation, a few points of difference will be noted. As has been remarked, the Lower bed is often calcareous, turning in places into a true marble, as at the Morgan Furnace; and the same formation is often talcy in character, containing in certain localities bunches and beds of a talcy material and in other places beds of argillite. An intimate mixture of these minerals with the quartzose material produces novaculite, which was formerly quarried just east of Teal Lake outlet. See Spec. 13, State Coll., App. B., Vol. II. Red oxide of iron in grains and small bunches, is not infrequent in the Lower bed, as can be seen in northeast quarter of Sec. 22, T. 47, R. 26.

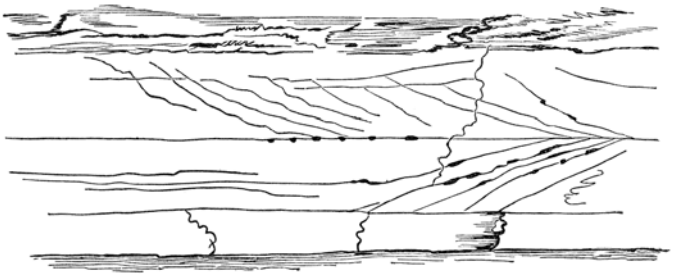
So far I have seen neither marble, talc, nor novaculite in the Upper Quartzite, and only once, at the Lake Superior Mine, have I seen argillite associated with it. As this exception has much interest, it will be fully considered in another place. The Lower Quartzite is seldom conglomeritic, the upper one often so, and in places on the Spurr Mountain range it is a true conglomerate, containing pebbles of white and glassy quartz and jasper. See Specs. 115 to 118, App. A, Vol. II. At Republic Mountain large fragments of ferruginous schist are seen in the base of the Upper bed. Southwest of the Old Washington mine it is a coarse conglomeritic rock, which is in places schistose or slaty. See Spec. 122, App. A, Vol. II.

The matrix of this variety (See also Spec. 6,085, University of Mich. Cabinet) is a soft, micaceous, slaty material, containing fine grains of specular ore and holding pebbles of white quartz. The Upper bed overlying the east end of the Jackson, and that over the New York mine, also hold pebbles. Mica scales and epidote were found in the same bed at the Republic Mountain, and in places it had almost the appearance of fine-grained granite.

As if to leave in our minds no shadow of doubt, as to the sedimentary origin of this rock, nature has, in addition to the conglomerate on the Spurr Mountain range, given us a variety of the Upper Quartzite, which can only be described as a fine-grained, friable, banded *sandstone*. See Specs. 358 and 359, App. A, Vol. II. The alternations of magnetic sand with quartz sand, producing the stripes, is very interesting in connection with the origin of these ores. It is doubtful if any true breccias (conglomerates with angular pebbles) occur associated with the rocks here described, if at all in the region. The brecciated rocks, a variety of "mixed ore" found in formation XIII., is believed to have had the origin ascribed under Group A.

Specimens of University of Mich. Cabinet, Nos. 6,193, 6,084, 6,180, 6,211, 6,219, and 6,122 are from these quartzite beds. Specs. 8 to 14, State Coll., App. B, Vol. II., are from the Lower bed, and Specs. 50, 51, and 52, same Coll., are from the Upper. The extensive beds of quartzite, which occur in the Menominee region, will be fully considered in Chapter V. This rock is also of frequent occurrence in the L'Anse range and toward the Montreal river, as will appear in following Chapters. A beautiful example of false stratification, or discordant parallelism, was observed in this last-named region, as is shown by Fig. 2, sketched near the south quarter post of Sec. 10, T. 47, R. 45. It was a true granular quartzite, but showed deposition marks almost as plainly as a fresh-cut sandbank.

Fig. 2.
False bedding (discordant parallelism) of Quartzite—Gogebic Region.



[2. False bedding (discordant parallelism) of Quartzite—Gogebic Region]

F. MARBLE (*Limestone and Dolomite*).

(See Mr. Julien's descriptions, 101 to 113, App. A, Vol. II.)

The association of this rock with the Lower Quartzite, or rather the transition of the latter into marble, has been mentioned. This transition is seldom complete, the marble being always more or less silicious. As is usual in such cases, the change is gradual, producing all varieties, from calcareous quartzite to silicious marble. The prevailing colors are light gray, salmon and reddish. The purest varieties often present a sparry structure, with large lamellar facets like orthoclase feldspar, with which it is often confounded, but from which it can readily be distinguished by Its softness. Beds of argillite are invariably associated with the marble. See Fig. 19, App. E, Vol. II. Outcrops often present minute ribs or ridges of the more silicious layers, left by the weathering away of the purer marble.

The mean specific gravity of a large number of specimens averaged 2.82. See App. B, Vol. II. Pure marble has the same composition as pure limestone, of which it is simply a crystalline or highly altered form, that is, it is a carbonate of lime;—if carbonate of magnesia is present in considerable quantity, as is often the case on the Upper Peninsula, the rock becomes a dolomite. Marble is readily distinguished from its effervescing with acids, when pulverized.

Marquette marble has been considerably used as a blast furnace flux, for which purpose it only answers passably well, on account of the silica so generally present; silica, in the form of quartz, and jasper being always present in the *ores*. It is very desirable to have none in the *flux*, for it is to get rid of silica in the form of slag, that lime is used in the furnace. Large amounts of Kelly island limestone, which is quite pure, Is now being imported. For building purposes, its hardness, variability in texture and the difficulty of securing large blocks, have so far prevented its use; beautifully variegated small blocks can, however, be easily procured. Specs. 6,198, 6,199, 6,200, University of Michigan Cabinet, are from the Morgan Furnace quarry, and Specs. 106 to 113, State Col., App. B, Vol. II., from the Chocolate quarry, just south of Marquette, all belonging to formation V., represent the chief varieties of this rock.

No marble has been observed in the L'Anse district, nor between Lake Gogebic and Montreal river, but it is one of the most abundant rocks in the Menominee region, where it occurs in a much purer form than in Marquette, usually more dolomitic. See Chapter V. and Specs. 102 and 103, App. A, Vol. II. Marble of similar quality is also abundant in the vicinity of Fence and Michigamme rivers, in Towns 44 and 45, R. 31. See Spec. 105, App. A, Vol. II.

G. ARGILLITE OR CLAY SLATES AND RELATED ROCKS.*

(Constitutes bed XV., and occurs in bed V. and elsewhere.)

It was previously mentioned under Groups E and F, that beds of clay-slate were sometimes interstratified with layers of quartzite and marble. Fine examples of this, in the case of both rocks, can be seen respectively at the Greenwood and Morgan furnaces. In addition to these, at least two distinct beds of argillite have been made out; one immediately beneath the ferruginous schist of formation X., to be seen In outcrop on the south shore of Teal lake, near west end, and in the railroad cut about one mile east of Negaunee. See Spec. 20, App. B, Vol. II. Another and far more extensive bed is XV., which forms the stratum next above the Upper Quartzite; boulders of this bed, which had the appearance of being near the parent ledge, were found in the railroad cutting, near the pockets at the Washington mine. At the Champion this formation is exposed In the branch railroad, and it is found at numerous points on the north shore of Lake Michigamme.

The prevailing color of this rock is usually dark brown or blackish, but where associated with the marble it is sometimes reddish. It has a true slaty cleavage, distinct from the bedding, but seldom splits in sufficiently large or regular slates to warrant us in supposing it may in places produce roofing slates, although experienced persons express the belief, that good slates will yet be found in the Marquette region. Black carbonaceous matter is often present in this slate, a preponderance of which produces the rock which will be described hereafter under J. A variety at the Greenwood furnace contains a large amount of iron-pyrites; and the first stack built of it had to be taken down, from the decomposition of this mineral. The slate in the branch railroad cut, at Champion, shows a slight tendency to be micaceous and holds garnets. See Spec. 56, App. B, Vol. II. Silicious bands often exist In this rock, faintly marking Its bedding at an angle with the cleavage, as can be seen in Spec. 20, App. B, Vol. II.

Overlaying the Lake Superior and Barnum ore deposits, hence occupying the place of the Upper Quartzite, is a greenish-gray schist, obscure in its composition, and somewhat like the magnesian schists D, but apparently of the same general character as this group. See Spec. 55, App. B, Vol. II. This rock may very properly be regarded as the connecting link between Groups D and G, which evidently graduate into each other, as did C

and D. It is frequently stained reddish-brown along the seams and cracks, proving the presence of protoxide of iron, and shows in places beautiful dendritic delineations of manganese. This formation does not show the cleavage structure, so conspicuous In the schists of Group D, which are bedded with the pure ore at these mines. At the most westerly opening of the Lake Superior, thin beds of quartzite appear. Indicating that the presence of argillite In this bed is probably only local. See Map No. IX.

An, example of a magnesian schist (D) graduating Into an argillaceous variety can be seen in the slate which overlies the specular ore of No. I pit, New England mine, which, by its high specific gravity (3.03), evidently contains considerable iron. Another ferruginous and probably chloritic variety occurs on N. W. ¼ Sec. 31, T. 47, R. 25, where explorations for Iron have been made by the Morgan Iron Co.

The average specific gravity of a number of typical specimens of argillite was 2.75. See App. B, Vol. II. The rocks above described are illustrated by Specimens 1,039, 1,072, and 1,036, App. C, Vol. II.

Beyond the limits of the Marquette region, we find in the recently explored Huron Bay district, particularly in the south part of T. 51, R. 31, the finest clay slates so far discovered in Michigan. Several competent experts have examined this district, and pronounced the slates of the best quality for roofing and other purposes, and In Immense quantity. See Spec. 81, App. B, Vol. II. Companies are now at work In this district, the organization of which is given at the end of Chap. I. For an account of the clay-slates in the Menominee region, see Dr. H. Credner's papers (Leipsic).

This rock also occurs west of Lake Gogebic, as will be mentioned hereafter.

*Mr. Julien has in App. A, Vol. II., given the results of much study of these rocks, and has divided them into the true argillites and several other varieties possessing a different composition. See descriptions 189 to 225. As this difference cannot readily be made out by the unscientific, and as it is not important to the practical man, it will not here be attempted to separate these varieties.

### H. MICA-SCHIST.

(Formation XIX. contains the principal development of this rock. See Mr. Julien's description. No. 301, App. A, Vol. II.)

There appears to be but one extensive stratum of this rock, the character of which is unmistakable, which is at the same time the youngest and one of the thickest beds of the whole Huronian series. This formation, which I have numbered XIX., forms the surface rock along the south shore of Michigamme lake, among its islands, along the outlet for several miles, and westward from the lake through the southern parts of T. 48, Ranges 31 and 32, as shown on Map III. The rock is sometimes so silicious as to be rather a micaceous quartzite, but usually its true character is very plain. It frequently contains seams and bunches of white quartz, occasionally seams of black hornblende, and often holds numerous Imperfect crystals of a delicately pink-colored, coarsely fibrous mineral, which Prof. Brush decided was andalusite, and brownish, smaller, and more perfect crystals of staurolite.

Andalusite and staurolite have not been observed elsewhere in the Marquette region in rocks of any age. Imperfect small reddish garnets are sometimes abundant, but they were not observed at the same places as the first-named minerals, and seemed to be nearer the base of the formation. The mica, which usually holds but little quartz, is of a brownish color on fresh fracture, weathering more grayish; its scales show a constant tendency to bend themselves around the Imbedded crystals, like the fibres of wood around a knot. The projecting rounded crystals give the weathered rock a warty look, having somewhat the appearance of a conglomerate, as can be seen on the most southerly islands in Lake Michigamme. The specific gravity of this porphyritic mica-schist varied from 2.81 to 2.89, the mean being 2.84. See Specs, 1,031, App. C, and 61, App. B, Vol. II.

