REPORT
ON THE
GEOLOGY AND TOPOGRAPHY
OF A PORTION OF THE
LAKE SUPERIOR LAND DISTRICT,
IN
THE STATE OF MICHIGAN

BY

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IN TWO PARTS.

PART I.
COPPER LANDS

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GEOLOGICAL REPORT ON THE COPPER LANDS OF LAKE SUPERIOR LAND DISTRICT, MICHIGAN

LETTER
FROM
THE SECRETARY OF THE INTERIOR,
ENCLOSING

The geological report on the copper lands of Lake Superior land district, Michigan.

MAY 16, 1850.
Referred to the Committee on Public Lands, and ordered to be printed.

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DEPARTMENT OF THE INTERIOR,
Washington, April 29, 1850.

SIR: I have the honor to communicate, herewith, a letter from the Commissioner of the General Land Office, transmitting the report of Messrs. Foster and Whitney, United States geologist, on the copper lands of the Lake Superior land district, Michigan.

I have the honor to be, very respectfully, your obedient servant,

T. EWING, *Secretary*.

Hon. HOWELL COBB,
Speaker of the House of Representatives.

GENERAL LAND OFFICE, *April* 26, 1850.

SIR: I have the honor to communicate, herewith, a report from Messrs. Foster and Whitney, United States geologists, on the "copper lands" of the Lake Superior land district, in Michigan, accompanied by a number of views of the principal features of that interesting region, with diagrams of the mines, &c., illustrating the work. There is, also, accompanying this report, a *fac-simile* of a map of Lake Superior and the adjacent regions, made by the Jesuit missionaries in 1670 and 1671, and published at Paris in 1672.

This report contains a vast fund of valuable information, and the publication of it will be an important addition to the cause of science. It would have been communicated with my usual annual report, but the time since those gentlemen were appointed was too short to enable them to prepare it in season. It is now submitted as supplementary to that report, and I respectfully request that it may be so communicated to Congress.

With much respect, your obedient servant,
J. BUTTERFIELD, *Commissioner*.

Hon THOMAS EWING,
Secretary of the Interior.

BOSTON, *April* 15, 1850

SIR: We herewith present to you a report on the "copper lands" of the Lake Superior land district. When it is considered that this district embraces an area of more than sixteen thousand square miles; that nearly the whole of that area is an unbroken wilderness; that we were required to explore considerable portions of it with sufficient minuteness to designate the character of each quarter section; and, that, in the accomplishment of this object, our camp equipage and provisions, and even our canoes, were carried for long distances on the backs of men; and that the limited state of our supplies often compelled us to press on without regard to weather—under these circumstances, we trust we shall be pardoned if it be found that we have fallen into minor errors, or hastily passed some points which were deserving of a more minute examination. In the delineation of the main features of the region, we trust that this report will be found correct.

With sincere thanks for the aid afforded us in the prosecution of these researches by several of the officers attached to the bureau over which you preside, we subscribe ourselves,
Sir, with great respect, your most obedient servants,
J. W. FOSTER.
J. D. WHINEY,
United States Geologists.

TO HON. JUSTIN BUTTERFIELD,
Commissioner of the General Land Office.

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INTRODUCTION.

Historical sketch.—Raymbault and Jogues's voyage to Saut. Ste. Marie.—René Mesnard visits Lake Superior.—Alloüez follows.—Dablon and Marquette follow.—Grand Council.—Marquette proceeds to Green Bay.—Discovers the Mississippi.—His death.—Alloüez's death.—Early map of this region.—Effect of the Missionary labors on the Indians.—Travels of Hennepin; Charlevoix; Henry; Mackenzie.—Expedition of General Cass; of Schoolcraft; of Maj. Long.—Dr. Houghton; his labors and death.—The treaties by which this district was ceded.—The several acts of government in reference thereto.—The act authorizing the survey.—Its organization.

The first steps towards the exploration of the country bordering on the great chain of North American lakes were taken by the Jesuits of Canada, more than two centuries ago, under the auspices of Count Frontenac, then governor general of that region.

On the 7th of September; 1641, Charles Raymbault and Isaac Jogues, two missionaries of the order of Jesus—an order whoso memorials are to be found in every quarter of the habitable earth—accompanied by Hurons, left the bay of Pentanguishene in a bark canoe for Saut Ste. Marie. At the head of this bay they had established a mission. It formed, at that time, the western terminus of the travelled route between Montreal and Lake Huron, by way of the Ottawa river and Lake Simcoe, and for years afterwards, while the power of France in the Northwest remained in the ascendant; constituted an important link in a chain of posts extending for more than two thousand miles.

The route of Raymbault and Jogues lay through the Georgian bay, thence among the countless islands that stud the channel of the St. Mary's river. After a voyage of seventeen days they arrived at the falls (Saut,) where they found an Indian village with a population of two thousand souls. The abundance of white fish, and the facilities for capturing them in the foaming rapids, have made this the chosen resort of the Chippewas for centuries. The chiefs received them kindly and invited them to dwell in their midst. "We will embrace you as brothers," they said, "and profit by your words."

They here learned of the existence of a lake still beyond, called by the Kitchi-gummi, (Big lake,) surpassing in magnitude either Huron or Michigan, then called Illinois, beyond whose western limits was a destitute of trees, but covered with grassy plains, through which herds of buffalo and deer.

Here dwelt the Sioux or Nadouessi, a race at once warlike and indomitable. At that day a feud existed between the two tribes, which has been perpetuated to the present time.

Late in the season Raymbault returned to Peritanguishene with the intention of revisiting the Saut in the succeeding spring, and establishing there a permanent mission; but consumption, brought on by repeated exposures and privations, was fast hurrying him to the grave. The following year he returned with Jogues to Quebec, where he died October 22, 1642. Father Jogues started to return, but in ascending the St. Lawrence was captured by the Mohawks, a predatory band infesting the shores and tributaries of Lake Erie. After having been subjected to the most ignominious treatment, himself scourged, and his Huron attendants committed to the flames, he was ultimately ransomed by the Dutch in the vicinity of Albany. He revisited France, but soon returned to the scene of his labors with a spirit unabated and a zeal unquenched.

René Mesnard followed in the track of Raymbault. On the 28th of August, 1660; he left Quebec, taking with him a scanty stock of necessaries; "for I trust," said he, "in that Providence which feeds the little birds of the air, and clothes the wild flowers of the desert." He was past the meridian of life, but possessed all the zeal of youth. He went forth with the presentiment that he was performing his last journey, for, in writing back to a friend, he remarked: "In three or four months you may add my name to the memento of deaths." Having arrived at the Saut, he proceeded to coast along the southern shore in a canoe, and on the 15th of October reached the head of Keweenaw bay, which he named St. Theresa—the day of his arrival being the anniversary day of patron saint. Here he remained until the following spring, when he left, accompanied by a single Indian, for Chaquamegon bay, near the head of the lake. They took the route through Portage lake; and while the voyageur was conveying the canoe across the portage, the good Father wandered into the woods, and no trace of him was afterwards obtained. This happened August 20, 1661. The world applauds the heroism of Columbus who launched out upon a trackless ocean in search of a new world. The humble missionary who, committing himself to the guidance of savage attendants, voyaged for days with a boundless waste of waters on one side, and on the other an unbroken wilderness, showed a degree of courage and enthusiasm which, has rarely been rivalled, and which ought to rescue his name from oblivion.

Claude Alloüez followed in his footsteps. On the 8th of August, 1666, he embarked at Three Rivers, accompanied by four hundred Indians, who were on their return from Quebec. In the beginning of September he arrived at the Saut, and entered Lake Superior, "which," said the good missionary, "shall henceforth boar the name of M. de Tracy, in token of the obligations the

people of this region are under to him;" and this is the name applied to it on the earliest map.

"The savages," he continues, "respect this lake as a divinity, and offer sacrifices to it because of its size, for it is two hundred leagues long and eighty broad, and also in consequence of its furnishing them with fish, upon which all the natives live when hunting is scarce in these quarters. * * * It happens frequently that pieces of copper are found, weighing from ten to twenty pounds. I have seen several such pieces in the hands of savages; and since they are very superstitious, they esteem them as divinities, or as presents given to them to promote their happiness by the gods who dwell beneath the water. For this reason they preserve these pieces of copper wrapped up with their most precious articles. In some families they have been kept for more than fifty years; in others, they have descended from time out of mind—being cherished as domestic gods.

"For some time there was seen near the shore a large rock of copper with its top rising above the water, which gave an opportunity to those passing by to cut pieces from it; but when I passed that vicinity it had disappeared. I believe that the gales which are here frequent, like those of the sea, had covered it with sand. Our savages tried to pursuade me that it was a divinity who had disappeared; but for what cause they were unwilling to tell."* He passed the bay called by Father Mesnard St. Theresa, where he met "two Christian women, witnesses of his (Mesnard's) labors, who had preserved their faith, and sparkled like two stars in the midst of the darkness of infidelity. Having refreshed their memories with our mysteries, we proceeded on. After having travelled one hundred and eighty leagues along the border of the take, on the southern side, where the Lord hath often tried our patience by means of gales, famine, and fatigue, both day and night"—many a poor voyageur has since uttered the same complaints—"we landed on the 1st of October at Chaquamegon." This is the old La Pointe of the voyageurs. He describes it as a beautiful bay, on whose margin dwelt numerous savages: their warriors amounting to eight hundred. Here he paused in his wanderings, erected a chapel, and commenced the work of winning the savages to the standard of the cross. He found that the Chippewas were meditating a warlike expedition against their ancient enemies, the Sioux. He was permitted to advise, and succeeded in diverting them from the enterprise. Here he dwelt for two years. His fame reached the surrounding tribes, who gathered around to satisfy their curiosity and receive the benefit of his instruction. During this period he visited Fond-du-Lac, where he met with some of the Sioux, who informed him of a country to the west abounding in prairies, over which roamed the buffalo, and that there was a great river called Messepi, (Mississippi,) whoso banks were inhabited by the beaver. He extended also his mission among the Nipissiriniens, on the north shore of the lake.

In the fall of 1667 he returned to Quebec to procure aid in establishing missions in the Northwest; and such was his ardor, that in two days after his arrival he was on his way back to his forest home.

*Charlevoix, in his Travels, has appropriated almost verbatim Alloüez's description.

In 1668 Claude Dablon and James Marquette proceeded to Saut Ste. Marie for the purpose of establishing a permanent mission. Of the personal history of the former little is known, but the latter was in the prime of life; highly educated, and fitted to adorn the court of Louis; but he sacrificed all of these advantages, and passed his life among a race comparatively low in the scale of intellectual organization. From this period Saut Ste. Marie dates its settlement; and it is therefore, as Bancroft remarks, the oldest within the limits of the State of Michigan.

The following year Marquette succeeded Alloüez at La Pointe, and the latter removed to Green Bay.

In May, 1671, a grand council assembled at Saut Ste. Marie. The chiefs from fourteen of the tribes of the' Northwest and the soldiers of France sat in council together. Mr. Tallon, then governor general of New France, had sent there Monsieur de St. Lusson to take possession, in the name of his Majesty, of all lands lying between the east and west, and from Montreal to the South sea, as far as it could be done. When assembled, the ambassador selected a hill above the village, planted the cross, and raised the arms of the King. The cross was first blessed with all the ceremonies of the Church by the Superior of the missions; and while it was being raised, the *Vexilla* was chanted by the assembled Frenchmen, to the great admiration of the savages. The shield of France was suspended, from a cedar post above the cross while they were chanting the *Exaudiat*, and prayers were offered for the sacred person of his Majesty. St. Lusson formally took possession of the lands; after which guns were discharged, and other manifestations of joy exhibited. Father Alloüez was present, mindful of the interests of his divine as well as temporal master.* The same year Marquette removed to St. Ignace, north of Mackinac. Here he built a chapel, and gathered about him the wandering Hurons. Marquette and Dablon made numerous excursions to the tribes which dwelt in the territory now embraced in northern Illinois and eastern Wisconsin. Marquette, like Alloüez, had heard marvellous accounts of the region beyond the Great Lake, and longed to explore it; but it was not until the year 1673 that he was enabled to carry his project into execution. His route lay up the Fox river, through Lake Winnebago, and thence down the Wisconsin into the Mississippi. In this expedition he was accompanied by Joylet, a courtier of France. They descended the mighty current as far as Arkansas, and then turned back. They represented that they were hospitably entertained by the Illinois, who dwelt upon its banks, while by other tribes they were repulsed.

* Alloüez pronounced the following panegyric on the King, which is worthy of being preserved:

"It is a most important affair which calls us together. Cast your eyes on that cross, which is so high above your heads. 'Tis there where the Son of God was willing to be attached and to die, in order to satisfy His eternal Father for your sins. He is the master of our lives, and also of heaven, and earth, and hell. If is He of whom I have so often spoken, and whose name and word I have borne into these distant lands. But, at the same time, look upon that other column, to which are attached the arms of that great chief of France, whom we call King. He lives beyond the sea. He is the chief of chiefs, and has not his like in the world. All the chiefs, whom you have seen, and of whom you have heard, are but children compared with him. He is like a great tree, while they are mere shrubs which we tread upon. You know Onnontio, (governor general,) the renowned chief of Quebec. You know that he is the terror of the Iroquois, and that his name is sufficient to make them tremble, since he has desolated their kinds, and carried fire among their settlements. There are beyond the sea ten thousand Onnontios like him, who are but warriors of that great chief, our King, of whom I speak. When he says 'I go to war,' everybody obeys, and these ten thousand chiefs raise bands of warriors both for the land and for the sea. Some embark in ships, like those you have seen at Quebec. Your canoe will hold but four or five men—twelve to the utmost. Our vessels carry four and five hundred, and even a thousand. Another portion go to war on land, but in such numbers that, when arranged in double ranks, they would reach 60 Mississaquenk, which is twenty leagues from here. When he attacks, he is more fearful than thunder. The earth trembles, and the air and the sea are on fire from the discharge of his cannon. He has been seen in the midst of his squadrons covered with the blood of his enemies; so many of whom has he put to the sword, that he does not number their scalps, but merely the rivers of blood which he has caused to flow. He carries such a number of captives with him that he does not value them, but lets them go where they please, to show that he does not fear them. Nobody dare make war on him. All nations beyond the sea have sued for peace with great submission. They come from every quarter of the globe to listen to him and admire him. It is he who decides upon the affairs of the world. What shall I say of his riches? You think yourselves very rich when you have ten or twelve sacks of corn, and hatchets, and kettles, and other things of the kind. He has more cities than you have men, which are scattered over a space of more than five hundred leagues. In each city there are shops containing- hatchets enough to cut all your wood, kettles enough to cook all your caribou, and sugar enough to fill all your wigwams. His house extends further than from here to the Saut, is higher than the tallest of your trees, and contains more people than he largest of your settlements ever contained."

This relation of the voyage of Marquette was not published until some time after his death, and by some it is regarded as fabulous; but Bancroft is disposed to adopt it as worthy of entire credence.

Late in the season the voyageurs reached Chicago. Joylet hastened to Quebec to announce the results of their discoveries, while Marquette remained to plant the standard of the cross among the Miamies.

The manner of his death is thus narrated by Bancroft: "'In sailing from Chicago to Mackinac during the following spring, he entered a little river in Michigan. Erecting an altar, he said mass after the rites of the Catholic church; then, begging the men who conducted his canoe to leave him alone for half an hour,

> 'In the darkling wood,
> Amid the cool and silence, he knelt down,
> And offered to the Mightiest solemn thanks,
> And supplication,'

At the end of half an hour they went to seek him, and he was no more. The good missionary, discoverer of a world, had fallen asleep on the margin of a stream that bears his name. Near the mouth, the voyageurs dug his grave in the sand."* This event happened May 18, 1675. Alloüez died soon after in the midst of his labors among the Miamies.

The Jesuits made a map of this region as early as 1669, which was published in 1672. We suspect that it is the work of Alloüez and Marquette, but it bears no name. DabIon thus speaks of it: "It was got up by two Fathers, very intelligent and observing, who did not wish to incorporate anything except what they had seen with their own eyes. That is the reason why they have only inserted the upper part of Lakes Huron and Illinois, although they have coasted much on both."

When it is considered that these men were not engineers, and that to note the geographical features of the country formed no part of their requirements, this map may, for that age, be regarded as a remarkable production, although points occasionally are laid down, half a degree from their true position. The whole coast, sixteen hundred miles in extent, as well as the islands, were explored. Even Caribou, a low island in the midst of the lake, and not visible except within a few leagues, did not escape their observation.

*History of the United States, volume 1.

Alloüez, Marquette, and Jogues were remarkable men, and, had their lots been cast in a different sphere, they would have left a more, durable impress upon the age in which they lived. Their efforts to win the tribes of the Northwest to the standard of the cross, prosecuted with great zeal, and under circumstances of privation and suffering, may be regarded as abortive.

There is something impressive in the rites of the Catholic church—something in its mysteries calculated to overawe the wild men of the woods. So long as the missionary was in their midst and superintended their labors, they yielded to his guidance and adopted his recommendations, so far at least as conduced to their comfort; but when he withdrew, with equal facility they glided into their former habits. The superstructure raised with so much care fell to the ground the moment the sustaining hand was withdrawn. The effect of the contact of the two races has been to afford the Indian additional incentives to vice, while his intellectual and moral elevation has been little advanced; and at this day, it cannot be said that he stands higher in the scale of civilization than when first known by the white man.

Such knowledge as we possess with regard to the early discoveries in the Northwest is derived from the "Relations de ce que s'est passé de plus remarquable aux Missions des peres de la compagnie de Jesus en la Nouvelle France." They are comprised in many volumes, to be found, in the library of Harvard College.

The occurrence of native copper naturally excited the wonder of the first voyageurs, and the references to it are numerous. The first mention is made in the Relation for 1659-'60. An Indian, named Awatanick, who had passed from Green Bay to Lake Superior the year previously, reported "that its borders were enriched with lead mines, and copper of such excellent quality that it is

already reduced in pieces as large as the fist. There may also be seen rocks which contain large veins of turquoise," (green silicate of copper.)

The relator adds that he has heard of the existence of gold on St. Joseph's island, and that the rivers of Lake Superior bring down grains of gold.

Another relator states that diamonds occur on some of the islands at the foot of Green Bay.

In the Relation for 1669-'70, Father Dablon says: "We have learned from the savages some secrets which they did not wish at first to communicate, so that we were obliged to use some artifice. We do not, however, vouch for everything contained in the following account. After entering the lake, the first place met with containing copper is an island about forty or fifty leagues iron the Saut, towards the north shore, opposite a place called Missipicooatong, (Michipicoten.) The savages relate that it is a floating island, being sometimes near and at others afar off. A long time ago four savages landed there, having lost their way in a fog, with which the island is frequently surrounded. It was previous to their acquaintance with the French, and they knew nothing of the use of kettles and hatchets. In cooking their meals, as is usual among the savages, by heating stones and casting them into a birch bark pail containing water, they found that they were almost all copper. After having completed their meal, they hastened to re-embark, for they were afraid of the lynxes and hares, which here grow to the size of dogs. They took with them copper stones and plates, but had hardly left the shore before they heard a loud voice exclaiming in an angry tone, 'Who are the thieves that carry off the cradles and the toys of my children?' They were very much surprised at the sound, not knowing whence it came. One said it was the thunder; another that it was a certain goblin called Missibizi, the spirit of the waters, like Neptune among the heathen; another that it came from the Memogovissioois, who are marine men, living constantly under the water, like the Tritons and Syrens, having long hair, reaching to the waist; and one of the savages asserted that he had actually seen such a being. At any rate, this extraordinary voice produced such fear that one of them died before landing; shortly after, two others died, and one alone reached home, who, after having related what had happened, also died. Since that time, the savages have not dared to visit the island, or even to steer in that direction." The Father attempts to explain this superstition by supposing that they were poisoned by using the copper boulders in cooking their meat, and that the supernatural voice was an echo of their own, and that the vanishing and reappearance of the island was due to fogs and haze which hang about it. He concludes by adding that it is a common belief among the savages that the island contains an abundance of copper, but that no one dare approach it.

"Pushing along to Le Grand Anse, (Neepigon bay,) we come to an island called 'Thunder island,' which is noted for its abundance of metal. (This is probably St. Ignace.) Further to the west is an island called Menong, (Isle Royale,) celebrated for its copper. It is large, being twenty-five leagues long and seven leagues distant from the main land. One bay at the northeast extremity is particularly remarkable. It is bounded by steep cliffs of clay, in which there may be seen several strata or beds of red copper separated from each other by layers of earth. In the water is seen copper sand, which may be gathered with spoons, although there are pieces as large as acorns. This large island is surrounded by several smaller ones, some of which are said to consist entirely of copper. One, especially, near the northeast corner, is within gunshot of the main island. Further off in that direction is one called Manitou-minis, on account of the abundance of copper. It is said by those who have visited it, that on a stone being thrown against it, a sound like that of brass when struck is heard.

"After having reached the extremity of the lake, there may be seen (one day's journey) on the south shore, by the water's edge, a mass of copper weighing 600 or 700 lbs., so hard that stool cannot cut it; but when heated it may be cut like lead."

On one of the islands near Chaquamegon bay, he relates that copper rocks and plates are found, and that he ^bought of the savages a plate of pure copper two and a half feet square, weighing more than 100 lbs. He supposes that they have been derived from Menong, and that their transport has been effected either by floating ice or by powerful winds from the northeast, which have rolled them along the bottom of the lake.

He mentions the fact that the Ottawa squaxvs, in digging holes in the sand to hide their corn; often find masses weighing 20 or 30 lbs. "Near the river Nantonagon (Ontonagon) may be seen a bluff, from which stones of red copper fall down into the water. Three years since we were presented with a piece from that locality weighing 100 lbs. We have cut some pieces from it, and sent them to Talon, at Quebec. The savages do not all agree as to the place whence it is derived. Some say that it is where the river begins; others, that it is close to the lake, in the clay; and others, at the forks, and along the eastern branch of the river.