Descending in the series, the next mica-schist to be noticed is entirely different from the above, in being black, and decidedly dioritic in its affinities. It occurs in the upper part of diorite bed XL at Republic Mountain. The deposit Is not extensive, and its relations with the diorite indicate that it is a local variety, apparently graduating into dioritic schist.*

One other mica-schist, that associated with the Cannon ore on Sec. 28, T. 47, R. 30, deserves notice. This rock resembles XIX. only in the brownish color of its mica; it contains no crystals of other minerals, and is always quartzose, sometimes to the point of becoming a micaceous quartz-schist. The age of this rock has not been satisfactorily determined, but it is near the base of the series. The striking peculiarity of this variety is the fact, that in places the mica is replaced by micaceous specular iron ore, thereby becoming a specular schist, a rock very nearly related to the itaberite of some writers. The Cannon Iron Company's explorations, in which a fair specular slate ore has been found, are located in a highly ferruginous part of this bed. See Spec. 16, App. B, Vol. II. The relations of this rock with the lower quartzite of the North belt, Menominee Iron region, is fully discussed in another place.

*The local micaceous character of bed XV, has been noticed.

### I. ANTHOPHYLLITIC SCHIST.—(in bed XVII. and others.)

(See Mr. Julien's descriptions 174 to 178, App. A, Vol. II.)

Immediately below the great mica-schist bed, XIX., and probably separated from it by a stratum of quartzite, XVIII., is a well-defined stratum of a slightly magnetic rock, varying in color from brownish-black to dull slate on fresh fracture, and grayish to blackish in outcrop. It often shows manganese,* and always a fibrous, light-brown

mineral, which Prof. Brush, from the examination of some imperfect specimens, decided to be anthophyllite,† a variety of hornblende, and suggested the name here employed for this group.

Numerous outcrops of the rock occur along the north shore of Michigamme lake, and a fine development at the mouth of the Bi-ji-ki river, as well as at the Champion furnace, where layers rich in manganese occur. A specimen afforded Dr. C. F. Chandler 25.2 per cent, of metallic iron, and 4.37 per cent, of metallic manganese. See Specs, 58 and 59, App. B, Vol. II., and 178 App. A, Vol. II.

Below the ore formation XIII., at the Spurr Mountain, are layers of schist of a similar character, a specimen of which afforded Mr. Britton 45.21 metallic iron, 1.78 metallic manganese, 26.36 silica.

A moderate increase in the percentage of iron and manganese therein found (which may very likely take place in some part of the bed) might render this rock a workable ore, particularly as the associated mineral is an easily fusible hornblende instead of the silica so common in the other ores. Ores containing 12 to 20 per cent, of manganese need not be rich in iron, to give them merchantable value.

Underlying this formation (XVII.), or perhaps forming its base, is a rock, numbered XVI., which at Champion and on Sec. 26, T. 48, R. 31, shows a tendency to pass into a *limonitic schist*, and may very likely afford workable soft hematite ore in some part of its course. The propriety of giving this rock, about which so little is known, a distinct stratigraphical designation, may be questioned; but its ferruginous character, pointing toward the possibility of commercial value, led to this course.

South of the Washington mine, and therefore stratigraphically below the ore formation,—for the whole dips north,—there is an obscure schistose rock of a gray color, weathering brown, and containing very little iron, often garnets, but made up chiefly of a light brownish fibrous mineral, which is probably anthophyllite, but which in places resembles mica. These rocks are extensive, stretching from the Champion mine eastward to the old Michigan mine. They are generally slightly magnetic, and unquestionably occupy the place of the silicious ferruginous schists of Group B. The diorites associated with them are also peculiar, the two sometimes resembling each other. This obscure series is well illustrated by Specimens 6,086 to 6,099, University of Mich. Collection. See also Specs. 174 and 175, App. A, Vol. II., and 27, App. B, Vol. II. Their affinities are apparently with this group.

*This variety resembles plumbago, and may contain carbon.

†Prof. Dana now regards anthopholite as a distinct mineral.

### J. Carbonaceous Shale.

(See Mr. Julien's descriptions, 246 to 251, App. A, Vol. II.)

The presence of plumbago or graphite (a form of carbon) was noticed in the anthophyllitic schists, last described. Carbonaceous matter has also been observed in various clay-slates, as was noticed in describing the Argillite Group, and we could have placed this rock there as a variety of clay-slate, very rich in carbonaceous matter. It is of a bluish-black color, but burns white before the blow-pipe, marks paper like a piece of charcoal, is soft and brittle, slaty in structure, and is the lightest rock yet found, having a specific gravity of but 2.06.

This rock has been found in the Marquette region only at two localities: 1. The S. C. Smith mine, T. 45, R. 25, where it seems to bound the iron-ore formation on the northeast. See Spec. 6,163, University of Mich. Collection.

(2.) On the south side of Sec. 9, T. 49, R. 33, along Plumbago brook, as will be fully described in the account of the L'Anse Iron range, is a large deposit of carbonaceous shale, a specimen of which gave Prof. Brush—carbon, 20.86; earthy matter, 77.78; moisture, 1.37. Another sample from same locality gave Mr. Britton—moisture and carbonaceous matter, 22.51; oxide of iron, 4.37; earthy matter, 73.12. See Spec. 64, App. B. Vol. II. These analyses prove the material to have no commercial value, but possess scientific interest as proving the existence of a large amount of carbon in the Huronian rocks. The equivalency of these shales with the members of the Marquette series has not been established; they are undoubtedly Huronian, and are, I suppose, younger than the ore formation XIIL

## CHAPTER IV.
## GEOLOGY OF THE MARQUETTE IRON REGION

### I. Michigamme District.

In describing the geological structure of the Marquette Iron series, I shall begin with the Michigamme district, because its structure is simplest, the iron ranges easily followed on account of their magnetism, and because my explorations and surveys have there been more thorough than in either of the other districts.

The **Champion mine**, 33 miles west of Marquette, is at one of the most extensive, regular and typical deposits of ore in the whole region (see Map No. VII.). The strike is a few degrees south of west, and dip north at an angle of 68°. The extent and nature of the workings at the date of the survey may be seen by reference to the map. Up to this time the mine has produced an aggregate of 225,000 tons of magnetic and slate ore of first quality. The general form of the ore mass is that of a huge irregular lens, or flattened cylinder-shaped mass, which

thins out to the east and west to so narrow a width, as not to be workable. The easterly portion of the deposit is black, fine and coarse-grained magnetic ore; the westerly portion is specular slate ore, with a small admixture of magnetite. The local magnetic attractions are very strong and are fully considered in Chapter VIII. The position of the plane dividing the two varieties is approximately shown in the sketch of workings on Map No. VII. The whole mass here described is not, however, pure ore, as may be seen by inspecting plans of the first and second levels on the map. Minor irregular lens and pod-shaped masses of pure ore, "mixed ore" (banded ore and quartz), together with whitish and greenish magnesian schists, alternate like the muscles of an animal, forming, as a whole, a comparatively regular deposit. Overlying the ore on the north side is a hanging wall of gray quartzite, the thickness of which is considerable, but could not be accurately determined on account of the drift. Immediately south of the ore. If it may not be regarded as a part of the ore formation, is a banded jaspery or quartzose rock, containing some iron. Next south, and underlying the whole ore formation, as may be seen by an outcrop near the east end of the mine, is a bed of diorite ("greenstone"); this rock in places becomes schistose and chloritic in character. South of the diorite is a silicious schist and then a swamp. The arrangement of these beds may be seen in geological section A—A," on the map, where they are numbered in Roman numerals X. to XIV., the latter designating the quartzite.

Following the Champion range east one mile, we arrive at the **Keystone Company's mine,*** where but little work has been done, and the arrangement of the rocks in consequence not so easily made out. A small bed of magnetic ore was opened at this locality two years ago, and what is said to be a large deposit of specular ore has but just been discovered on the same place. Five hundred feet north are a number of outcrops, indicating the presence of a heavy bed of conglomeritic schist, which holds masses of quartzite, varying in size from pebbles to others two feet by one thick, and even larger. It also contains flattish fragments of various schists and slates. Further north it passes into a brownish schist, containing pebbles of quartzite. This rock is believed to correspond with the overlying quartzite of the Champion, and is marked XIV. on the map and sections. North of this, and exposed in the railroad cut, is a micaceous slate, containing garnets, marked XV., and represented by Specimen 56, State Collection, App. B, Vol. II.

North and west of this locality, about one-fifth of a mile, are a number of test-pits, in many of which is exposed a soft, brownish, ferruginous rock, which affords hand specimens of soft hematite ore. This rock is marked XVI. 3 and is represented in the State Collection by Specimen 57, App. B, Vol. II. Immediately south of the Keystone workings is a specular schist or conglomerate, in which flattened pebbles, or very uneven lamina of quartz, are contained between thin layers of micaceous specular ore. This formation is believed to be the equivalent of XII. of the Champion mine section, and is so numbered on the map.

West and south are numerous extensive outcrops of a brownish banded magnetic schist, marked X. on Section C—C", Map VII.

*Late "Parsons Mine."

The arrangement and character of the rocks along the intermediate section, B—B' will be sufficiently understood from the above descriptions and an inspection of the map. The other formations represented will be considered in another place.

At the **Spurr and Michigamme mines** we find rocks identical in their general character and sequence, although the order is reversed, this series being on the opposite side of the basin from the Champion. Projecting all the facts observed along the north shore of Michigamme Lake on one plane, which we will assume to pass north and south through the Spurr Mountain mine, the following Geological Section is easily made out:

Commencing at the most southerly and uppermost bed (the whole series dips to the south), we have, first, a comparatively soft, grayish and blackish flaggy rock, containing considerable iron, a little manganese and often made up largely of a hornblendic mineral, which occurs in needle-shaped crystals. Professor Brush calls this rock anthophyllitic schist. See Specimens 58 and 59, State Collection, App. B, Vol. II., and Chap. III.

This rock is numbered XVII. on geological section No. 9, map of the Marquette Iron region, which see. It is also well exposed at the mouth of the Bi-ji-ki river, in the railroad cut just east, at the Champion furnace, and at numerous projecting points along the north shore of the lake.

The next rock to the north, in descending order, (numbered XVI. on the map and section,) on account of its tendency to decomposition, has never been seen in outcrop; it is exposed by the explorations for ore, made on the north side of Sec. 26, T. 48, R. 31, and at the Champion; its character was indicated in describing the Champion series, and need not be repeated here. As will be seen, this rock has the same number in each section, and the two exposures are believed to belong to the same bed. It is not improbable that future investigations may prove it to be a variety of the ferruginous anthophyllitic schist XVII., already described, a point which was considered in Chapter III., Group I.

Next below is a dark-colored clay-slate, which also, on account of its softness, is seldom seen in outcrop. It is, however, exposed on the point in northeast part of Section 29, and at other places along the north shore of the lake. On the Spurr mountain, geological section No. 9, this formation is numbered XV., and is believed to underlay the swamp and creek immediately south of the mountain which finds easterly prolongation in Black bay. As will be seen by reference to the Champion sections,

this rock is regarded as the equivalent of the micaceous clay-slate XV., there described.

North of this clay-slate, and immediately overlying the ore at both the Spurr and Michigamme mines, is a quartzose rock numbered XIV., which is in places a hard conglomerate, and again, especially when in contact with the ore, a fine whitish sandstone. See Specimen 52, State Collection, App. B, Vol. II., and Julien's descriptions, Specs. 358 and 359, App. A, Vol. II. This rock is unquestionably the equivalent of the upper quartzite XIV. of the Champion section, which, on the whole, it closely resembles in its lithological character. See also Group E, Chapter III.

The prevailing variety of ore of the mines on this range is a finegrained, somewhat friable, rich, blackish magnetite. See Specimens 40 and 41, State Collection, App. B, Vol. II., and also Iron Ores, Chap. III. There is also at the Michigamme mine a hard, fine-grained, steely magnetic ore, in considerable quantity. Analyses of these ores will be found in Chapter X. The surface indications, magnetic attractions, explorations and mining operations but just commenced, point unmistakably to large deposits of high grade magnetic ore at both localities.

The **Spurr Mountain** is an east and west ridge, the summit of which is 118 feet above Lake Michigamme and 75 feet above the creek, which passes south of it. This ridge terminates abruptly to the west near the centre of the northwest ¼ of the southwest ¼ of Sec. 24, T. 48, R. 31, where there is a natural exposure of merchantable ore 40 feet thick horizontally, being the largest outcrop of pure magnetic ore I ever saw. Mining operations, just begun, have demonstrated the thickness to be still greater, and the deposit to extend at least several hundred feet east and west, with a probability, based on magnetic attractions, of its extending much farther. The bold face, small amount of earth covering, softness of the ore, its apparent freedom from rock, convenience of the railroad and accessibility, present facilities for mining and shipping, which could not well be surpassed. The magnetic observations made at this locality, where the attractions were remarkably strong, are given with illustrative diagrams in the special chapter devoted to that subject. It is easy by means of the dip compass, to follow this iron range two-thirds of the distance along the north side of Michigamme lake, and west-northwest from the Spurr to the First lake, an aggregate distance of over nine miles, as may be seen by the map of the Marquette Iron region, No. III. It must not by any means, however, be supposed, that here is a workable deposit of ore nine miles long; this has not been proven, but on the contrary, it has been proven that for a considerable portion of this distance the ore is not workable, having altogether too large an admixture of rock. Therefore, while it may be confidently asserted, that all of the rich hard ore which will be found in this vicinity, will be in or near the belt of magnetic attraction already described, it may be asserted with equal truth, that at least three-fourths of the whole length of this belt is barren ground, according to the present standard of merchantable ore. The law of the distribution of the rich "chimneys," "shoots," or "courses of ore," as they are designated in different mining regions, along a given iron range, has not been made out. The subject is more fully considered in Chapters VII. and IX.

Besides the deposits already described on this range, one other has to be mentioned, that on the east side of railroad Sec. 23, adjoining the Spurr on the west. The magnetic attractions here are remarkably strong, and explorations have revealed the existence of a small workable deposit of first-class magnetic ore. Whether this deposit connects with the Spurr or not, was not fully determined.

As has been remarked, both the granular and compact varieties of magnetic ore occur at the **Michigamme mine.** The explorations on this location, which were conducted by the writer, developed in a distance of 1,200 feet, east and west, seven places, where pure ore existed of a thickness of from seven to thirty-five feet, rendering it probable, that the ore deposit is continuous and workable for the whole of this distance. Mining operations, which have commenced at this location, confirm these results. Pure ore was found in place at two points on same range west, on Sec. 19 of the Michigamme Company's property, but not enough work was done to prove their extent. Eastward the ore can be traced by the magnetic needle into Michigamme lake, on the south side of Sec. 20.

There can be no doubt these deposits and the Champion belong to the same horizon, being the opposite croppings of the synclinal basin, which passes under Michigamme lake; although the Champion deposit has not been traced westward, nor the Michigamme range eastward, to points where they come directly opposite each other. Whether the specular slate ore found so abundantly at the Champion will be found on the north side of the lake, remains to be seen. I see no reason why it should not; the explorations, so far, have been based entirely on magnetic attractions, and would therefore not be likely to result in finding specular ore.

Underlying the pure ore here, as at the Champion, is a ferruginous quartzose rock, which has an immense development on the Spurr-Michigamme range, where it is a well-characterized reddish quartz schist (jasper), containing thin layers of pure specular ore; these layers being occasionally thick enough to afford hand specimens. See Specimen 33, State Collection, App. B, Vol. II. A similar rock found, as will be seen hereafter, at the Republic mountain, where it has the same relative position and number, XII.

Underlying this iron series we find, as at the Champion, a diorite (greenstone), but which here has a much greater development, forming a conspicuous ridge which borders the Michigamme and Three Lakes valley on the north, and which has already been described under Topography in Chapter II.

This greenstone ridge is separated from the granite region to the north by a valley about half a mile wide,

which is underlaid by various schists and quartzites, about which little is known. Two are marked X. and V. on the Spurr-mountain section No. 9.

The most easterly developed mines in the Michigamme district are the **Washington** and **Edwards**, represented by map No. VIII. The general structure, which we are now considering, can be easiest made out at the Edwards and " old mine," which are adjacent, and about three-fourths of a mile west of the Washington mine proper. The general character and order of the ore and accompanying rocks at this locality is so similar to that of the mines already described, that a careful inspection of the map and accompanying sections leaves but little to be said. The Upper Quartzite XIV. is fully exposed in outcrop, as well as in the railroad cut, just west of the mines, where it is a coarse conglomerate, often schistose, as is shown by Specimen No. 51, State Collection, App. B, Vol. II.

The same formation is a compact gray quartzite at the Edwards mine, and at other points in the vicinity.

The ore formation XIII. affords at this group of mines all the varieties, already designated as being found at the Champion, Spurr, and Michigamme mines. Like the Champion, here are intercalated beds of magnesian schist, the arrangement of which are shown on the sections of workings given on the map already referred to, as well as in the plan of the Edwards mine, by A. Kidder, Plate XIX., Chap. IX., where the subject of detailed structure is more fully considered. One of these schists, of a decided talcy character, is represented by Specimen 54 of State Collection, App. B, Vol. II.

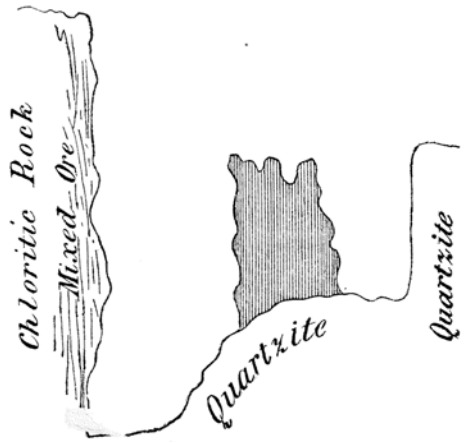
The underlying ferruginous quartzose rock, XII, has a large development south of the Edwards mine, and to it probably belongs the "red ore" of the old Washington. Southwest of the latter mine are large exposures of the peculiar conglomeritic specular schist, mentioned as occurring on the Keystone property, east of the Champion.

The dioritic formation, XL, is represented by a large outcrop of a greenish schistose rock, apparently chloritic, which can be seen immediately south of the old mine. Below this formation are alternating schists and diorites of different varieties, which are sufficiently well shown on the map and sections. One of the most interesting varieties is represented by Specimen No. 27, State Collection, App. B, Vol. II., procured 500 feet south of Pit No. 9, Washington mine.

The Washington mine proper presents some of the most complicated structural problems, to be found in the Marquette region, and I will not here either attempt their solution, or even advance the hypothesis which I have formed. Suffice it to say that, in general, the mine is a monoclinal deposit, dipping away from the St. Clair mountain (which term I apply to the high ground to the south) to the north and under the great swamp. The minor rolls, the peculiar faulting at the East Hill, and the trap dykes, would, if fully considered, occupy a chapter.

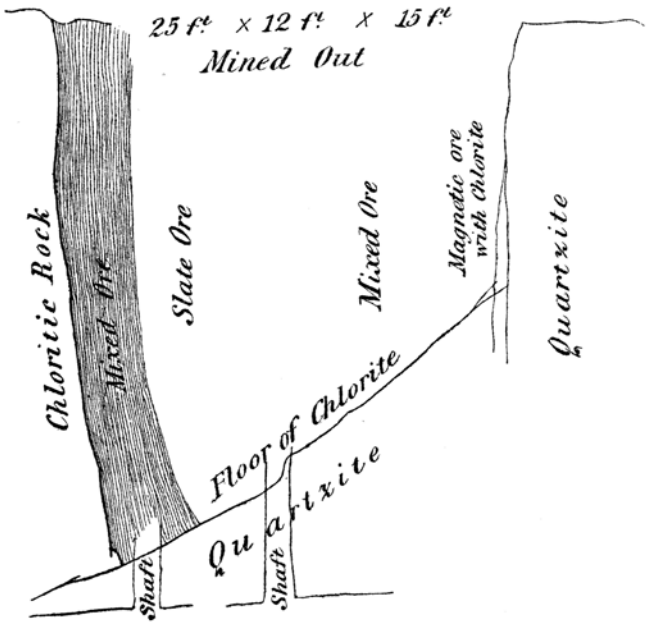
I cannot, however, pass to another mine, without noticing the singular manner in which the mass of ore, known as Anderson's cut, or Pit No. I, is terminated in its downward course, as shown by Figs. 3 and 4. It will have been observed, that the usual form of ore masses is *lenticular, i.e.,* they generally terminate by *wedging* out more or less gradually each way. This exceptional mass, as will be seen, is obliquely and abruptly cut off, the bottom rock being a quartzite of the same kind, that bounds the deposit on the north, and there is no evidence of faulting on the plane of this floor, or along the quartzite wall. An hypothesis to account for this phenomena, based on a sedimentary origin for these rocks, will readily suggest itself and need not be stated.

Fig. 3.—Looking East.




[3. Section of Anderson's Cut—Washington Mine]

Fig. 4.—Looking East.




[4. Section of Anderson's Cut—Washington Mine]

The **Republic mountain** and its prolongation on the Kloman lot, is the only remaining ore deposit of the class under consideration, which remains to be described in the Michigamme district. See map No. VI. The

**Magnetic mine** group, embracing the Cannon and Chippewa locations, belong to a different geological horizon, produce different ores, and will be considered hereafter.

The immense mass of pure specular ore, which was naturally exposed near the centre of the north ½ of the southeast ½ of Sec. 7, T. 46, R. 29, could leave no reasonable doubt in the mind of the experienced observer, that this deposit of ore was one of the largest, if not *the* largest, in the Marquette region. This outcrop, the extent of which is shown on the map of the Republic mountain, being there marked "pure specular ore," is, so far as I know, the largest outcrop of any equally rich ore, ever found in the United States.

The elevation of the ore, 120 to 150 feet above Michigamme river, gives an unsurpassed opportunity for mining operations, which began in the spring of 1872, and confirm, as far as they extend, the "surface show." Several other small outcrops of pure ore occur in the iron belt, one of the largest of which is near the centre of the Kloman mine lot, in southwest fractional ¼ of Sec. 6, same Township.

The numerous outcrops of rock and ore at this mountain, the strong magnetism possessed by three of the beds, the remarkable uniformity in thickness of the several formations, and the bold topographical features presented, all of which were carefully surveyed and are faithfully represented and explained on the accompanying topographical, geological, and magnetic maps and charts (Plates VI. and XII. Atlas), leave but little more to be said in this place, regarding the general structure of the Republic mountain.

The lithological character of the rocks and ores will also be fully understood from the 14 specimens from this locality, which are embraced in the State Collection, App. B, Vol. II. The ten formations represented by colors on the map, as composing the Huronian series, will now be enumerated, commencing with the lowest, which reposes non-conformably on the Laurentian granites and gneisses.*

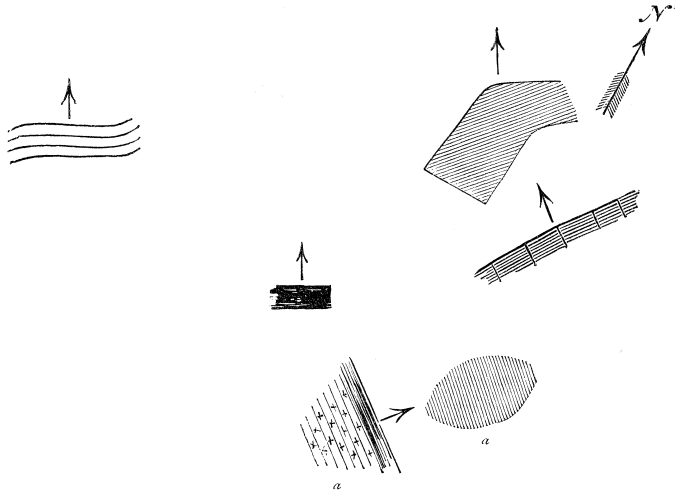
The lowest bed of the series will be numbered V., for reasons which will hereafter appear.

V. A quartzose rock, which is exposed at but a few points, and is best seen near 4,600 southwest and 6,200 southeast (see rectangular ordinates on map), from which locality Specimen 8, State Collection, App. B, Vol. II., was obtained.