"Further on is found the long spit, (Keweenaw Point,) which we have compared to the arrow of the bow. At its extremity is an island six feet square, which is said to be entirely of copper. Finally, to complete this survey of the Great Lake, we would add, that it is stated that mines of the said metal are found in several places to the south. All these circumstances, together with others which it is not necessary to mention, are deserving of tin attentive examination. We would also mention an oxide of copper, which is said to come from the crevices of certain rocks, (Pictured Rocks,) and the occurrence of certain pebbles along the shore, which are somewhat soft and of an agreeable green color. If God prospers our undertaking we shall speak about it next year with more knowledge and certitude."

Hennepin and L'Hontan passed through the lower lakes, but did not enter Lake Superior.

Charlevoix, whose voyage was published at Paris in 1744, passed through the great chain, and his observations are well worthy of perusal. He mentions that pieces of copper occur on the islands of Lake Superior, and that he knew a brother of the order, a goldsmith by trade, who, while on a mission at Saut Ste. Marie, had made chandeliers, crosses, arid censors of it.

Shortly before the treaty of Paris, in 1763, by which the whole of this territory was ceded to the British Grown, Alexander Henry, an Englishman, visited Mackinac for the purposes of trade. At that time the Indians regarded the English as intruders, and entertained towards them hostile feelings. Henry was among the few who escaped the massacre at old Fort Mackinac, and owed the preservation of his life to the offices of a friendly Indian, who contrived to convey him to the northern shore of Michigan, whence he made his way to Saut Ste. Marie. In 1771 he superintended a mining enterprise in the vicinity of the forks of the Ontonagon river, near the site of the copper rock.

Their workings were prosecuted in the clay bluffs which line the banks of the stream, and the miners during the winter perforated the hill to the distance of forty feet. Having neglected to secure their work with supports, on the approach of spring the earth caved in and destroyed their drift. A boat-load of provisions was sent to the miners from the Saut, but, much to the surprise of Henry, when it returned on the 20th of June, he found the whole establishment of miners aboard. It is not surprising that explorations so ill-directed and visionary should prove abortive; and yet the miners represented that, in the progress of the work, they frequently met with considerable masses of native copper, and believed that they would ultimately have reached a large body of that metal.

In the month of August, 1772, the mining force was transferred to a vein on the north shore. Little was done during the winter, but before the close of autumn the miners had penetrated thirty feet into the solid rock. The vein, which at the beginning was four feet in breadth, had, in the bottom of the shaft, contracted to four inches. Under these discouraging circumstances, further mining operations were abandoned.

Henry concludes, from the results of his unsuccessful experiment in mining, that the copper can never be profitably mined, except for local consumption, and that the country must be cultivated and peopled before this can take place. He remarks, it was in the hopes of finding silver in sufficient abundance to make the speculation profitable, that the works were commenced. He speaks of the discovery of this metal in only one place. Pointe aux Iroquois, where, according to his authority, a Mr. Norburg, a Russian gentleman, acquainted with metals, discovered a blue stone of eight pounds' weight, which was sent to England and found to contain sixty per cent. of silver.

None of the early explorers seem to have noticed the existence of metallic silver associated with the copper, although we know that, among the numerous masses of copper which have been picked up on the shores of the lake, some have contained a considerable quantity of silver interspersed through them.

In 1819, General Cass, under the authority of the Secretary of War, directed an exploring expedition, which passed along the southern shore of Lake Superior, and crossed over to the Mississippi. This expedition had among its principal objects that of investigating the northwestern copper mines, and was accompanied by Mr. H. R. Schoolcraft, in the capacity of mineralogist and geologist. His observations are recorded in his "Narrative Journal of Travels from Detroit northwest, &c.," published in 1821.

In the spring of 1823, Major Long, acting under the orders of the War Department, and accompanied by several scientific gentlemen, started on an expedition, the object of which was to explore the river St. Peter's and the country situated on the northern boundary of the United States, between the Red river of Hudson's bay and Lake Superior. In returning, they coasted along the north shore of this lake. Professor Keating, in his narration of the expedition, remarks that they had seen native copper (boulders) strewed in many directions over the great valley drained by the Mississippi and its tributaries.

All the early explorers seem to agree in the opinion, that if deposites of copper should be discovered in this region, yet, so great is its distance from a market, and so wild and unsettled the character of the country, that there would be no hope of their being profitably worked—at least for many years to come.

The attention of the government was called to the mineral resources of the Northwest during the presidency of the elder Adams, and a commission was instituted with the view of exploring this region; but we have been unable to ascertain why nothing further was done in this matter.

Such was the state of things up to the time when Dr. Douglass Houghton, State geologist of Michigan, in the prosecution of his labors, commenced the exploration of the northern peninsula, and by his official reports awakened attention to this distant region. In his annual report, presented to the legislature of Michigan, February 1, 1841, the great features of the country were sketched with a masterly hand, and the first definite information with regard to the occurrence of the deposites of native copper in the rocks was laid before the world. After this preliminary reconnaissance of the country, Dr. Houghton entered into a contract with the United States government to execute the linear survey, of the northern peninsula in connexion with a geological survey, according to the system devised by him in connexion with Wm. A. Burt, esq. Dr. Houghton had, in the prosecution of the State geological survey over the extensive territory of the southern peninsula; found how great an amount of labor and how large a corps of geologists would be required, were the whole ground to

be gone over by the geological parties, and had availed himself of all the information which could be obtained from the linear surveyors who had directed the United States surveys in various sections of the State. He had engaged them to notice the rocks which they should cross with their lines, and, if practicable, to procure specimens of them, so that he might thus obtain a general idea of a region which, he had neither time nor means to explore fully himself. In the course of these inquiries he received, a great amount of valuable information, especially from Mr. Burt; and he was thus led gradually to the idea of adopting a system, which should connect the two surveys, so that they might be executed under the authority of one person, and then a. systematic arrangement of a great number of observations be brought to perfection. The survey of the northern peninsula was arranged on this principle. The township lines were to be run by Mr. Burt, or under his supervision, while the subdivisions were to be made by other deputy surveyors—-Dr. Houghton having the especial control of the whole. All rocks crossed by lines were to be examined, specimens taken, and the exact locality noted, while at the same time as much information as could be obtained was to be collected in relation to the geological and topographical features of the country. The detailed arrangements with regard to the collection of specimens, and the plan of accompanying the surveyors along the lines by a special barometrical observer, were admirable. This system had been fairly organized, and the field-work of one season nearly completed, when his melancholy death, by drowning, on the night of October 13, 1847, occurred. Most of the results of his extended personal observations were thus lost to the world, and the system was gradually abandoned, though for some time the linear surveyors were required to make geological observations; yet, as they were not systematized by any person familiar with the science of geology, the results were never laid before the world in an available form, although much information of value was placed in the possession of the department.

Dr. Houghton was a man of indomitable energy and perseverance, and. fervently devoted to the cause of science. Had he lived to complete this great work, he would have erected an enduring monument to perpetuate his name. He died in the discharge of his duty, prematurely for the cause of science, prematurely for his own lame.

The lands composing die Lake Superior district were acquired by the United States by virtue of the following treaties:

1st. With the Ottawas and Chippewas, concluded March 28, 1886—ratified May 27, 1836—by which were ceded the lands bounded on the north by Lake Superior, on the east by the St. Mary's river, on the south by Lake Michigan, and on the west by the Escanaba and Chocolate rivers.

2d. With the Monomonees, concluded September 3, 1836—ratified February 15, 1837—by which was ceded a tract bounded on the east by the Escanaba river, on the south by Green Bay, on the west by the Monomonee river, and on the north by an irregular line extending from the mouth of the Brulé to the head waters of the Escanaba.

3d. With the Chippewas of the Mississippi and Lake Superior, concluded October 4, 1842—ratified March 23, 1843—by which was ceded the remainder of the district washed by Lake Superior on the north, and extending west from Chocolate to Montreal river, and southerly to the boundary between Wisconsin and Michigan. In this cession Isle Royale was also included.

Each of these treaties, however, embraced other lands than those described.

Shortly after this last cession, applications were made by individuals in different parts of the Union for permission to explore and locate any tracts supposed to contain valuable ores. These applications were granted by virtue of a joint resolution of Congress, passed as far back as 1818, in reference to the "lead lands" of Illinois. The applicant in the first instance was allowed to select a tract of three miles square; but this was subsequently modified, limiting him to one mile square. He was required to make the selection within one year, to mark the corners thereof, to leave a person in charge to point out the bounds, and to transmit to the proper department a description and plat of the same. On the receipt of This plat the applicant was entitled to a lease for the term of three years, renewable for an additional term of three years, provided Congress did not otherwise direct; annexed to which were certain conditions: the most important were, that the lessee should work such mines with due diligence and skill, and render to the United States six per cent. of all the ores raised—to be delivered at such points within the district as the latter might indicate.

The Committee on Public Lands of the 29th Congress, 2d session, decided that the Department of War had no authority to grant leases of *copper* mines, and recommended that these tracts be surveyed and sold.

On the 6th of May, 1846, in conformity with the decision of the President of the United States, the further issue of permits was suspended.

The whole number of permits granted under the authority of the Department of War amounted to about one thousand—nine hundred and sixty-one of which were located. Sixty leases for tracts of three miles square, and three hundred and seventeen for tracts of one mile square, were perfected, and mining companies organized under them.*

At the subsequent session of Congress an act was passed, entitled "An act to establish a new land district, and to provide for the sale of mineral lands in the State of Michigan," approved March 1, 1847.

By the first section of this act, all of that portion of the public lands in the State of Michigan lying north of the boundaries of the Saginaw and Grand river land districts in the State, known as the northern peninsula, with the islands in Lakes Superior, Huron, and Michigan, and in Green bay, the Straits of Michillimackinac. and the river St. Mary's, within the jurisdiction of said State, was included in one land district, to be called the Lake Superior land district.

The second section provides that the Secretary of the Treasury cause a geological examination and survey to be made and reported to the Commissioner of the General Land Office; that the President be authorized to cause such of said lands as may contain copper, lead, or other valuable ores to be exposed to sale, first giving six months' notice of the times and places of such sale in such newspapers of general circulation in the several States as lie may deem expedient, with a brief description of the lands to be offered—showing the number and locality of the mines known, the practicability of discovering others, the quality of the ores, the facilities for working the mines, and the means and expense of transporting their products to the principal markets of the United States; and that all of the lands in the said district not reported as mineral be regarded as agricultural.

*Report of D. R. McNair, Mineral Agent; Ex. Doc. No. 2, 30th Congress, 2d session.

The third section secures the rights of those persons in possession by occupancy under permits, or leases, from the Secretary of War. The other sections of the act in no way relate to the objects of the survey, and a recital of their provisions is omitted.

From the time of the issuing of the permits the business of mining has been prosecuted with vigor, and in many instances with success. The day is not distant when the product of these mines will supply the home demand, and add much to the national wealth. In a business like this, proverbially uncertain the world over, there have been many failures, many schemes of wild and extravagant speculation, and many plans of ill-advised and ill-directed mining, which have resulted in the ruin of those engaged in them. Extravagant expectations were held out in the commencement, which the mining, experience of the world declared could never be realized.