VI. Is a magnetic, bright, banded, silicious and chloritic schist, containing considerable iron. See Specimen 15, State Collection, App. B, Vol. II., from near locality of Specimen 8. Very large exposures of this schist occur on the northeast side of the mountain, and southeast of Bear lake. The regular, various-colored stripes, which this formation, as well as VIII. and X. displays, strongly suggests a rag carpet. The greenish layers are apparently chloritic, the whitish and grayish are quartz, and the brown and dark gray are silicious layers of the red and black oxides of iron. Some of these lamina are quite pure iron ore, and the whole mass may contain from 15 to 30 per cent, of metallic iron. The magnetic power displayed by these schists is remarkable, as will be seen by inspecting the charts and explanatory text already referred to.

*This sketch (6,100 southeast and 4,700 southwest, Map VI.) represents outcrops of Huronian quartzites and schists dipping north-northwest, and the Laurentian gneisses, *a a*, clipping northeast, the latter being within 50 feet of the former. The actual contact is not seen, but the stratigraphical relations indicated, in connection with the wide difference in their lithological character, leaves no doubt in my mind of the non-conformability of the two systems, the Huronian being the youngest. This non-conformability can also be observed on the L'Anse Range. See page 156.

Fig. 5.




[5. Non-conformability of Huronian and Laurentian Republic Mountain]

VII. Is a diorite of the general character of those, so fully described by Mr. Julien in App. A, Vol. II., as will be seen by reference to Specimen No. 18, State Collection, App. B, Vol. II.

VIII. This magnetic silicious schist in its lithological character differs in no essential particular from No. VI., already described. See Specimen No. 19, State Collection, App. B, Vol. II. This formation is noticeably thin, not exceeding 40 or 50 feet, the other beds being from three to five times this thickness, as can be seen on the map.

IX. Is a Diorite similar to VII. See Specimen No. 22, State Collection, App. B, Vol. II.

X. A magnetic silicious schist similar to VIII. and VI., but containing in places more iron, as at 5,600 southeast and 2,500 southwest, from which locality Specimen 23, State Collection, was obtained. This, it will be observed, is a fair specimen of magnetic flag ore, containing probably 45 per cent, of metallic iron.

XI. This formation is made up of a coarse-grained diorite, in which a light grayish and reddish feldspar is a conspicuous ingredient, as may be seen on the Kloman lot, as well as at the knob southwest of Bear lake, from

which Specimen No. 29, State Collection, App. B, Vol. II., was obtained.

A schistose variety, containing considerable black mica, occurs in the same formation, at 3,400 southwest and 5,300 southeast, where Specimen No. 30, State Collection, was obtained, although it does not truly represent the prevailing variety at this locality.

XII. This is a reddish quartz or jasper schist, containing thin lamina of specular ore, and very similar to the corresponding formation of the Spurr mountain series already described, as will be seen by an examination of Specimen 32, State Collection, App. B, Vol. II.

XIII. We have now reached the iron-ore formation, the principal outcrops in which have been enumerated. Four varieties of material chiefly make up this formation, which in the order of apparent quantity are as follows:

*a*. A banded rock made up of alternating layers of red quartz or jasper and specular ore, designated by the miners as "*mixed ore,*" the richer varieties of which are now shipped as second-class ore. See Specimens 36 and 37, State Collection, App. B, Vol. II. The contorted and plicated lamina of this rock, brought out by the alternating bright red and steely bands, and which could be but poorly illustrated in Figs. 19 to 29, App. K. Vol. II., are very beautiful, being often contorted and plicated in a striking manner. See Iron Ores, Chapter III. It may be remarked in passing, that such contortions in the constituent lamina of rock formations generally indicate the presence of great folds in the whole formation, as is plainly the case at this locality.

On the southwest side of the basin, at points in the ore formation marked "specular conglomerate" on the map, occurs a true schistose conglomerate, in which pebbles, chiefly quartz, are bedded in a matrix of silicious ore. On the supposition that this rock may be a secondary form of the laminated or mixed ore, and from a desire not to multiply subdivisions in this connection, it will at present receive no further consideration.

*b*. Next to the mixed ore in quantity, so far as can be judged by what can be seen, is the pure *specular* ore. See Specimen 46, State Collection, App. B, Vol. II. The specific gravity of these specimens varied from 5.09 to 5.56, the average of four being 5.24, or greater than that of any other ore in the region, which should indicate a somewhat greater richness in metallic iron; whether furnace work will confirm this, remains to be seen.

*c*. The next in supposed order of quantity is a rich, black, *magnetic* ore, similar to the Spurr and Champion ores, but much coarser in its grain. See Specimen 39, State Collection, App. B, Vol. II.

*d*. Dividing the specular ore below, from the magnetic ore above, can be seen, in cut No. I, Republic mine, a bed several feet in thickness of a *magnesian schist* similar to that previously mentioned, as being found in the Washington and Champion mines. See Specimen 53, State Collection, App. B, Vol. II.

XIV. The Upper Quartzite at Republic mountain is a gray massive rock, sometimes banded, and, near the contact with the iron, sometimes conglomeritic, containing large and small flattened fragments of flaggy ore. The prevailing variety is represented by Specimen No. 50, State Collection, App. B, Vol. II.

XV. Near the south point of Smith Bay is a considerable outcrop of what appears to be a dioritic schist, not unlike Specimen 31, State Coll., containing mica and garnets. It has some resemblance, as will be seen by the description, to the micaceous clay-slate of corresponding number of the Champion section, Specimen 56, App. B, Vol. II.

The horse-shoe form of the surface rocks, as indicated by outcrops, which is so conspicuous a feature on the map, taken in connection with the dip of the strata, as indicated by the arrows and geological section, leave no doubt whatever as to the structure of Republic mountain. It is evidently the south-east end of a synclinal trough with Smith's Bay in the centre, under which, at an unknown depth, all the rocks represented would be found and in the same order. The conjectural division plane, dividing the quartzite and ore (see section), may be regarded as hypothetical, only as to its position, which of course can finally be determined by boring.

It will be observed, that where the northeast side of the horseshoe crosses the river, there is an offset of about 250 feet to the right, and that where the southwest arm of the shoe should cross the river, but very little appearance of Huronian rocks can be discovered on the west side, the Laurentian rocks to a great extent taking their place. These facts can be best explained, by supposing a *fault* to follow the line of this portion of the river; the east being the down side. On this supposition the Huronian rocks on the west side would have been eroded to a much greater extent than on the east, leaving as a consequence the narrow and incompleted series, shown on a section through the Kloman mine.

The proximity of the Champion ore deposit to the Laurentian, it being only about 400 feet distant, while at the Keystone (three-fourths of a mile east) the distance is three or four times as far, leaving room for a greatly increased thickness of vertical brownish banded magnetic schist (see Map VII.), can be best explained, by supposing a *fault*, similar to that just described, but having a direction nearly at right angles; that is, east by south.

These two instances are the best established cases of faults on a large scale, that have come under my notice, in the whole region.

Calling to mind the series of rocks, which have been described as occurring at the Spurr, Michigamme, Champion, Keystone, Edwards, Washington, and Republic mines, we are irresistibly led to the conclusion, that they are equivalents of each other, belong to the same series, and are of the same age. This hypothesis has already been introduced and carried through the descriptions by the corresponding numbers, which have

been attached to equivalent formations in each section; it will no longer be regarded as an hypothesis, but accepted as a demonstrated theory. The Republic mountain section, it will be seen, is most complete for the rocks immediately below the iron, and the Spurr mountain section for those above. The latter embraces one formation of great extent and interest, which was not described, viz.:—XIX., which is made to include the several varieties of mica schists, so extensively developed on the south shore and among the islands of Lake Michigamme. This schist is often very silicious, and, in places, contains numerous crystals of garnets, andalusite and staurolite. See Specimen 61, State Collection, App. B, Vol. II., and Group H, Chapter III.

Near the centre of Sec. 25, at the west end of the lake, is a large mass, probably a ledge, of light-gray quartzite, which may fill in part at least, what appears to be a blank between the anthophyllitic schist XVII. and the mica schist XIX., just described. The number XVIII. is provisionally attached to this quartzite.

We have now described fifteen members of the Huronian series, from V. to XIX., both inclusive. This mica schist is the youngest member of the series, so far as my observations extend, to be found on the Upper Peninsula. It is proper to remark, however, that equivalency, member for member, of the Marquette rocks with the L'Arise, Gogebic and Menominee series, has not been established; they are all Huronian, and it is doubtful if any are younger than XIX.

With regard to the strata below V., there is less certainty as to their order and equivalency. I believe, that the iron ore and associated rocks, to be seen at the **Magnetic, Cannon, and Chippewa** locations, belong here. They are in any event the equivalents of each other, and are very near the base of the Huronian series. See Geological Section, No. 10, map of the Marquette iron region, which extends from the Cannon to the Chippewa. At the latter location is a considerable deposit of ferruginous, silicious schist, or lean flag ore, in which occurs, in what I understand to be an irregular pocket-like mass, a peculiar specular ore of fair percentage, greenish-gray color, and containing numerous bright facets, which resemble scales of mica. This is in comparatively low, wet ground, and the extent of the deposit has not been determined. It resembles the Gilmore ore at north side, Sec. 26, T. 47, R. 26, Cascade range, the two being unlike any other ores in the region.

About 100 tons of 55 per cent, ore was taken from the latter location several years since, but work was not continued. The Gilmore deposit, as well as the Chippewa, is nearly in contact with the Laurentian.

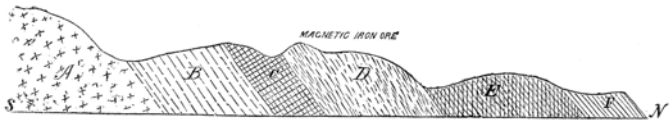
At the **Cannon** location is a banded jaspery rock, holding thin layers of specular ore, which bears a striking resemblance to the rock of formation XII., and even to some varieties of "mixed ore." See Specimen 16, State Collection, App. B, Vol. II. A seam, several inches thick, of pure specular ore, was found here, but did not enlarge on being followed downward. The remarkable characteristic of this schist is the fact, that on following the range northwest and southeast, mica replaces the ore, and we have a micaceous quartz schist, or mica schist depending on the quantity of the latter mineral. These facts, already noticed, possess interest in their bearing on the nature of the Felch mountain ore deposit of the Menominee region, hereafter to be considered.

By far the most promising mine of this group, so far as existing explorations reveal, is the **Magnetic,** in south ½ of northwest ¼ of Sec. 20, T. 47, R. 30. The existence of a workable deposit of magnetic ore of medium richness has been proven. This ore, although highly magnetic, differs entirely in its character from those already described, as will be seen by inspecting Specimen No. 17 of State Collection, App. B, Vol. II. It is very hard, exceedingly fine-grained, and breaks into cubic or tabular pieces. Its structure is more like the flag ores than the first-class magnetites. It should yield about 55 per cent, in the furnace, although none has as yet been worked. The gangue is largely actinolite, instead of the more common quartz, which will help the reduction of the ore.

The relative geological position of this ore is shown in the accompanying north and south section, in connection with Map No. III., already referred to. As to the age of the series represented, I have but little doubt on account of their proximity to the Laurentian, and on lithological grounds, that they are the equivalents of the lowest rocks of the Republic mountain series, and are probably older than the lower quartzite V.

FIG. 6.

Geological Section (looking west).
Magnetic Mine. Sec. 20, T. 47, R. 30.




Level of water in Lake Michigamme 950 feet above L. S.

SCALE OF FEET.

A. Granite. B. Micaceous Quartz Schist. C. Quartzite and Quartz Schist.
D. Banded Magnetic Schist (ore). E. Greenstone or Diorite. F. Dioritic Schist.

[6. Section of Magnetic Mine. Section 20—T. 47—R. 30]

B, C, D are undoubtedly the equivalents of the specular and micaceous schists of the Cannon series.

The line of magnetic attraction, running southwest and south, and finally south by east from the Magnetic mine, which has been traced to Sec. 9, T. 45, R. 30, is one of the longest and most persistent belts of attraction in the whole Lake Superior region. The maps of the United States Linear Surveyors mark its position very plainly, as is shown in the chapter on the Magnetism on Rocks, Plate v. Comparatively little exploration has been made on this range; but I see no reason why deposits of the character and equal in value to the magnetic, may not be found along it.

A large amount of very poor ore, and a small amount of very good ore, has been found in south part of Sec. 7 and the north part of 18, T. 47, R. 28; and quite recently a workable deposit of first-class specular ore is reported to have been found there, the locality being known as the **Michigan Mine.** Specimen No. 2, State Collection, App. B, Vol. II., is from this deposit.

Clarksburg, Geological Section No. 6, map of Marquette iron region, records the leading facts to be observed in this vicinity. The Roman numerals marked on the several formations express their *relative* ages correctly; whether they also express the equivalency of these rocks with the Washington and other series previously described, I am not quite certain. Specimen No. 3, of State Collection, from formation marked III., possesses lithological interest, as being a Huronian rock allied to the Laurentian gneisses.

### 2. Negaunee District.

Following the same principle here that guided us in describing the mines of the Michigamme district—that is, beginning with those simplest in geological structure—we find on the **Saginaw** and **New England** range of mines (being the most westerly of this district), a structure almost identical with that of the Champion and Spurr mines. Referring to Geological Section No. 4, map of Marquette iron region, the rocks in the vicinity of the New England mine are represented as follows:—The ore formation XIII. is made up, as at the Republic mountain, of "mixed ore" (banded ore and jasper), magnesian schist and pure specular slate ore; magnetic ore being absent here, as in all the mines of this district. The quantity of specular slate ore at this mine is, so far as known, small; the small lens-shaped mass, that was formerly worked, having been abandoned.

Overlying the ore formation is the Upper Quartzite, XIV., dipping at a low angle to the north, as may be seen just north of the Parsons mine. This quartzite again comes to the surface about half a mile north, in a flat synclinal, where it again dips north and does not rise until we reach the New Excelsior mine, owned by the Iron Cliff Co., which is shown on the section.*

Returning to the **New England mine,** we find between the ore XII. and the quartzite XIV., a mass of specular conglomerate, somewhat similar to that described as existing at the Republic mountain, where it was regarded as belonging to the ore formation. The fact that it overlays the pure ore at this locality, and has lithological affinities with some of the conglomeritic varieties of the Upper quartzite, leads me to doubt in which formation it should be included. I incline to the view, that it belongs in XIV.

*This general section was constructed more than a year before ore was found at this locality, but it has not been found necessary to make any changes in it.

Formation XII., underlying the ore, is here widely different in its lithological character and economic value from the corresponding formation of the Michigamme district, where, it will be remembered, it was a valueless reddish quartz schist, containing thin lamina of iron. If we suppose tepid, alkaline waters to have permeated this formation, and to have dissolved out the greater portion of the silicious matter, leaving the iron oxide in a hydrated earthy condition, we would have the essential character exhibited by this formation as developed on the New England-Saginaw range, and as will be afterward seen at the Lake Superior mine. This is not offered so much as an hypothesis to account for the difference, as to illustrate the facts observed. The prevailing variety of rock in this formation is a brownish silicious schist, containing a considerable amount of iron (Specimen 26, State Collection, App. B., Vol. II.). Scattered through this formation are here and there large and small pockets of soft earthy hematite ore, having usually the most irregular forms, that can possibly be conceived. This subject was discussed under iron ores, Chapter III. Specimens 34 and 35, State Collection, are ores of this class.

The **Winthrop and Shenango mines** are in this formation, and are producing hematite ores as rich as any now worked in the district, and excepting perhaps the Lake Superior and McComber, richer than any other of this class, as indicated by analyses, Chapter X.

Underlying this hematite formation is a diorite, XI., similar in its general character to the rock, having a corresponding number in the Michigamme district; below this and south, are various ferruginous schists and diorites, corresponding in a general way with the Michigamme series, but which have not been carefully examined in the vicinity of the New England mine. Recent explorations afford opportunities for study, which did not exist when this section was made.

The series at the **Saginaw** and intermediate mines, as well as further west, is so near an exact duplicate of what has been given above, as to require no further mention than to state, that the deposits of specular ore are larger than at the New England, which has been mentioned as being rather small for profitable working. There has been too little work done at these new mines, to determine the extent of the deposits, but I see no reason to suppose that any of those now worked will prove very large. The fact that Sec. 16, the Parsons and New England mines, have produced specular ores and have been abandoned, is significant. No doubt, considerable amounts of first-class ore will be taken out on this range at a profit. The only question is, whether they will continue to produce such ore in quantity for a series of years, at a fair cost for mining.

This range of ore has been traced westerly into the northeast ¼ of Sec. 24, T. 47, R. 28; west of this the drift becomes very deep and the ore range is lost. A shaft 67 feet through the sand in this vicinity found no ledge. Whether there is any stratigraphical connection between this ore formation and the Washington, six miles distant west by north, is not determined. So far as is now known, it is economically a blank in the Marquette iron belt. Work now in progress at the new Michigan mine,

already noticed, may throw light on this interesting and important question. It is not at all improbable, that the Negaunee and Michigamme districts may be independent ore basins, in which case the intervening rocks, which are all Huronian, would consist of the lower members of the series, that is below XIII. Even should this be the case, valuable hematite and flag ores may be found in this now barren district.

The new **Excelsior Mine,** previously mentioned and shown on the New England section, is near the southeast corner of Sec. 6, T. 47, R. 27, and is, as will be seen, the opposite cropping of the basin. There is so much drift between these ranges, that not much can be said definitely about the nature of the intervening rocks; but it seems probable that we have here a great basin, underlaid by ore at an unknown depth, and that the New England and Excelsior deposits are related to each other in the same way, as it was assumed are the Champion and Michigamme deposits. This could be cheaply tested, and possibly an important discovery of ore made, by a drill-hole through the quartzite, near the railroad on the west side of Section 16. All efforts to find an extension of the Excelsior deposit east and west have so far failed.

Returning to the New England range and following it eastward, we find that near the south ¼ post of Section 16, it bends suddenly to the northeast, making its way diagonally across this section to the **Lake Angeline Mine,** which produces specular ore, having such admixture of jasper, as to cause it to rank intermediate in the market between first and second class ores. Whether the deposit worked at this mine belongs to bed XII. or XIII., I have not determined, the ore partaking somewhat the character of each. The overlying rocks on the north are covered by the waters of Lake Angeline.

To the south is a high ridge of diorite, XI., on the south side of which is an extensive deposit of soft hematite, owned and worked in part by the Lake Angeline and Iron Cliff Companies.

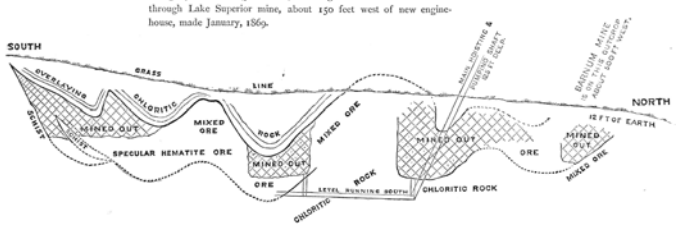
I suppose this hematite to belong to formation X., and therefore of the same age as the Negaunee and Foster hematites, which will be fully described below. It will be borne in mind, that the hematite ores on the Saginaw range occur in formation XII.

Without attempting to point out at present the structural relations of the Lake Angeline and Lake Superior ore deposits, we will pass at once to a consideration of the latter mine, one of the most extensive, productive and geologically interesting in the Marquette region.

The accompanying map, No. IX., representing the **Lake Superior** specular and hematite workings, together with the **Barnum mine,** is intended to give the geological facts to be observed in considerable detail, as well as the condition of the workings in 1870. The structure of the east half of this mine is more complicated, than that of any other in the district, and some questions connected with it remain unsolved.

Regarding for the present the west half of the mine only, we find presented on a small scale about the same structural phenomena, which is so prominent a feature in the Republic mountain rocks. The basin, or trough, in this case, however, abruptly narrows up, the sides and bottom being as it were gathered in, as if to be tied, at a point just south of the engine-house; to the west the outcropping edges of the basin diverge rapidly, and its bottom sinks Into the earth in the same degree. If we suppose the frustrum of a hollow cone, lying with its axis horizontal and its small end towards the east, to be cut in two by a horizontal plane, representing the surface of the ground, the lower half will represent my conception of the form of the Lake Superior-Barnum ore basin. Conceive now this cone to be made of sheet-lead, and to be considerably bent and dented, and the illustration will be still more applicable.

Fig. 7.—Sketch (part ideal) showing north and south section through Lake Superior mine, about 150 feet west of new engine-house, made January, 1869.




[7. Section of Lake Superior Mine made in 1869]

A study and comparison of sections D—D', C—C', B—B', and A—A', in connection with the plan of the mine (Map IX.) will, I think, render it plain that this conception of the structure is in accordance with the facts; although the minor folds and faults considerably obscure and confuse the general structural question. Of course, it is not absolutely proven, that the Barnum deposit dipping south, and the continuation of the main Lake Superior deposit, now worked in Pit No. 25, which dips north, are opposite croppings of the same bed, and that the intervening space is underlaid by the ore formation, and that, therefore, if work continue long enough they will eventually connect under ground; but certainly all the facts point to this conclusion. The importance of this theory in its bearing on explorations for ore, mining and valuing ore deposits, is very apparent. It shows, that such formations are not vein or dyke-line deposits, but true stratified beds, like the rocks by which they are enclosed. Their structure is therefore essentially the same as the coal, limestone, sandstone, and slate-beds, which are regarded as sedimentary deposits from water, subsequently more or less altered by heat pressure, and chemical waters acting during immense periods of time.

The Lake Superior-Barnum deposit evidently has a *bottom,* which will be reached within a period, of which it is worth while for the present generation to take some heed. So of many other deposits in the region.

As we go westerly from these mines the basins become, as we have seen, wider and correspondingly deeper. A depth of 300 feet in the Edwards mine reveals no essential change in the dip of the deposit, as will be

seen by reference to the plans of the mine. The same is true of the Champion mine.

The time may come when, having worked out the steep upturned edges of the basins, and the flatter or deeper portions of the deposit are reached, ore properties will be valued somewhat according to the number of acres *underlaid by ore*, as coal now is.

Fig. 8.

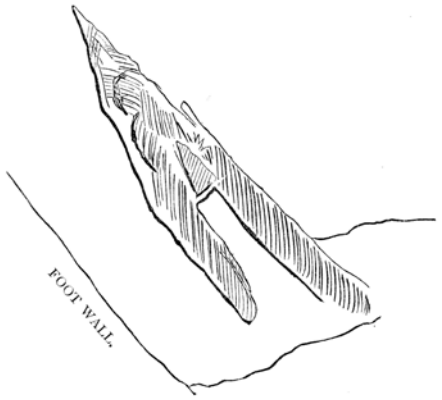
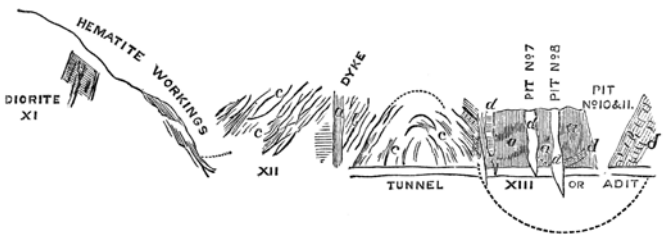



Fig. 8, represents on a large scale the south or left-hand end of the section represented in Fig. 7, and brings out the peculiar form of the "horse" of magnesian schist, which is shaded, the ore being white.

[8. Part of Lake Superior Mine on large scale]

Fig. 9.—Sketch showing Geological Section of the Lake Superior mine (looking west), near Sec. E—E', Map IX.




*a*. Chloritic schist. *b*. "Mixed ore." *c*. Limonitic schist (hematite rock). *d*. Pure Ore.