These, however, have passed away, and the business has settled down into a regular, methodical pursuit, affording an admirable field to the mining engineer for the display of skill and judgment, and yielding to the adventurers a reasonable return for the capital invested.

In the spring of 1847, pursuant to the provisions of the above-recited act, the Secretary of the Treasury appointed Dr. Charles T. Jackson to execute the required survey. After having spent two seasons in the prosecution of this work he resigned, and its completion was confided to Messrs. J. W. Foster and J. B. Whitney, the results of whose observations will be found embodied in the subjoined report.

In the prosecution of this work they have been aided by Messrs. S. W. Hill and Edward Desor, as first assistants, by Mr. William Schlatter as draughtsman, and Mr. W. D. Whitney as botanist.

The aid of Mr. Hill has been of the most essential service. His long residence in the district and his connexion with several public surveys in the Northwest, had given him opportunities of collecting a large fund of information, which has been cheerfully contributed to this work. His measurements and plans of the mines, his observations on the phenomena of veins, his contributions to the boundaries of the rocks, as illustrated on the accompanying maps, and his thorough and laborious explorations during his connexion with the survey, are all gratefully acknowledged by the geologists in charge.

The phenomena of the *drift* and alluvial deposites of this region have been ably investigated by Mr. Desor, and the results of his observations will be found embodied, by him, in that portion of the work which relates to the superficial and transported materials.

His previous investigations of the drift in parallel latitudes in western Europe, and of glacial action as manifested in the Swiss Alps, and the formation of shoals along the coast of the Atlantic as observed by him during his connexion with the Coast Survey, had qualified him to enter upon this field with every prospect of success.

When it is considered that the agricultural capacity of a soil results not so much from the decomposition of the subjacent rocks as from the superficial deposites strewn, over the surface, which have been derived in most cases from sources far remote, it will be found that an undue prominence has not been given to this subject. Besides, an investigation into the sources of these materials, and the agency by which their transport has been effected, forms one of the most interesting chapters in the physical history of the earth.

The results of his observations on the *fauna* of this region will be communicated hereafter.

The execution of the maps was confided to Mr. William Schlatter, and we do not pay him an underserved compliment when we say that he has completed the work with consummate skill and ability. Much of this work has been executed in the midst of the forest, beneath the shelter of a tent.

The investigations of Mr. W. D. Whitney were mainly directed to the flora of this region. His remarks on the nature of the forest trees, their geographical distribution and the economical uses to which they may be applied, will be incorporated in a subsequent report.

Before concluding this introduction we desire to return our thanks to the several captains of mines for their hospitality and for the facilities afforded us in investigating the phenomena of veins. Without

exception, we have found them intelligent and ready to communicate ail of the information in their possession.

To the linear surveyors, particularly to Mr. John Burt, we desire to render our thanks for the communication of valuable information.

To the late surveyor general, Hon. Lucius Lyon, of Detroit, we also desire, in a public manner, to express our thanks for his promptness in furnishing plats, and for other aid rendered in the prosecution of this work.

We are fully aware that this report is, in many respects, defective; such as must necessarily result from the investigation of a wild and almost unbroken wilderness, with limited facilities at our disposal. We trust, however, that we have accomplished something in elucidating its true geological structure and its vast mineral resources.

CHAPTER I.
PHYSICAL GEOGRAPHY,

Boundaries of the Lake Superior land district.—Extent of the lake.—Islands.—Harbors.—Bays.—Coast.—Michigan.—Extent.—Bays.—Islands.—Huron.—Rivers.—Mountains.—Table of heights.

The region which forms the immediate subject of this report is bounded on the north by Lake Superior, on the east by the St. Mary's river, on the south by Lakes Huron and Michigan, and on. the west by the Montreal and Menomonee rivers, including the several islands belonging to the United States, and within the jurisdiction of Michigan. It is known as the *Lake Superior land district*, and contains an area of 16,237 square miles.

It is included between latitude 45° and 49° north; and longitude 83° 45’ and 90° 33' west from Greenwich. Its coast, more than 800 miles in extent, is washed by three of the great North American lakes.

Lake Superior, the largest expanse of fresh water on the globe, contains 32,000 square miles. Its surface is elevated, according to Captain Bayfield, of the English Admiralty survey, 627 feet above the ocean-level, while portions of its bed are several hundred feet below; thus forming one of the deepest depressions in the surface of the earth, excluding those portions covered by the oceanic waters. Its coast is 1,500 miles in extent; its maximum length, from Gros Cap to Fond-du-Lac, in a direct line, is 355 miles; its maximum breadth, from Grand island to Neepigon bay, 180 miles.

The shape of the lake is very irregular, its widest expansion being near the centre, while its extremes are contracted. Its northern shore is rocky, affording many bold headlands, and many deep and spacious bays. Numerous groups of islets gird the coast, which appear to be peaks, or aiguilles, connecting with the main rock far below.

Of the larger class may be mentioned St. Ignace, at the outlet of Neepigon bay, 1,300 feet in height; and Pie island, at the outlet of Thunder bay, which rises to the height of 850 feet. They are both composed, in the main, of rocks of igneous origin, and present bold and picturesque outlines.

The southern coast is studded with fewer clusters. Towards the head of the lake there is a group known as the Apostle islands, composed of sandstone, and attaining an inconsiderable elevation. The channels between them afford good harbors, accessible from every point. La Pointe, situated on Madaline island, is already a place of some commerce.

Grand island, about midway between the extremes of the lake, affords one of the finest and most beautiful harbors in the world. Its northern shore, where exposed to the surf, is lined with high cliffs of sandstone; but the southern portion slopes gradually to the water's edge-

Towards the eastern extremity are several low islands, composed of sandstone, which are of no great importance.

In addition to these are two remarkable islands in the midst of the lake, both of which are doe to volcanic action. These are Isle Royale and Michipicoten; the former belonging to the United States, the latter to Great Britain.

Isle Royale is situated in the northwestern part of the lake, being intersected near the centre by the 89th degree of west longitude, and the 48th of north latitude. Its course is northeast and southwest; its length about forty-five miles; its width about eight miles; its area two hundred and thirty square miles.

It is traversed by numerous parallel .ridges, running with the course of the island, which nowhere attain an altitude of more than 600 feet above the lake-level. At the northeast extremity they are prolonged beyond the main land, and resemble the fingers attached to the human hand. These fingers afford safe and commodious harbors. The numerous long and narrow inlets which indent the coast result from its geological structure. Alternating bands of soft amygdaloid and hard crystalline greenstone, which oppose unequal resistance to the action of the elements, have contributed to form the peculiar outline of the coast. Powerful currents, at no remote epoch, swept over the island in a southwesterly direction, which ground down the softer beds and polished and grooved the harder, to their very summits. So thorough was this process, and so slightly have the harder materials, in the lapse of time, yielded to the ordinary action of the elements, that these grooves can be observed over surfaces of great extent, sharp and well-defined. No tree takes root upon these polished surfaces; the lichens even cannot find sustenance. The island everywhere presents a desolate appearance. Barren rocks; a dwarfed growth of cedars and birches, hung with drooping moss; abrupt cliffs, impassable marshes—these are the striking characteristics. The caribou, the lynx, and the rabbit are among the few animals that roam over its surface; the hawk, the owl, and the pigeon represent the feathered tribe.

Where the igneous rocks prevail we find deep and spacious inlets, among which may be mentioned Washington harbor on the west, Todd's harbor and McCargoe's cove on the north, the deep recesses formed by Locke's point, Blake's point, and Scovill's point, on the east, and Rock harbor, Chippewa harbor, arid Siskawit bay on the south. The southern point of the latter bay, which consists of sandstone, is approachable from the southeast, and also from the south, by a narrow and intricate channel. It abounds in hidden reefs, running parallel with the main land.

The numerous ridges which traverse the island longitudinally are uniformly bare and precipitous on the northwest and sloping on the southeast. The intervals are occupied by small lakes, wet prairies, or cedar swamps.

Michipicoten is situated in the northeastern portion of the lake. It is eighteen miles in length, and rises to the height of eight hundred feet above the water. It is a mass of greenstone, and one of the points selected by the Quebec Company for mining operations.

In the midst of the lake-is a remarkable islet, known as Standard's rock, so called in honor of Captain Charles C. Stannard, by whom it was discovered in 1844, while sailing the brig Astor.

It has been erroneously described as an isolated peak or needle, shooting up from the bottom of the lake, and affording deep soundings on every side. Such, however, is not the case. It rises about four feet above the water-level, and exposes a surface of fifty feet in length and twenty in breadth. During a storm the waves sweep over it, but its position is indicated by a long line of breakers. Professor Mather, who visited it in 1846; thus describes it in some MS, notes communicated to us: "A dangerous shoal extends a mile or more to the NNE. of the rock, and another, as indicated by the ripple, to the NNW. In approaching it, we passed over numerous ridges and deep troughs between—the rocky bottom plainly in view from ten to fifteen and twenty feet below the surface." To the south and southwest of the rock the water is deep, even at its base. It is a sandstone of a dark red color, and somewhat metamorphosed by heat, and disposed in nearly horizontal layers. Its bearings, from the most reliable information, are, from Manitou island, at the head of Keweenaw Point, SE. ½ E. 27 miles; from Point Abbaye, E. by N. ¾ N. It lies in the direct route between Grand Island and Keweenaw Point, so that it is necessary for the navigator to make a detour to avoid it.

This is the only reef known to exist in the midst of Lake Superior, and it is a matter of surprise that it remained so long undiscovered.

Professor Mather states that at the time of his visit a strong current was setting eastward, which drifted the vessel more than half a mile from her course. The lake was cairn and the breeze light; the approach to the rock, therefore, is dangerous even under the most favorable circumstances.

The northern shore is much more deeply indented than the southern. Among the deepest of these indentations may be mentioned Neepigon, Black and Thunder bays, which, for the most part, are lined with elevated ridges extending down to the water's edge. No place in the northwest presents a view of greater magnificence than is afforded in the vicinity of Fort William. Blackened walls of slate and trap, covered with a dwarfish growth of cedar and birch, are seen on every side. To the south Pie island rises out of the lake, like an immense castle, to the height of 850 feet: to the west, McKay's mountain, a thousand feet in height, overhangs the valley of the Kaministiquia, its flanks composed of basaltic columns as regular as those of Staffa: to the east, Thunder cape, 1,350 feet in height, with unbroken cliffs extending for seven miles, resembling a vast colonnade, juts into the lake, beyond which the eye rests upon a dark expanse of water bounded only by the horizon, while to the north serried ranges of mountains rise one above the other until, their outlines are dimly traced against the sky.

The general trend of the southern coast is east and west, to which, however, Keweenaw Point forms a remarkable exception. Starting from its base, it projects for fifty miles into the lake, taking a northeasterly direction 5 then curving inwardly, it pursues for twenty miles an easterly .course, terminating in an abrupt headland which rises to the height of 800 feet above the lake. This configuration is due to a range of trappean hills, which in their widest expansion do not exceed twelve miles, or attain an elevation greater than 900 feet above the lake.

The southern coast is less rock-bound and irregular than the northern. The principal indentations are Chaquamegon bay, Keeweenaw and Huron bays. This difference in the character of the two coasts results from the diversity in their geological structure.

Where the rocks consist of different degrees of hardness the coast presents numerous inlets, bays, and harbors, with deep but narrow channels; but where the rocks are of nearly uniform consistency, the shores are gently curved, the bays wide, and the harbors sparse. Thus it will be seen, by inspecting the geological map, that where the igneous rocks prevail, the coast Is finely indented; where the sand stones prevail, the coast is gently curved. Copper harbor, Agate harbor, and Eagle harbor are excavated in a belt of amygdaloid, included between two belts of conglomerate, which offer greater resistance to the action of the sea and the atmosphere. A stream or a fissure may have served originally as an inlet to the waters, whose excavatory power was circumscribed by the harder and firmer sedimentary rocks.

Between Eagle harbor and the Montreal river the coast, composed of sandstone, presents no projecting headlands, no sheltered bays. To the east of Keeweenaw bay there are several bold projections which result from the joining of rocks of unequal resisting power. The heads of the promontories generally consist of granite or basalt, connected with the main land by low

and narrow spits of sandstone. Granite Point and Presqu'isle are examples of this kind. Within the present century the connecting link may be severed, and the promontories become insulated like the Huron islands, which at no remote epoch were undoubtedly connected in a similar manner with the main land.

Lake Superior occupies an immense depression, which has been for the most part excavated out of the soft and yielding sandstone. Its configuration on the east and north has been determined by the irregular belt of granite before noticed, which forms a rim effectually resisting the further encroachments of its waters. Limited patches of sandstone, such as Caribou, Parisien, and Maple islands, have escaped the process of demolition, and indicate the ancient limits of the detrital rocks.

The configuration of that portion of the lake lying west of longitude 88° appears to have been caused by two axes of elevation extending in parallel lines from the northeast to the southwest, which upraised the sandstone, causing it to form a synclinal valley. Another valley of a like character occurs south of the trap range of Keweenaw Point and the Ontonagon region, in which the water has excavated a deep and spacious bay; but its encroachments are limited in that direction by the granite bosses of the Huron mountains. Let any one who doubts that the configuration of the lake results from geological causes consult the map of this region, and he will be satisfied that all the projections and indentations of the coast conform in a remarkable degree to the main lines of upheaval.

The southern coast of this district is washed by the waters of Lakes Huron and Michigan. The superficial area of the latter is nearly a third less than that of Superior, being twenty-two thousand square miles, while in depth it is not much inferior. It is elevated five hundred and seventy-eight feet above tide-water, and depressed forty-nine feet below Lake Superior. The rocks which compose its rim are of a sedimentary nature, and afford few indentations suitable for harbors. The immediate shores are low, and lined in places with immense sand-banks. The water shoals gradually in approaching the coast. Green Bay in other countries would be regarded as a lake of great magnitude—its length being one hundred miles, its average breadth twenty. Great and Little Traverse bays occur in the eastern coast, and Great and Little bays d'Enoch in the northern. The maximum length of the lake is three hundred and twenty miles, its maximum width one hundred, and its circumference somewhat less than one thousand miles. Its form is oblong, with much uniformity in its outlines. The islands are sparsely distributed, and attain an inconsiderable height. Two clusters occur—one at the outlet of the main lake, the other at that of Green Bay.

Lake Michigan is connected with Lake Huron by the Straits of Mackinac, forty miles in length, and four in breadth. At the narrowest point within this strait there are two considerable islands—Bois Blanc and Mackinac. The former is a low, wooded island, twenty-five miles in circumference.

Mackinac is only about three miles in diameter, and rises to the height of three hundred and fifteen feet; it is walled on every side by bare cliffs of limestone, which afford many scenes of picturesque beauty. As a military post, it may be considered as the Gibraltar of the lakes. Formerly it was one of the principal depots of the American Fur Company; but of late years the traffic has rapidly declined. The commanding position of Mackinac did not escape the keen eye of the Jesuits. Dablon speaks of it, in 1670, as the centre of three great lakes; and from that day to the present it has been an important point—a sort of council ground—in the negotiations between the two races. The harbor is excellent. There is nothing to make this island a place of any great commercial importance; but had the government relinquished the fee of the lands, it would have presented a far different appearance from what we now behold. Michimackinac signifies big turtle, so called from a fancied resemblance in the contours of the island to the form of that animal.

Lake Huron is little inferior in dimensions to Michigan, its greatest length being two hundred and sixty miles; its greatest breadth one hundred and sixty. Its circumference is eleven hundred miles; its area twenty thousand four hundred. Its shape is that of an inverted cone. Georgian bay, one hundred and seventy miles in length and seventy in breadth, forms the northeastern portion, and lies exclusively within the British jurisdiction. Saginaw, a deep and wide-mouthed bay on the western coast, is the principal indentation. The rim of the lake is composed for the most part of detrital rocks, which are rarely exposed. In the northern portion of the lake, however, the trap rocks on the Canada side intersect the coast. The waters possess great transparency, and extend to a depth not surpassed by those of Superior and Michigan. They rarely attain a temperature higher than 50°, and are stocked with fish of the finest flavor. The surface exhibits the dark-blue, or blue-black, so characteristic of the ocean.

The northern coast, in the vicinity of the outlet of the St. Mary's, abounds in numerous clusters of islands, which form, the most attractive feature in the landscape. Captain Bayfield is said to have landed on ten thousand, in the prosecution of his survey, and to have estimated the whole number at thirty thousand.

The following table, with some alterations, exhibiting the area, elevation above the sea, arid depth of the five great lakes, is taken from the report of S. W. Higgins on the topography of Michigan:

Lakes.	Greatest length.	Greatest breadth.	Mean depth.	Height above sea.	Area in square miles.
	Miles.	*Miles.*	*Feet.*	*Feet.*	
Superior	355	160	900	627	32,000
Michigan	320	100	900	578	22,000
Huron	260	160	900	578	20,400
Erie	240	80	84	565	9,600
Ontario	180	35	500	232	6,300
Total					90,300

The entire area drained by these lakes is estimated, on the same authority at 335,515 square miles.

This district is a part of that immense plain bounded by the Appalachian chain on the east, arid the Rocky mountains on the west, and extending north and south from the Gulf of Mexico to the Arctic sea. Its mean elevation above the sea is less than a thousand feet, and its culminating points nowhere exceed 2,500 feet. They can hardly be dignified with the name of mountain chains, but may be regarded as the more elevated portions of a gently rising and widely extended plateau.

The beds of the great lakes are depressions, reaching far below the ocean level.

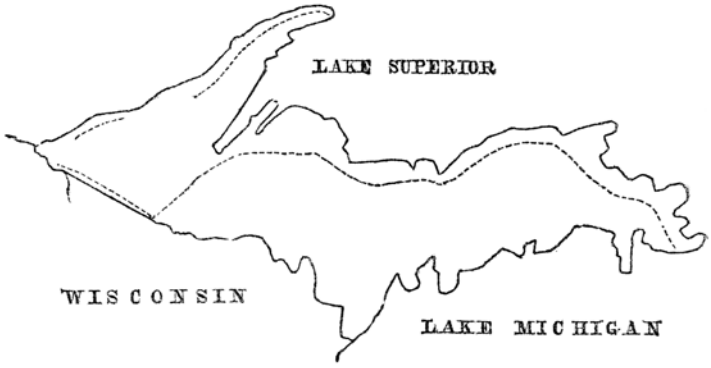
In this plain, with their branches interlocking, the two great rivers of North America have their origin—the Mississippi and St. Lawrence; the one discharging its waters, through many mouths, into the Gulf of Mexico; the other expanding into a gulf many hundreds of miles in extent before it becomes merged in the ocean.

These rivers are as diverse in character as in direction. The Mississippi is the longer, but the St. Lawrence discharges the greater volume of water. The one abounds in difficult rapids, the other in stupendous cataracts—the one is subject to great fluctuations, the other preserves an almost unvarying level. The waters of the one are turbid; those of the other possess an almost crystal purity. The one affords few lake-like expansions; the other swells into vast inland seas. Both have become the great highways of commerce, enriching the regions through which they flow, and supplying the inhabitants with the varied products of distant climes.

Lake Superior is fed by more than 80 streams, none of which, attain any considerable magnitude, and are adapted only to canoe navigation. Those which flow down the northern slope of the basin are longer than those of the southern, and the water, being more exposed to the direct rays of the sun, possesses a higher temperature. They all have rapid descents, and, flowing over rocks which oppose great resistance to the action of water, abound in falls and rapids. The carrying-places around these obstructions are known as "portages." Communication throughout the northwest between distant points is effected almost entirely with the canoe. It serves the same purpose as the ship on the ocean, or the camel on the desert. This kind of inland navigation has created a class of men of marked peculiarities, known as voyageurs. They are a hardy race, patient of toil, and cheerful under the most untoward circumstances. In their frail barks they pass from Lake Superior to the Mississippi, to Hudson's bay, to the Pacific, and even to the Arctic ocean.

Rivers.—Rivers are the great arterial features of our globe; they define the valleys, give boundaries to the hills and mountain ranges, and if traced to their source, enable us, with the aid of a few well determined culminating points of contiguous ranges, to trace upon our charts the general feature of the country through which they flow.* This knowledge is particularly desirable at this day, when rapid communication is sought between distant points by means of railways. By barometrical observations extended over most of the district the elevation of the watershed line has been determined. These will aid in the selection of the most practicable route between the two lakes, and enable the observer to form a pretty correct idea of the physical features of the region.

The following diagram shows the course of the watershed in this district. It is represented by the irregular dotted lines:



It will be seen that the streams flowing into Lake Michigan, in the eastern portion of the district, head near Lake Superior. Proceeding west, the line is deflected from the upper lake, and another line diverges towards the northeast. The main line is due to the upheaval of the granite; the secondary line to that of the trap.

We will describe the rivers of this region in their order of succession, rather than with reference to their magnitude.

The Montreal is a river of no great magnitude, being navigable above the falls at its mouth by canoes only during the time of flood. It is formed by the union of the Pine and Balsam rivers, thirty-four miles above its mouth, following its meanders. At this point, according to Captain Cram, it is eight hundred and four feet above Lake Superior. Flowing over hard unyielding rocks, it abounds in numerous rapids and cataracts. Near its mouth it is precipitated eighty feet over a sandstone ledge. Pour miles up, there is another fall of about the same height, but much more picturesque. The aboriginal name of this stream is *Ka wasiji-wang-sepi*, or White Falls river.

The *Black* and *Presqu'Isle* are streams of considerable magnitude, which have their sources in the granite near the southern limits of the district. They flow north westerly, and, breaking through the trap range, discharge themselves into Lake Superior.

*Captain F. W. Beechey, R. N.—Manual of Scientific Inquiry, art, "Hydrography."