[9. Section of Lake Superior Mine through hematite workings]

Passing to the east portion of the Lake Superior mine, I confess myself unable to give any intelligent hypothesis of its structure. The facts observed are in part recorded on the Map of the mine on section E—E', and on the accompanying sketch, in part ideal, which represents on a small scale a section near E—E'. There seems to have been such a gathering together, crumpling, squeezing and breaking of the strata, as to nearly obliterate the stratification. An attempt has been made to represent the present condition of things, so far as revealed, by the workings. The remarkable features are the great masses of light grayish-green chloritic schist, having a vertical east and west cleavage, no discernible bedding planes, and holding small lenticular masses of specular ore, which conform in their strike and dip with this cleavage, and which seem to have no structural connection with the main deposits. They appear like dykes of ore, squeezed out of the parent mass, which we may suppose to have been in a comparatively plastic state, when the folding took place; or they may have been small beds, contained originally in the chloritic schist, and brought to their present form and position by the same causes, which produce the cleavage in the schist. A comparison of these sections, showing effect of the folding on a large scale, with the figures (19 to 29, Vol. II.) representing the contorted lamina of the mixed ore of Republic mountain, will be found instructive. Indeed the same phenomena may be observed abundantly at the Lake Superior mine, and still better at the Cleveland knob.

Lake Superior mine sections E—E', and Fig. 9, may almost be said to represent a huge breccia.

The peculiar nature of the hanging wall of the Lake Superior mine deserves further notice. Instead of the quartzite, which we have hitherto found overlying all the deposits of rich ore, we have here a magnesian schist very similar to, if not identical with, that already mentioned as being associated with the ore, as will be seen by reference to the geological sections, and to Spec. 55, State Collection, App. B, Vol. II. These rocks are given, however, different colors on the maps. The hanging wall of pit No. 25, Section A—A', it will be observed, is made up of this schist and of layers of quartzite. Whether the Upper Quartzite is replaced by this schist, making it belong to XIV., or whether it is a member of the ore formation XIII., in which case XIV. would be wanting at this locality, I am not able to determine, but incline to the first opinion.

The hematite formation XII. is fully developed at this locality, producing an excellent ore which is extensively worked. The relation of this formation to the overlying and underlying rock is obscure, as has already been pointed out. This relation was very plain, it will be remembered, on the Saginaw-New England range.

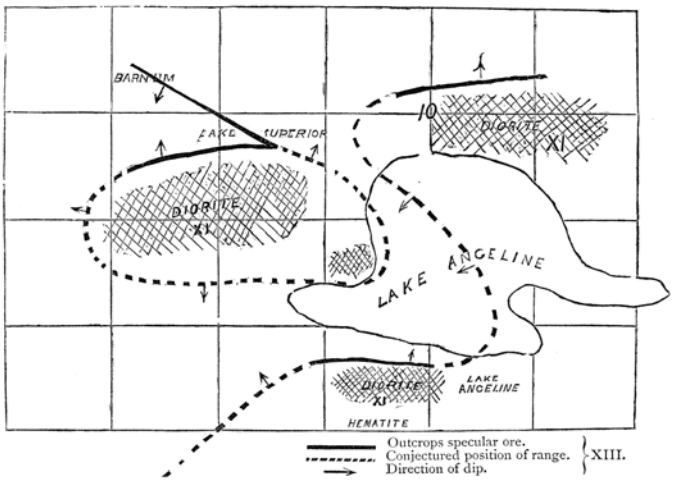
The structural hypothesis by which I have attempted to connect the Lake Superior deposit with the Lake Angeline on the south, and Marquette, Cleveland and New York mines on the east, need not be further described here, but will be understood I think, by those interested in the question, from an examination of the following figure in connection with the maps.

### New York, Cleveland and Marquette Mines.

The geological facts to be observed, the general structure, nature and extent of the workings of the New York mine, which is one of the most regular deposits in the district, are so plainly set forth on the accompanying Map, No. X., that but few words of description are necessary. It will be seen to be a monoclinal deposit, in every essential particular, like the Barnum, Champion and Spurr. Two interesting facts will be observed: 1st. The absence of formation XII.; the pure ore, with its associated chloritic schists, seems to occupy the whole space between the Upper Quartzite, XIV., and the diorite, XI. It maybe here observed that, as a rule, the purest ores are found in the upper part of the ore formation, that is, nearest the Upper Quartzite; the New

York mine presents an exception. 2d. The deposits on the north side of the railroad, worked by Pits No. 3 and 4, have a striking resemblance to the small deposits, Pits 16 to 21, of the Lake Superior mine, just described. The facts to be noted at the Collins location, just east, taken in connection with Pits 3 and 4 of the New York, point plainly towards the existence of a small independent trough, north of the Cleveland-New York deposit. Explorations and mining operations so far, do not indicate the presence of a large amount of first-class ore here.

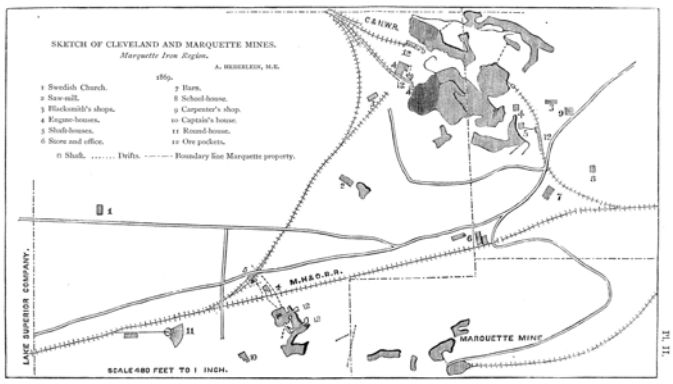
Fig. 10.—Sketch (part ideal) showing position of ore basins at Ishpeming.



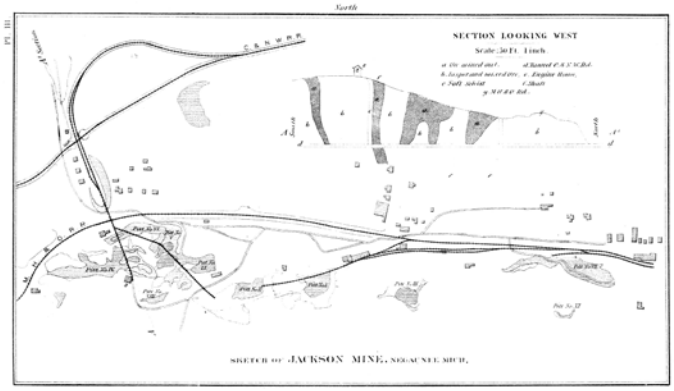

[10. Plan of Lake Superior and Lake Angeline Ore Basins]

I made no special survey of the **Cleveland mine,** the fund at my disposal not permitting it; the main object of the survey in this direction being, to represent in detail a sufficient number of typical mines, to cover the various structural phenomena to be found in the district. The sketch of the Cleveland and Marquette mines, Plate II., from A. Heberlein's map, in connection with the New York mine (Map No. X.), will give a good general idea of this group. It will be seen, that the most northerly pit (Gents, No. 3) of the Cleveland mine, is a continuation of the New York deposit, having the same strike and dip. Gents pit is in one of the largest deposits of pure specular ore in the whole Lake Superior region. It dips south, forming the northerly edge of a narrow synclinal basin, which immediately comes to the surface again in the Swedes pit, where the ore has a northerly dip. These two pits produced in 1872 over 100,000 tons of ore. The ore basin widens and deepens to the west in a similar manner to the Lake Superior, and undoubtedly underlays the swamp, on which the village of Ishpeming is built. The connection of these deposits with those worked in the more southerly Cleveland and Marquette openings, has not received that attention which would enable me to express an opinion on the subject.

There can be little doubt, but that the Cleveland mine promises as well, if not better, for the future production of first-class specular ore, than any one of the older mines.




[II. Cleveland and Marquette Mines.]




[III. Jackson Mine]

## Jackson Mine and Negaunee Hematite Deposits.

No special survey was made of the **Jackson mine;** but the accompanying Plate (iii.), from O. Dresler's map and Atlas map of the iron Mines at Negaunee (No. V.) will make known the general structure of the mine, which is essentially similar to that of the Cleveland and Lake Superior. This mine, although it produces first-class specular ore, will be here considered in connection with the hematite deposits, because they are adjacent, and their geological structure can be most conveniently described together. The Jackson mine, so far as is known, is the extreme east end of the rich ore basin formed by bed XIII. No workable deposit of ore of any kind has been found north and east from this locality, and the ores to the south are believed to belong to a lower horizon, and to be, on the whole, inferior in quality.

Looking back over the field we have now hastily surveyed, and assisted by the map of the Marquette iron-region, it will be seen that, while there are many minor irregularities, on the whole the ore basin gradually widens towards the west, from a mere point at the Jackson mine to a width of fully five miles at the west end of Michigamme lake, beyond which too little is known, to enable us to accurately define its limits. It follows, therefore, that all the Huronian rocks north, east and south from the Jackson mine, are below, or *older than the ore formation* (XIII.) and all the rocks to the westward and inside of the ore-basin are *younger*, hence above it.

The large amount of exploration work, done in the vicinity of Negaunee, in searching for hematite within the last few years, has aided greatly to develop the geological structure of that locality. But unfortunately, the money I had to expend here was more than exhausted, before this work began, so I have been enabled only in part to avail myself of it.

The facts observed are mostly recorded on the local map, mentioned above, and on the general map of the region. By reference to the former it will be seen, that a belt of country, about one mile wide, extending southeast from the Jackson mine, is dotted over quite irregularly with hematite workings, which are mostly on lands leased from Edward Breitung, as is explained in a note on the map. These mines produce dark-colored earthy hematite, containing metallic manganese, often up to an average of 5 per cent., varying considerably in the amount of metallic iron, but on the whole averaging lower, than the hematite ores heretofore mentioned, as will be seen from the chapter on analyses. I believe these ores all belong to one formation, No. X., in which, up to this time, no merchantable ores, except the Lake Angeline hematite, have been mentioned as occurring; it is at least certain, that they are older than formation XII., which embraces the Lake Superior and Winthrop deposits.

The geological sections A—A' through the Himrod and Green Bay mines, and B—B' through the Jackson Company's new hematite and old specular ore workings, fully illustrate the hypothesis of structure adopted. It will be seen, that the ore is contained between two beds of diorite, IX. below and XL above, and that there is associated with the ore, chloride schists and various ferruginous schists and flag ore. These last-named rocks, it will be remembered, made up this entire formation in the Michigamme district, where hematites are wanting, as are magnetic ores in the district we are describing. Underlying the lower diorite mentioned, is a clay slate, which is in turn underlaid by a gray quartzite, to be seen outcropping near the centre of the north half of Sec. 8, and represented in Sec. A—A; under the number VIII. This is undoubtedly the same quartzite to be seen in the railway cut near the northwest end of Goose lake, where it is overlayed by a soft schist. See formations VIII. and XL, Geological Sec. No. I, Map III. The clay slate on south shore and near west end of Teal lake, and exposed in railroad cut one mile east of Negaunee, is also believed to be of the same age.

The lithological character of the several formations, mentioned above, will be better understood by an examination of the following specimens of the State Collection: No. 21 quartzite from VIII.; No, 20 is a clay slate also from VIII.; No. 31 is from diorite IX.; Nos. 24 and 25 are hematite ores from formation X.; No. 26 is a specimen of ferruginous silicious schist from the Foster mine, which is also regarded as belonging to the same formation (X.); Specimen 28, from the same formation, is a magnetic, chloride, silicious schist.

Referring again to Map No. V., it will be observed, that the Jackson Company's hematite workings, the McComber, Maas and Lonstorf's most northwesterly opening, the Rolling Mill, Himrod, Spurr and Calhoun, and Iron Cliff Co.'s Sec. 18 mines, are all in a rude curve, skirting the great development of diorite, which seems to limit these deposits on the southwest, and under which they all dip. The remaining openings are mostly contained in a narrow belt, which extends east-southeast from the Grand Central, diverging from the other range, which curves to the south. The diorite ridge which runs through the centre of the latter range is apparently a synclinal ridge underlaid by ore, which should therefore dip towards it from all directions, as is the fact so far as known. Undulations in the bed now unknown, may very likely bring the ore to the surface at several other points.

There can be no doubt of the great extent of this ore; it certainly can be on the average more cheaply mined and shipped than any other ore in the region, except perhaps the hematites of the Taylor and S. C. Smith mines. Location at the junction of two railroads, and contiguity to a prosperous village, are additional advantages, which will go a long way towards offsetting the disadvantages of lower percentage. The presence of several per cent, of manganese in this ore helps its working in the furnace, rendering it a desirable mixture. The McComber mine was first opened, and its ore is well and favorably known to many furnacemen. My analyses indicate, that this is a richer ore than the other mines of this group, but this cannot be established without further developments, as work has but just begun at most of them.

The **Teal Lake** ore deposit belongs to the same formation, as may be seen by an inspection of the map and sections. I have not been able, however, to find any good hematite in the old exploration pits, now nearly filled; a lean flag ore is very abundant.

The **Foster mine**, near southwest corner of Sec. 23, T. 47, R. 27, is another hematite deposit belonging to formation X. It has produced a considerable amount of hematite ore of medium grade, which contains no manganese; the deposits, or rather pockets, are pre-eminently irregular in form and uncertain in extent. The geological position of the Foster range is shown on Map No. III. and accompanying sections.

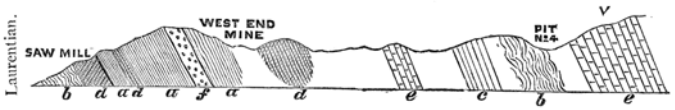
**The Cascade Range.**—The deposits on this range are the only ones now wrought, which remain to be described in the Marquette region. Like nearly every other described in this report, this ore was known to the United States linear surveyors, and afterwards examined and commented upon in considerable detail by Foster and Whitney. The range extends east and west through the south part of T. 47, R. 26. See Map III. The locality known as the **Gilmore mine,** at ¼ post between sections 23 and 26, is the most easterly point at which ore has been seen in quantity. This, it will be observed, is about three and one-half miles east, and two miles south, of the Negaunee hematite mines. The range has

been traced west by south from this place for five miles, or to a point just four and one-half miles south of the Jackson mines. This country has recently been opened up by a branch of the C. and N. W. road, which closely follows the ore range. The principal openings have been made by the **Cascade, Pittsburg and Lake Superior, Carr and Gribben Iron** companies, who shipped an aggregate, in 1872, of over 40,000 tons, nearly all of which was by the first-named company and its lessees. The last two named companies — Carr and Gribben— have done too little work, to enable us to speak with much certainty about their deposits. (See tables, on Sheets XII. and XIII., Atlas.) By reference to the chapter on analyses, which is quite full regarding these ores, it will be seen that they have, on the average, less metallic iron and more silica, than the standard hard ores of the district. The West-End mine, however, worked by the Cascade company, and which produced last year about one-third of their product, appears to be an exception to the above rule, and to rank nearly with the first-class specular ores; certainly considerable amount of high grade ore was taken from this pit last year, but whether it was kept separate from the leaner varieties in the shipments I do not know. The ore which largely prevails is a silicious or quartzose, or jaspery (practically these words have the same import) red oxide, having a characteristic coarse, slaty, or *flaggy* structure; hence the name by which they are known throughout this report. They correspond nearly in composition, although not in their appearance and geological position, with the second-class ores of the old mines, as the analyses referred to prove. See Iron Ores, Chap. III. Some varieties closely resemble, if they are not identical with, certain varieties of the high grade ores; but as a rule they are lighter in weight, duller in color and lustre, are harder under the knife, and pre-eminently flaggy or slaty in structure. I have not been able to obtain a statement of the working of these ores in the furnace. Further information regarding their lithological character may be obtained from descriptions of Specimens 5 and 6 of the State Collection, App. B, Vol. II.; the latter is the beautiful "Bird's-eye" slate ore from the Bagaley and Wilcox pit. Specimen 7 is from the diorite bed, which overlays the West-end mine, and is interesting from its resemblance to granite in outcrop.*

*Mr. Julien has determined the feldspar in this rare variety to be orthoclase.

The structural position which these ores seem to me to occupy is shown on geological section No. 2 of Map No. III. They are near the Laurentian, and the whole series is overlaid by a talcy quartzite, which I believe to be the equivalent of No. V. of the Republic mountain series, and to be the same bed, which outcrops so conspicuously on the north side of Teal lake, and is calcareous at the Morgan furnace and at the Chocolate flux quarry, where it strikes the shore of Lake Superior. This rock varies more widely in its lithological character, than any other in the region, as will be pointed out elsewhere. If this hypothesis is correct, it will follow, that these ores are the equivalents of the Michigan and Magnetic ores of the Michigamme district, and are older than any iron bed made out in the Republic mountain series. The fact, that no iron in quantity has been found north of Teal and Deer lakes under quartzite V., where we should expect to find the opposite cropping of the Cascade series, is to be regarded in considering this question. The shortness of this range, which appears to terminate abruptly to the west, has not been found far east, and has altogether a local and isolated character, is significant. A hasty examination will satisfy any one that the *quantity* of ore in these deposits is very great, and that it is very favorably situated for mining and transporting. The accompanying north and south section represents the different rocks to be seen outcropping on this range, projected on one plane. No attempt has been made to group them under formations I. to IV., to which they are supposed to belong. The general section No. 2, Map III., which has been mentioned, should be examined in connection with this sketch.

Fig. 11.—Geological section across Cascade range, looking west.—Part Ideal.




*a*. Flag ore or silicious hematite schist, in places quite rich. *b*. Banded jasper and specular ore with flag ore. *c*. Hematite rock or hematitic silicious schist. *d*. Diorite and dioritic schist. *e*. Quartzite. *f*. Conglomeritic and brecciated quartzite.

[11. Section across Cascade Range]

The **Iron Mountain, Ogden and Tilden** mines, not now worked, produced flag ores similar to those of the Cascade range, but not so rich on the average. These deposits belong, as will be seen by Map No. III., to formation X.; the Iron Mountain and Tilden mines being in opposite croppings of the same basin. The **Foster mine,** as has been observed, is also in the same formation, being overlaid and underlaid by flag ores, The Negaunee hematite and Teal lake ores being also in X., make that formation remarkably fruitful in the quantity and variety of ore, which it contains; but it does not, so far as known, hold the high grade specular ores in quantity.

### Lower Quartzite, embracing Marble and Novaculite.

A brief consideration of the question of materials for *furnace flux* may come within the limits determined for this report. The subject, so far as the Silurian limestones are concerned, has been fully considered by Dr. Rominger, in Part III., who gives many analyses. The Menominee marbles will be mentioned In Chapter V. on that region. No calcareous, or other rock suitable for flux, has yet been found in the Laurentian system of the Upper Peninsula, although in Canada large beds of marble occur in this oldest series. It remains only for us to consider the silicious variegated marbles, found in the eastern part of the Marquette region, none having been worked west of Goose lake, which happens to mark the most easterly show of iron. The purest stone is found at the Morgan furnace, seven miles west of Marquette, where a heavy east and west bed of silicious marble,

with vertical dip, and having associated with it clay slates, is prominently exposed. The prevailing colors are light-gray and pink. Specimens 11 and 12, State Collection, are from this locality; and Specimen 70, from the Gorge, represents the chloritic schist, which underlies the marble on the north.

The Chocolate Flux quarry on the shore of Lake Superior, three miles south of Marquette, is another locality, from which a small amount of furnace flux has been obtained. But the admixture of quartzose matter is here so great, that its use has been abandoned. Specimens 9 and 10, State Collection, represent the so-called "marble" and slate from this locality. It and the associated rocks are fully described in the extract from Dr. Houghton's unpublished notes, given in Appendix E, to which a sketch is appended. Mr. Julien examined a full suite of specimens from this locality, which are described in App. A, Vol. II., Nos. 106 to 113. No other marble locality possesses sufficient interest, to warrant mention, although flux has been quarried at several points near Goose lake. It has been mentioned that the novaculite quarry, just east of Teal lake, from which whetstones were taken more than twenty years ago, is in the same formation. These stones are not now worked. See Specimen 13, State Collection, App. B, Vol. II.

During the past season several car-loads of quartzite were quarried in the same vicinity, and used as lining for Bessemer steel converters, at Capt. E. B. Ward's works, for which purpose it answered well.

The various marbles, slates, and quartzose rocks described above, are all believed to belong to one and the same formation, the Lower Quartzite (No. V.), which, it will be remembered, underlies the Republic mountain series, and overlies the Cascade series. This formation is one of the most interesting, geologically, in the Marquette region, and is worthy of a far more careful study than I have been able to give it. Specimens 8 to 13, inclusive, State Collection, App. B, Vol. II., represent several varieties of rock from this formation; as many more varieties could easily be procured, including some very fair specimens of iron ore from south and east of Goose lake.

A brief description, in addition to what has already been given, of the great geological basin formed by this quartzite, which embraces within its folds the great mass of the Huronian rocks, and nineteen-twentieths of all the ore, will possess interest. Like the ore horizon XIII., which we saw came to a point at the Jackson mine, and widened to the west, so the opposite croppings of this quartzite converge to the east and come together at the Chocolate Flux quarry, already described. From this starting-point the *south rim* of the basin bears away towards Goose lake, where some minor folds and low dips make it the surface rock for a large area northeast of the lake. From the south end of the Lake west, the formation has a prevailing talcky character, often argillaceous and sometimes conglomeritic; it has a great thickness and strikes west by south. West of the Cascade it seems to assume more the character of a chloritic gneiss and protogine, or at least a well-defined bed of protogine rock occupies the position in which we would expect to find the quartzite. See Map No. III. and sections.

The *northerly rim*, starting also from the Chocolate quarry, maintains a nearly due west course, crossing the railroad at the Morgan furnace (where it holds the maximum amount of lime), forms the barrier rock in the Carp at the Old Jackson forge, passes north of Teal lake and south of Deer lake, occasionally at various points further west, and last, so far as I know, north of the Spurr mountain, nearly 40 miles west of Lake Superior.

### 3. Escanaba District.

The most southeasterly deposit in the Marquette region, and one which is entirely isolated from the localites already described, is the **S. C. Smith Mine,** producing soft hematite ore; it is located on Sects. 17, 18, and 20, T. 45, R. 25, and connected by a branch with the C. and N. W. railroad. It is but 42 miles from Escanaba, giving it a great advantage in distance over any mine, now shipping ore through that port. The geographical position is less remarkable than what might be called its geological isolation, for it appears to be in a small patch of Huronian rocks, in the midst of a great area of barren territory, underlaid by the Laurentian and Silurian systems. See Map III. The discovery of this deposit, a few years since, by Silas C. Smith, Esq., reflects great credit on his knowledge of the nature and distribution of ore deposits, and his perseverance in searching for them. Mr. Smith also first directed attention to the Republic mountain, .which was, until within a few years, called by his name; he also made the first explorations in the Menominee region.

The few outcrops about the S. C. Smith mine, and the small amount of work done, when my examinations were made, enable me to say very little about its geological structure. The ore range runs northwest and southeast, approximately parallel with the Escanaba river, and cuts the southwest corner of Sect. 17. Contiguous on the northeast (whether underlying or overlying I am unable to say) is a bed of black clay-slate, in places identical with the so-called "plumbago" of the L'Anse range, which has been heretofore considered. Numerous fragments of a similar slate, probably belonging to the same formation, are found on the east side of Sec. 29. Laurentian granite is seen on both sides of the river, just east of this locality, away from which we have a right to assume the slate dips, rendering it probable, that the whole series dips southwesterly, in which case the slate would form the foot-wall of the ore deposit, as on the L'Anse range. On Section 20, west of the river, a talcky schist, holding grains of quartz, was observed, but its relations with the other rocks were not determined.

Near the west ¼ post of Section 20, and at other points in the vicinity, a flag-ore of good quality has been found; a specimen from one of the test-pits gave Mr. Britton 56 per cent, of metallic iron; whether there is any

considerable amount of ore of this degree of richness has not, I think, been determined. Hand specimens of very fair specular ore could be found, but, as a whole, it seemed to me to be much more closely allied to the flag ores. Small boulders of this kind of ore had been found in this vicinity by C. E. Brotherton, some years ago.