The Ontonagon—or Nantonagan, according to the orthography of the Jesuit map—is the largest of all of the streams within this district which flow into Lake Superior. It has three principal affluents which combined, drain an area of not less than thirteen hundred square miles. Their sources are found near the southern limits of the district, interlocking with those of the Chippewa and Menomonee. One of the affluents of the west branch drains a large inland lake, known as Agogebic or Little Fish lake, which lies about seven hundred feet above the main lake. The waters are clear, cold, and deep, and swarm with fish of the finest flavor. After leaving this lake, the course of the stream is northeast along the junction of the sandstone and trap, until it unites with the main .river, and has, in pi ices, excavated a channel in the sandstone to the depth of one hundred feet. After this junction the combined stream turns abruptly to the north, flowing across the trap range in a natural depression, through which it finds its way to the lake. The southern and eastern branches, for a greater portion of their courses, flow through a country deeply covered with stratified clays, and their channels are excavated in the yielding beds. The banks in places rise to the height of one hundred and fifty feet, and are so precipitous that it is a task of great labor to clamber to their tops. The depth of water in each of these branches is sufficient to float a canoe, but numerous portages occur in consequence of the great accumulation of drift-wood. Some of these "rafts" are fifteen rods in extent.

At the mouth of the Ontonagon there is a sand-bar, on which there is ordinarily from five to six feet of water. Daring the spring-flood this bar is often washed away, but it is reformed by the northerly winds, which drive in a heavy sea. The extension of piers from this point for the distance of four hundred feet seaward, so as to confine the current within a narrow compass, would remove this obstruction and render the entrance at all times accessible. The bar once passed, them is a spacious harbor two hundred and fifty feet in width and eight miles long, with a depth of water between twelve and fifteen feet. The mouth of the river has already become a place of much importance, and an improvement of this kind would be of great value to this portion of the mining region, although its construction would be a work of much labor and expense. The nearest points where vessels can take refuge in a storm are La Pointe and Eagle Harbor, each of which is about seventy-five miles removed.

A keel-boat seventy-five feet in length, and capable of carrying ten tons, plies between the mouth of the river and the Minnesota landing, distant fifteen miles. Three miles below this point occur the Grand rapids, which present a very serious obstruction to the navigation. These, however, have been so far improved by removing the boulders from the channel, that boats can ascend by poling or warping.

Between Keweenaw Point and the Ontonagon there are several small streams, which have their origin in the trap range and flow northward into Lake Superior. Their descent is rapid, and they afford an abundant supply of hydraulic power. Two inconsiderable streams occur near the head of Keweenaw Point, Eagle and Montreal rivers. The former flows along a longitudinal valley for a distance of six miles, then breaks through the trap range at nearly right-angles with its former course, and is precipitated into the lake. It is the only stream of any magnitude in the vicinity of the mines on the Point, and its waters have been already employed in the washing of the ores.

The *Little Montreal* flows through a longitudinal valley between two ranges of trap, and enters the lake a little below the eastern extremity of the point.

The *Sturgeon*, with the exception of the Ontonagon, is the largest river on the northern slope of the axis between Lakes Superior and Michigan, and its sources are elevated more than a thousand feet above its outlet. The area drained by its tributaries is five hundred and seventy-five square miles. For the first twenty miles its course lies through the granite and metamorphic rocks, and the descent is rapid; after that it enters a broad and slightly undulating plain deeply covered with transported materials, and discharges itself into Portage lake. Its entire length, including its sinuosities, is not less than sixty-five miles. For the last fifteen miles of its course, it rims parallel with Keweenaw bay. Between its mouth and township 51, range 34, its course is very tortuous. Its banks are composed of clay, with pebbles intermixed, and rise from six to eight feet above its surface. Its width at this point is about one hundred and forty feet, its depth about four feet, and a luxuriant growth of forest trees, consisting of elm, maple, linden, and black ash, lines its banks.

After crossing the correction line the country changes in its character. The ravines are numerous and deep, and the ridges of sand and clay attain a higher altitude. A change is also observable in the forest trees, the cedar, fir, and white birch supplanting the elm, the maple, and the ash.

One of our party, Mr. Hill, ascended this river in a canoe for a distance of twenty-five miles. His progress was occasionally obstructed by driftwood, around which he was compelled to make portages. The lower portion of this valley may be regarded as among the best agricultural tracts in the northern peninsula. The Sturgeon has, in the course of ages, formed a delta at its mouth about four miles in extent. It contains many lagoons, which at one time formed the bed of the river. This bottom annually yields a luxuriant crop of blue-grass, which is mowed and conveyed to L'Anse.*

Portage lake, which may be regarded as an expansion of Sturgeon river, lies in the form of a rhomb at the base of Keweenaw Point. It is about eighteen miles in circumference, and has three principal arms—-one connecting with Keweenaw bay, another with Torch lake, while the third extends to within a mile of Lake Superior, on the northwest side of the Point, across which there has been a portage from time immemorial.†

*L'Anse properly signifies "the bay, or creek," but throughout this region it is applied to designate the settlements at the head of Keweenaw bay. These consist of a Catholic mission on the west side, and a Methodist mission on the east. There are about four hundred souls, consisting of Indians, half-breeds, and whites; the first largely predominating. Their pursuits consist in fishing and hunting; cultivating, however, patches of potatoes, for the growth of which the soil is admirably adapted. At each mission there is a school. The government employs a blacksmith, a carpenter, and a farmer, whose duties are to aid and instruct the Indians in their respective arts. There are also three or four traders who furnish the Indians with goods, in exchange for fish and peltries. At the head of the bay is a saw-mill owned by Mr. Boswell, which annually turns out twenty thousand feet of lumber, worth from ten to thirteen dollars per thousand at the mill.

†Father René Mesnard was lost while crossing this portage, on the 20th of August, 1661. It is strange that no headland, or lake, or bay, throughout this vast region bears the honored name of him who was the first white man to explore them.

By pursuing this route between La Pointe and L'Anse, the distance is shortened about eighty miles. The river connecting Portage lake with Keweenaw bay is about four miles in length, being broad and deep. The water on the bar at the mouth, however, is but about four feet deep.

Between Keweenaw bay and White-Fish point there are no large rivers. The principal streams are the *Huron*, *Dead*, (Du Mort,) *Carp*, *Chocolate*, *La Prairie*, and *Two-Hearted*. They have their sources near the lake, and descend rapidly, affording abundant water-power. They are not navigable for canoes even, except for short distances, but their mouths, for the most part, afford tolerable boat harbors.

The *Tequamenen* is among the largest streams on the northern slope. Its length is sixty-five miles, and the area drained by it not less than six hundred square miles, and its course is nearly parallel with that of the lake coast. It can be ascended to the foot of the falls fifteen miles up, in coasting boats, and still further in canoes by making portages around the obstructions.

Passing to the southern slope of the axis, the *Manistee* is the principal river in the eastern portion of the district. It drains a flat, swampy country, about 1,300 square miles in extent. It has four principal affluents which come in from the northwest, some of whose branches head within five miles of the Lake Superior coast. Over this area are scattered numerous lakes which serve as reservoirs to collect and retain the superfluous water.

The White-Fish, Escanāba, and Port rivers flow into Little Bay d'Enoch. Each drains an area varying between 400 and 500 square miles, and all may be ranked among the second class rivers of this region. Their banks are covered with pine forests, and large quantities of lumber are annually shipped to Chicago and other ports.

The *Menomonee*, which forms in part the boundary between Michigan arid Wisconsin, is the largest river within this district with the exception of the St. Mary's. Some of its sources lie within fifteen miles of Lake Superior—its outlet is two hundred miles distant. Its eastern branch, called the Machigamig, or river flowing from a big lake, rises in the Huron mountains, which are 1,249 feet above Green bay. After crossing the summit level in township 48 north, range 32 west, there are a series of natural meadows covered with grass, through which flows a small, clear stream, across which one may leap with ease. After pursuing this for about three miles, we come to where it discharges itself into a small lake called by the Indians, *Sagiagáns*. This is the head of canoe navigation between Keweenaw bay and Green bay of Lake Michigan,* and lies 1,049 feet above that lake. There are two other lakes in close proximity, connected together by tortuous streams. A sharp range of granite hills bounds them on the north, while to the south the country is level and marshy. Between the second and third lakes occurs Portage No. 1, three-fourths of a mile in extent, and on the right bank of the stream. The descent is twenty-four feet—the channel being filled with numerous boulders. Portage No. 2 is on the left bank of the stream, a short distance above the point where it discharges itself into the Machi-gummi, or Big lake, (section 25, township 48 north, range 31 west.) The Portage is three-fourths of a mile long—the descent twenty-nine feet.

*In the fall of 1848 we passed over this route to Green Bay. Our canoe was borne by two voyageurs from L'Anse to this point, distant twenty-five miles, over elevations 1,200 feet above the lake, through cedar swamps where for miles we had to hew our way, and wade through meadows knee-deep in water. It was a herculean feat of strength and endurance, accomplished in little more than two days; and Agindos, whose shoulders bore the bulk of the burden, deserves to be particularly named. As this route is practicable, but never travelled except by Indians, we will describe it with some minuteness.

Machi-gummi lies 1,014 feet above Lake Superior. It occupies the entire length of township 48, range 30, and in its southern prolongation extends into the adjoining township. On the north it is bordered by .a range of hills rising in conical knobs to the height of two hundred feet: on the south, the country is less elevated. Its surface is dotted with numerous small islands rising up dome-shaped, with much regularity of outline. These summits are clothed with a dwarfish growth of cedar and fir, while their sides exhibit blackened masses of hornblende.

This lake is seldom visited by the white man, but the Indians resort here to hunt and trap. Along its shores are valuable deposites of iron, and its solitude may be disturbed within the present century by the sound of the forge-hammer and the puff of the steam-engine.

At the outlet of this lake the stream becomes augmented to the width of sixty feet, with an average depth of two feet; and the descent is very rapid: the water is highly colored, and flows over a gravel bed.

About a mile below the outlet occurs the third portage, on the left bank of the stream. It is a mile in length; the descent 35 feet. The bed of the stream is filled with

boulders of hornblende and granite. Portage No. 4 occurs in section 7, township 46, range 29, on the left bank. Length half a mile, descent 14 feet.

Between these two portages the river is confined within narrow alluvial banks, but it occasionally enlarges into lake-like expansions which are fringed with tail grasses. These become the resort of innumerable waterfowl, while the wooded banks are the chosen haunts of the beaver and otter. Pealed sticks, of yellow birch, often seen floating in the stream, indicate the proximity of the former, while numerous "slides" in the plastic clay-banks show that we were in the neighborhood of the latter.

This portion of the country, though elevated, contains few ridges. The rocks rarely emerge to the surface, but are concealed by heavy accumulations of sand, clay, and gravel, mingled together pelê-mêlé. The stream descends rapidly, and its channel is filled with large blocks of hornblende and granite.

Near the north part of township 46, ranges 29 and 30, a ridge rising two hundred feet above the surrounding level is seen, ranging north of west. Towards the river it presents a nearly unbroken cliff one hundred and thirteen feet in height, which, on examination, proved to be nearly pure specular oxide of iron.