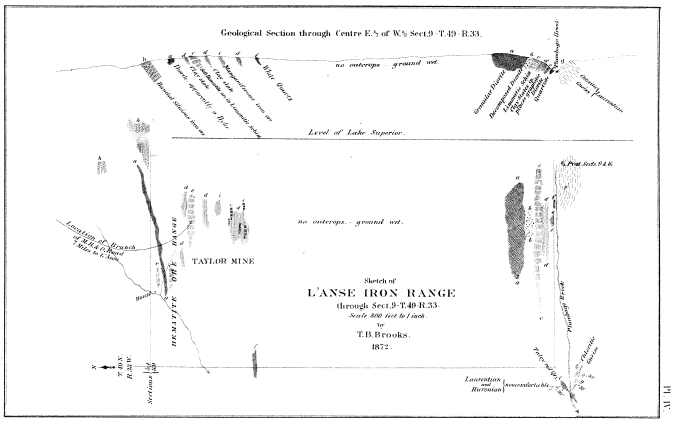
Lapping over the upturned edges of the black slate on Sec. 17, and extending towards the east, is a horizontal Silurian limestone, which is, however, cut off by the river, beyond which numerous outcrops of granite and gneiss rear their heads above the flat sand plain. Silurian rocks are also seen on parts of Sec. 19, but west and northwest the country is all Laurentian, so far as I have been able to learn. South and east is a great plain, undoubtedly underlaid by Silurian rocks, but affording no outcrops, except near Little lake, where an isolated hill, apparently Huronian, rises out of the plain; I have not learned that any indications of iron have been found there.

I regret not having had the time and means to make a re-examination of this interesting and important district, after last season's extensive developments, and reluctantly present this imperfect sketch for want of fuller and more complete data.

### 4. L'ANSE DISTRICT. (See Plate IV.)

The United States surveyors marked " iron ore" in two places on the line between Sects. 4 and 9, T. 49, R. 33. A quartzose or silicious brown and red ore can be seen outcropping, at several points in this vicinity. These facts early drew the attention of explorers to this district, and a considerable amount of land was bought from the government, for iron, as early as 1864. The fine harbor at the head of Keweenaw bay, only seven miles distant, and the abundance of excellent hard wood, tributary to this bay, have long caused it to be regarded as one of the best points in the northwest, at which to make charcoal pig-iron, and establish other manufactories related thereto. The soil along the protected shores of Keweenaw bay is good, which led to the establishment of Indian missions there many years ago. A circle having the village of L'Anse as a centre, and a radius of 35 miles, would embrace the Washington, Edwards, Champion, Republic, Michigamme, Spurr Mountain, Magnetic and Taylor mines, with others less promising, together with all the copper mines in the Portage Lake district, the Hecla-Calumet mine, as also the principal mines in the Ontonagon district. It would also embrace all the roofing slate territory to which attention has already been directed, and an immense sandstone area, about which little is known. The amount of hard wood within the circle would be surpassed by very few equal areas on the Upper Peninsula, and the quantity of pine is large. A railroad running west, tapping the Ontonagon copper region, and continuing through the Gogebic and Montreal river mineral region, so as to connect with the Northern Pacific road, would, with existing roads and the excellent water communication, make the greater part of the area described easily accessible from L'Anse. If the advantages of the geographical position of L'Anse have not been here overstated, it is somewhat remarkable that the locality should have remained so long undeveloped. The want of railroad communication with the outside world was, undoubtedly, the main reason. What effect the very heavy grades, encountered within ten miles of the town, will have on the amount of ore which will be carried there from the Michigamme district, remains to be seen. The ore from the Taylor mine, and others that may be opened on the L'Anse range, can be put on board vessel at L'Anse at less cost for transportation, than any equally good ores with which I am acquainted, on the entire chain of the Great Lakes.

As has been before remarked, the L'Anse iron range, sq far as made out, lies in the north part of T. 49, R. 33, the best ore being in Secs. 9, 8, 4, and 5; it has a general easterly and westerly trend, like nearly all of the iron ranges of the Upper Peninsula.




[IV. L'Anse Ore Range, Section 9—T. 49—R.33]

The **Taylor Mine,** the only point where the existence of a workable deposit has been demonstrated by actual exploration, is near the centre of the northeast ¼ of northwest ¼ Sec. 9, T. 49, R. 33. This ore deposit is 950 feet above the surface of Lake Superior, and seven miles from L'Anse by railroad, built or building. The ground slopes gently to the west, affording an excellent opportunity for attacking the ore, which is covered by but a few feet of earth. The timber in the vicinity is first-rate hard wood.

The prevailing variety of ore at the Taylor mine is a soft hematite, similar in character to that of the Lake Superior and Winthrop mines. A number of analyses of average specimens, the results of which are given in full in Chapter X., varied from 44 to 57 per cent, metallic iron, with a remarkably small percentage of silica for an ore of this class. I see no reason to doubt but that a hematite can be mined here, which will yield an average of 55 per cent, of pig-metal in the furnace. Cross trenches and drifts show the deposit to have a maximum thickness 20 to 25 feet free from rock, and three or four times this thickness of such mixtures of ore and rock, as usually occur at hematite mines. The distance between the most easterly and westerly points at which ore has been found, is about 1,000 feet, but up to this time the

explorations made have not demonstrated the deposit workable, as to quantity and quality, for more than about one-fourth of this distance. The oft-mentioned irregular pocket-like character of these deposits makes it difficult to predict, with any degree of certainty, regarding them, beyond what can be actually seen. But the heavy bed of hematitic rocks, which show a constant tendency by their decomposition to pass into ore, together with what has been actually developed by the workings, leaves no reasonable doubt but what there is here a large workable deposit of ore.

About 200 feet south of this ore deposit, and overlying it (the whole series dip south), is a bed of highly manganiferous iron ore, average specimens of which have yielded as much as 44 per cent, of the oxide of manganese; such ore must, of course, be comparatively poor in iron; this subject was considered under iron ores in Chapter III. The deposit is of uniform quality for a thickness of ten feet, and was penetrated by a shaft for the same distance. One per cent, of oxide of manganese was reported in some of the analyses of soft hematite mentioned above, showing the general dissemination of this substance, which seems to have its greatest concentration at the point we are describing. Whether this ore would possess value in the manufacture of metallic manganese, I am not able to say, but its presence, undoubtedly, gives additional value to iron ores, in improving the quality of the metal produced, and causing the ore to work more easily in the furnace, besides especially adapting the metal for steel manufacture.

Several other "shows" of iron in this vicinity are worth mentioning. Near the south ¼ post of Sec. 4, being on the north face of a high hill, is an extensive outcrop of several varieties of flag ore, more or less mixed with rock, in the vicinity of which considerable exploration work has been done. Some rich hand specimens of specular ore have been procured at this locality, but the great mass of the material to be seen is made up of layers of silicious ore, banded with quartzose material, the latter greatly predominating. The indications of hematite to be seen here are not promising. I see no reason why a flag ore yielding from 40 to 50 per cent., may not be sought for with reasonable chances of success. A similar ore was found several hundred feet farther north. The quantity of this mixed material existing in the S. ½ of S. ½ Sect. 4 is undoubtedly very great.

In the S. ½ of the N. E. ¼ of Sect. 8 are outcrops of hematitic rocks, which point towards the continuation of the Taylor mine series, making this a promising ground for exploration. Further west and southwest the ground falls off, the drift deepens, and no outcrops of any rock, so far as I know, are to be found, except in the immediate valley of Plumbago brook, where in Sect. 13, Town 49, R. 34, is an outcrop of argellite, which suggests a possibility of there being roofing-slate in the vicinity. Three miles west of the Taylor mine is the east edge of a treeless, sandy plain, which occupies nearly the whole of T. 49, R. 34, and extends into the townships south and west.

A similar desert country is passed through by the Peninsula Railway, commencing 7 miles from Negaunee. This latter, however, is underlaid chiefly by Silurian rocks, while the other is believed to be Huronian.

On the south side of Sect. 9, between Plumbago brook and the diorite ridge, which extends easterly and westerly more than one-half way across T. 49, R. 33, is a range of hematitic rock, similar to that at the Taylor mine, but which is not so promising for ore, so far as explorations have revealed. It has been traced for a distance of more than half a mile, and is the rock which immediately underlies the diorite, being itself in turn underlaid by clay-slate, the whole series dipping to the north, as will be seen on Plate IV.

Before dismissing the economic consideration of this district, it would be proper to notice the so-called "plumbago," found so abundantly in the north bank of Plumbago brook; but as this subject has been fully treated under the head of Carbonaceous Shale, Chap. III., it need not be further referred to here.

The **Huron bay slates** with associated rocks, may be regarded as belonging to the L'Anse series, although more than ten miles away in a northeasterly direction.

This district, which is now being explored for roofing-slate, affords indications of iron at several points, which I have not had such opportunity to examine, as would enable me to make any definite statement about them. So far as I can learn, those best acquainted in the district are not sanguine as to the existence of workable deposits of merchantable ore. At the end of Chap. I. will be found brief statements, regarding the slate companies now at work in this little-known district.

An inspection of Plate IV., in connection with what has been said, makes it necessary to add very little, regarding the structure of this range. The absence of outcrops through the central portion of Sec. 9, leaves the geological section quite incomplete. There can be little doubt, however, but that the quartzites, diorites, clay-slates and hematitic schists, so well exposed on the north side of Plumbago brook, where they dip north are the equivalents of the Taylor mine series, which dip south, although the sequence is not exactly the same; and the diorite, so conspicuous on the south rim, is not exposed on the north side of the basin, unless the dyke-like mass of greenstone north of the Taylor mine represents it, which I do not think probable. The absence of outcrops also makes it impossible to determine whether there are any minor folds between the two croppings of the basin. If there are no such folds, then there is room for a considerable series of rocks above or younger, than those enumerated; and among them should occur, if it exists here at all, the rich hard ore of the Marquette district. It is assumed in this hypothesis, that the rocks to be seen are the equivalents of formations I. to X. of the Marquette series; this assumption is based chiefly on lithological grounds. Any

rich hard ores found must be specular or red oxides, as there is an entire absence of magnetic attraction in the L'Anse district. Magnetic ores have not as yet been found associated with soft hematites, so far as I am aware, in the Upper Peninsula.

The diorite immediately north of the Taylor mine has been mentioned as *dyke-like*. Whether it actually cuts the series of clay and ferruginous slates and schists at an acute angle, was not determined, but in places it certainly has that appearance. If it does so, it is the only case that has come under my observation, in which the Huronian diorites (often termed greenstones and traps) do not conform with the schistose and slaty strata, with which they are associated. This locality, in connection with others which show *unmistakable dykes* of magnesian *schist* cutting various rocks, is worth the study of the geologist, but is comparatively not of much importance to the explorer and miner. Mr. Julien, as will be seen by reference to App. A, Vol. II., Specs. 342 to 353, regards the L'Anse greenstones as a peculiar variety of diorite.

Another point of considerable interest, in connection with the diorites of this locality, is the *dioritic sand*, which forms the base of the great south bed, and separates it from the underlying hematitic schist on the south. This material is an angular, coarse, dark, greenish sand, and has evidently been produced by the disintegration of the rock, which is in places quite friable.

But by far the most interesting geological fact to be observed at this locality, and one, the importance of which can scarcely be overestimated in considering the grand subdivisions of the Azoic rocks, is the *nonconformability* of the Huronian, or iron-bearing series, with the older Laurentian, which can be observed in the gorge formed by Plumbago brook, about 400 feet southwest of the southwest corner of Sec. 9, T. 49, R. 33 (See Plate IV.). Here a talcky, red, quartz-ose rock, dipping at a low angle northwest, and which is unmistakably Huronian, is seen nearly in contact with a Laurentian chloride gneiss, which dips at an angle of about 35° south-southwest. The same phenomena can be noted at a point near the Republic mountain (see page 126); and the nonconformability is further proven by the fact that the Laurentian generally abounds in dykes of granite and diorite, which are almost entirely absent from the Huronian.