Portage No. 5 is on the right bank of the river, in township 45, range 29; length two and a half miles. The river for a long distance above presents a series of rapids, many of which are difficult and dangerous.* The descent between the foot of Portage No. 4 and the head of Portage No. 5 is eighty-seven feet; the descent of Portage No. 5 is thirty-seven feet.

*We have indicated on the general map the position of the rapids; and in this report we have described their character with some minuteness. We have done this for the benefit of future navigators. When one arrives at the head of a rapid white with foam and dotted with projecting rocks, he is desirous of knowing beforehand whether the descent be practicable; for once within the current, there is do power to retrace.

We have often had occasion to admire the dexterity displayed by our Indian voyageurs in descending long and difficult rapids. It requires a quick eye instantly to detect the deepest part of the channel, and to determine, by the break of the water, the position of hidden rocks—a vigorous hand to guide the frail canoe as it dashes on its tortuous course with the speed of a race-horse. Accidents often occur, but fortunately the means of refitting are always at hand— to wit, birch bark and spruce gum.

Portage No. 6 is on the line of sections 29 and 30, township 44, range 29; length one-eighth of a mile. It is caused by an accumulation of flood-wood, so thickly matted that bushes and flowers have taken root, and flourish luxuriantly. Here the winter trail to Green Bay passes, and the mail courier has availed himself of this obstruction to cross the river.

Within this township the Machigamig receives from the right its two principal tributaries, the Mitchikau or Fence river, and the Nebegomiwini or Night-watching river. The origin of these terms, as explained by our voyageurs, was this: At one time the deer were observed to be very numerous about the mouth of the former river, and the Indians, to secure them, built a fence from one stream to the other. They would follow rather than overleap this barrier, until they were entrapped by their concealed foe. This method of capturing the deer is also practised on the Menomonee.

The latter stream abounds in beaver and other game; and it is the practice of the Indians, in the clear moon-light nights, to watch on its banks for their appearance; hence the origin of the term.

Portage No. 7 is about two miles below the mouth of the last-named river, (township 43, range 31.) It occurs on the right bank, and is only one-quarter of a mile in length. The river here falls perpendicularly nine feet. A high range of slate rocks, rising from the immediate banks one hundred and fifty feet, was observed.

Portage No. 8 (township 48, range 31) is over a ridge of hornblende and feldspar rocks, through which the river has excavated a channel length one-eighth of a mile, descent seventeen feet.

Portage No. 9 is in the same township and range, about four miles below the former, on the left bank of the river; it is one mile and three-quarters long, the descent being forty-two and a half feet. The ridge, bearing north 72° east, attains an elevation of one hundred and fifty feet, whose summit is composed of granite, but the flanks consist of hornblende and mica slate, folded over it like a mantle. The banks of the stream are lined with precipitous ledges, and, altogether, it forms one of the most beautiful and romantic gorges on the Machigamig. The country in this vicinity is traversed by numerous ridges, more or less broken, which nowhere attain a great elevation. The rocks emerge to the surface at short intervals, and the immense accumulations of drift noticed above are wanting.

Portage No. 10 is in the north part of township 42, range 31, about a mile and a half below the latter, on the left bank of the stream length one mile and an eighth. The current is rapid both above and below, the descent between the two being fifty-six feet. At the foot of the rapids are several small islands which divide the current.

The last portage (No. 11) is about one-quarter of a mile above its junction with the Menomonee. It is on the right bank of the stream, and one-eighth of a mile in length. The river here breaks through a ridge of hornblende slate, over which it is precipitated twenty-four feet. It is the most romantic of all the cascades on the Machigamig.

The length of this stream from Sagiagans, following its meanders, is about seventy miles, and its general course is south of west: the area drained by it is nearly eight hundred square miles. The Brulé, or Wesacota, here joins it on the right, and, after the junction, the united streams take the name of the Menomonee.

The Brulé has its origin in a lake of the same name, through which passes the south line of the boundary of this district. It is one of a chain of beautiful lakes which extends almost uninterruptedly along the whole southern

border. The current is rapid; but only two portages occur in its course, about ten miles above its mouth, near the junction of the Mequacumecum, in township 41, range 32. The stream is eighty or ninety feet in width, its bed rocky, and its banks studded with a thick growth of cedar, tamarack, and birch, whose overhanging branches often obstruct the passage of a canoe. The Indians have been accustomed to ascend this river from time immemorial, on their route from Green Bay to Vieux Desert, and numerous camping-grounds are to be found along its banks. Its ascent is at all times practicable in a light canoe. The Mequacutnecum is its principal affluent, which rises near the sources of the Sturgeon. It has as long a course, and drains as great an area, as the Brulé itself. This river, too, is frequently ascended by the Indians in their passage to Lake Superior. The length of the Brulé is about fifty miles. The area drained by the Brulé and Mequacumecum contains about nine hundred square miles.

The *Menomonee* may be characterized as a river of cataracts and rapids. Although it pours down a large volume of water, expanding in places to a width of 600 feet, so numerous are the obstructions, that it can never be adapted to other than canoe navigation.

Within the distance of twelve miles from the junction of the before described streams two portages occur, but the rapids at these places are sometimes run by voyageurs who are acquainted with the channel.

A short distance below Bad Water lake, two falls occur within the space of a little more than a mile, the descent in each case being about nine feet.* The portages are short, and both are on the left bank of the river, and over ridges of chlorite slate.

Great Bekuenesec (Smoky) Falls are situated in township 39, range 30, and are the most picturesque of all the cascades on the Menomonee. The portage is one mile and a half in length; and “within this distance," says Captain Cram, "the descent is 134 feet. This amount is divided into several chutes, with intervening rapids. The general aspect of this series of falls is very picturesque. At every change in the point of view, new and varied beauties are perceived." At the lower falls the water is precipitated in a sheet of foam from the height of forty feet. The river above is compressed between narrow and rock-bound banks, but below it expands into a pool 800 feet, in width.

Within the same township are situated the Little Bekuenesee-Falls, where the water, in the distance of 250 feet, fails thirty-five feet. The portage on the left bank is short but arduous. The descent of the river within this township exceeds fifteen feet per mile.

*The heights of the falls on the Menomonee are taken from the report, of Captain Cram, of the United States topographical corps.—Vide Doc. 33, 26th Congress, 2d session.

Near the west line of township 39, range 29, commence the Sandy rapids, which continue for more than a mile and a half. The bed of the stream is rocky, but the banks are lined with high dunes of sand, which make this portage, which is on the left bank, the most arduous on the Menomonee. The amount of fall here is twenty-one feet.

In the same township, and about two miles below, occur the Sturgeon falls. The descent here, in the distance of one thousand feet, is about thirteen feet. The river is contracted within a span of eighty feet, and rushes between perpendicular walls of rock. The portage is on the left bank, over a ridge eighty-five feet above the stream, at the foot of the rapids.

Before the construction of the dams near the mouth, the sturgeon ascended the river to this point, beyond which they could not go. Here the Indians were wont to resort in great numbers to fish, and the remains of their camp-fires are to be seen along the banks at short intervals. Quiver falls are situated in the south part of township 38, range 28. The descent is nine feet. The portage, one-fourth of a mile long, is on. the right bank. The Pemenée (Elbow) falls are five miles below. The principal descent is about eight feet, but immediately above are several ong and difficult rapids. The portage on the right bank is a mile in extent. A short distance below is Chippewa island, (township 37, range 28.) Between this point and the junction of the Brulé and Machigamig the country is ragged and broken. Numerous sharp ridges of slate, and hornblende and feldspar rocks are seen aggregated together, without much system. At most of the portages bare masses of rock are exposed, sometimes precipitous, but oftener worn and polished. The soil is thin, and for the most part sterile. Fires have swept through the woods which once covered the surface, so effectually as to leave hardly a living tree. Blackened trunks rise up on every side as far as the eye can reach. Over this dreary waste the birch and aspen have sprung up, and seem to struggle to gain a precarious support.

Below Chippewa island the soil is more genial. The valley is occupied by sandstones and limestones, and we meet with no sharp ridges, no exposures of rock, over large areas; but the country stretches out into gently rolling plains, traversed by occasional ravines. The river contains many rapids, but no falls.

The Menomonee is one hundred and twenty-two miles in length, or about two hundred including the Machigamig. The whole basin embraces an area of not less than twenty-eight hundred square miles.

For the purposes of navigation it is comparatively worthless, but it affords an indefinite amount of water-power. The lower portions of the valley are covered with extensive tracts of pine, which are beginning to be made available.

In this connexion we may mention the St. Mary's river, connecting together the two lakes, Superior and Huron. It is about sixty miles in length, flowing first a few degrees north of east, then bending abruptly, and flowing a few degrees east of south. Throughout its whole course it occupies the line of junction between the igneous and detrital rocks, forcibly illustrating to what an

extent the physical features of a country are influenced by its geological structure.

About twenty miles from the outlet of Lake Superior, at Saut Ste. Marie, the river flows over a sandstone ledge for the distance of three-fourths of a mile. The descent is between eighteen and a half and twenty-one feet, dependent on the stage of water in Lake Superior. Above the rapids the river shoals gradually from its banks, arid the water is not sufficiently deep to float a vessel for several rods from the shore. The banks of the St. Mary's are low, rising in no place over twenty feet above the surface of the water. Efforts have been made, and will doubtless be renewed, to induce the government to construct a canal around these rapids, and thus connect the commerce of Lake Superior with that of the lower lakes.

This connexion is much to be desired, and it is believed that the enhanced value communicated to the public domain would amply repay the expenses of the work. The mere construction of the locks is not all that is required. It will be necessary to extend a pier into the river, above the rapids, to protect the works and insure an entrance to the locks. This pier will be exposed to heavy currents, and at times to large accumulations of ice, and ought to be constructed of the firmest materials, and strongly protected. There are two points on Lake Superior, easily accessible, where materials of the most enduring character may be obtained for this work. Scovill's Point, at the eastern extremity of Isle Royale, affords a tough crystalline greenstone, traversed by divisional planes, which would assist materially in the quarrying. Vessels could approach within a few feet of the rock, and be in a sheltered position while loading.

The Huron islands, composed of granite, afford, perhaps, a still better material. It can be quarried within two hundred feet of the water, and delivered on a vessel by means of an inclined plane or with a derrick. The islands afford a good harbor at all times. This rock is also traversed by divisional seams, which will essentially aid the quarryman in getting it out. This granite, it is believed, will become an article of shipment so soon as there is a free communication with the lower lakes.

The mouths of many of the smaller streams flowing into Lake Superior are silted up with sand and gravel, through which the water filters. In other cases, where the waves break, for the most part, in one direction, the streams are deflected from their true course, and run parallel to the shore for a long distance, until the accumulated back-water breaks through the barrier and makes a passage to the lake.

Table of the principal rivers in the Lake Superior Land District.

Name.	Descent.	Length.	Course.	Area drained.	Outlet.
	Feet.	*Miles.*		*Sq. miles.*	
Montreal	804	34	NW.	420	Lake Superior.
Black	850?	30	NW.	250	Do.
Presqu'Isle	850?	35	NW.	280	Do.
Iron		25	N.	75	Do.
Ontonagon	900	85	NNW.	460	Do.
West Branch		50	NE	600	Ontonagon.
East Branch		45	NW.	250	Do.
Flint Steel		25	NW.	70	Lake Superior.
Fire Steel		35	NW.	85	Do.
Sleeping		15	NW.	100	Do.
Misery		20	NW.	75	Do.
Salmon Trout		12	N.	40	Do.
Eagle	602	12	NW.	15	Do.
L. Montreal	535	25	E.	30	Do.
Portage		4	SE.	200	Do.
Sturgeon	1,074	65	N.	575	Portage lake.
Fall	1,064	12	N.	75	Keweenaw bay.
Huron	1,100	20	NNE.	100	Lake Superior.
Dead (Du Mort)	1,000	40	E.	200	Do.
Carp	688	40	E.	20	Do.
Chocolate	520	25	WNW.	100	Do.
Tequamenon	200	65	NE.	600	Do.
St. Mary's	49	62	SE.		Lake Huron.
Carp of Michigan					Lake Michigan.
Pine		50	S.		Do.
Manistee		90	SSW.	1,300	Do.
White Fish		55	SSE.	450	Do.
Escanāba	1,060	75	SE.	575	Do.
Fort		75	SE.	400	Do.
Cedar		60	SE.	290	Do.
Menomonee	1,049	122	SE.	1,200	Do.
Brulé	900?	50	ESE.	320	Menomonee.
Mequacumecum		50	SSE.	575	Brulé.
Machigamig	1,049	70	SSW.	800	Menomonee.

Mountains

Mountains perform an important part in the economy of nature. While rivers have been aptly compared to the veins and arteries in the human system, conveying life and energy to the extremities, mountains, with equal propriety, may be likened to the spinal column which supports that system, giving it form and comeliness.

They condense the floating vapors and cause, them to descend in grateful showers. They are the repositories of most of the metals used in the arts. They determine the direction of streams—they prescribe the forms of continents.

The mountains of this region nowhere attain an alpine height. They occasionally occur isolated, but are oftener arranged in groups, or in parallel ridges.

1. Two granite belts occur in the Northwest—one forming the axis between the waters of Lake Superior and Hudson's bay; the other between Lake Superior on the north and Lake Michigan and the Mississippi river on the south. The outline of the Canada range is N. 60° E., though subject to minor irregularities. It forms the rim of the Canada shore for mere than two-thirds of its extent. The summits of this range are generally rounded, and rarely elevated 1,500 feet above the lake.

On the southern shore, a belt of granite approaches the lake near Dead river, and thence stretches westward, sinking clown into a somewhat broken plain southwest of Keweenaw bay. Its widest expansion is about thirty miles. This belt constitutes the Huron mountains, which in places attain an elevation of 1,200 feet above the lake. They do not range in continuous chains, but exist in groups, radiating from a common centre, presenting a series of knobs, rising one above another, until the

summit-level is attained. Their outline is rounded or waving—their slope gradual. The scenery is tame and uninteresting. Hemmed in by these knobs, it is not unusual to find numerous lakes and meadows covered with grass, forming an agreeable feature in the landscape. These meadows appear at one time to have been lakes, which have been filled with the detritus brought down from the surrounding hills, or drained in consequence of the water having worn down the barriers which existed at their outlets. Towards the western extremity of the district, the granite reappears in low ridges, and crosses the Montreal within twelve miles of its mouth. There are subordinate patches of granite in other portions of the district, attaining no great elevation, which will be described in the detailed report.

The metamorphic belt folded around the granite is traversed by numerous detached ridges of hornblende and feldspar rocks, ranging in E. and W. direction, and rarely rising more than 200 feet above the surrounding country, and present a more rugged aspect than the granite. A quartz range starts from the lake shore at the mouth of Carp river, and extends westwardly beyond Teal lake. Its outlines are sharp and well-defined, its escarpments bold, with fragments of rock strewn along its base. The boundaries of this group are defined on the accompanying maps.

2. A trap range starts from the head of Keweenaw Point and runs west twenty miles; then, curving to the southwest, crosses Portage lake near its head, and the Ontonagon river twelve miles from its mouth, and is thence prolonged into Wisconsin. Its length is more than one hundred and fifty miles; its width, from one to twelve. Between Iron and Presqu'-Isle rivers a spur shoots off in the form of a crescent, constituting the Porcupine mountains. Another spur branches off from the main chain on the south, and is prolonged nearly parallel with it for twenty miles. This belt is made up of parallel ranges, presenting step-like or scalar declivities on the side opposite the lake, while the other consists of gradual slopes. Mount Houghton, near the head of Keweenaw Point, rises up like a dome, to the height of eight hundred and eighty-four feet: the Bohemian mountain, near Lac la Belle, is little inferior in height. The valley of Eagle river, on the northwest, is hounded by abrupt, overhanging cliffs, some of which rise to the height of five hundred feet above the surrounding country.

In the vicinity of the forks of the Ontonagon the cliffs are equally bold, and from their summits the eye has an almost unlimited range. To the west, the trap range is distinctly marked for many miles, and the west branch of that stream flows along its base. The highest and most imposing cliffs are north and-east of Agogebic lake. Farther west, the ranges are less precipitous and more irregular, much of the country traversed by these rocks consisting of rolling table-lands.

The highest elevation attained by the Porcupine mountains is one thousand three hundred arid eighty feet. A remarkable gorge occurs in township 51, ranges 42 and 43. This gorge lies about two miles south of the lake, and in that distance the ground rises about a thousand feet. Suddenly the traveller finds himself on the brink of a precipice five hundred feet deep, at the base of which lies a small lake, so sheltered and hemmed in by the surrounding mountains that the winds rarely ruffle its surface. Gloomy evergreens skirt its shores, whose long and pendent branches are so faithfully reflected on the surface that the eye can with difficulty determine where the water ends and the shore begins. From this lake flows the Carp river, and the beholder occasionally catches a glimpse of its waters as they wind through the narrow valley towards the great reservoir. To the west, and extending for five miles, he sees a perpendicular wall three hundred feet in height—occasionally broken through by a transverse gorge—at the base of which are numerous fragments, which have tumbled from the cliffs above. Still further down is to be seen the rich foliage of the maple intermingled with the dark green of the fir and cedar, and still beyond succeeds a level plain, stretching out for twenty miles, and clothed with a dense growth of trees; while in the distance the Black river hills are seen, blue and indistinct, resting like a cloud upon the horizon.

That portion of the district occupied by the detrital rocks rarely rises three hundred feet above the lake. It is not unusual to see ridges of sand and clay forming considerable elevations. The Grand Sable is a remarkable accumulation of this character, rising to the height of three hundred and forty-five feet. Point Iroquois, at the outlet of the lake, is three hundred and fifty feet in height, and composed wholly of transported materials.

The following list comprises the heights of some of the principal points in the vicinity of Lake Superior. The surface of the lake is assumed as the base line, which is 627 feet above tide-water.

Northern shore (from Bayfield's chart.)

	Feet.
Pie island	850
McKay's mountain	1,000
Thunder cape	1,350
St. Ignace (estimated)	1,300
Les Petits Ecrits	850
Pic island	760
Michipicoten island	800
Gros Cap (estimated)	700

Keweenaw Point, approximately determined by barometer under Dr. Jackson.

Township 58, range 28, southwest quarter section 1, conglomerate ridge	641
Do do section 5, Manganese lake	136
Do do southwestern quarter section 5, trap range	307
Do do line between 12 and 13	467
Do do southwest quarter of 18	252
Do do line between 19 and 20	330
Do do southwest quarter of 20	370
Township 59, range 28, Brockway's mountain	421
Township 58, range 29, section 14, Montreal river	284
Township 58, between ranges 23 and 24, Mount Houghton	884
Township 58, range 29, Bohemian mount, at Lac la Belle	864
Township 58, range 30, conglomerate ridge, back of Grand Marais	659
Do do between sections 9 and 10, trap ridge	316
Do do do 15 and 16, trap ridge	730
Do do do 15 and 16, Little Montreal river	535
Do do northeast corner of section 21	550
Do do northeast corner of section 28	568
Do do northeast corner of section 33	696
Township 57, range 30, between sections 5 and six near Gratiot lake	294
Township 58, range 31, southwest quarter section 11, Copper Falls mine	225
Do do south line of section 14	825
Do do section 24, Northwest mine	630
Do do section 30, Phœnix mine	247
Do do section 36, south boundary	749
Township 57, range 31, section 1, trap range	843
Do do section 1, south boundary	611
Township 58, range 32, southwest quarter section 36, Cliff mine	588
Do do office	390
Township 57, range 32, northwest quarter section 1, North American mine	395
Do do southwest quarter section 2, Albion bluff	800
Do do northwest quarter secton 11, Albion mine	547
Do do office	
Do do south boundary of 28	388
Do do south boundary of 33	475
Township 56, range 32, section 7, Forsyth mine	520

District between Portage lake and the Montreal river.

Township.	Range.	Section.	Fraction.	Locality.	Height.
52	37	35		Algonquin location, house	625
52	37	34	Southwest quarter	Highest point of trap range	759
51	37	15	Southwest corner	Cabin of Douglass Houghton Co	478
51	37	15		Trap ridge, one-quarter of a mile east of last point	655
51	37	15		Ridge of conglomerate, one-half mile east of same	463
51	37	21		Trap ridge, one-eighth of a mile southwest of same	660
51	37	30		Trap knob, near southeast corner	633
50	38	6		Trap knob, near northwest corner	718
50	39	1		Trap ridge, 1 mile south of northeast corner of township	736
50	39	16		Cabin of Ontonagon Company	598
50	39	15		Minnesota Company's office	647
50	39	15		Summit of Middle Brother	758
50	40	36		Ontonagon Company's office	429
49	40	12		Trap bluff, above Ontonagon	416
49	40	5	Southwest corner	Clearing of Ohio Trap Rock Company, above Ontonagon	559
49	41	12		Ohio Trap Rock Company's mine	672
49	41	12		High bluff near same	781
50	40	30		Hill of quartzose porphyry	913
49	41	11		High trap bluff	776
49	41	11		Ontonagon river, at base of same	554
49	42	11		Bluff of red porphyry	1,099
49	42	11		Same, above its base	449
48	49	24	Northwest corner	Conglomerate ridge	586
48	49	24		House at location of Montreal River Company	369
49	43	14		Highest point of red porphyry	1,360
51	43	14		Carp lake	483
51	43	14		Cliff at Isle Royale Company's mine	915
51	43	14		Same, above Carp lake	485
51	43	27	Northwest corner	Location of Delavan Company	587
51	43	27		Same, above Carp lake	196
51	43	27	Northeast corner	Union River Mining Company's location	309
51	43	30		Conglomerate hill	931
51	43	16		Ridge of altered sandstone	691
51	43	32	Northeast corner	Location of Croton Company	690
51	43	32	Southeast corner	Cliff of jasper	1,191

District between Portage lake and the Montreal river—Continued.

Township.	Range.	Section.	Fraction.	Locality.	Height.
50	44	11		Highest point of Porcupine mountains	1,380
				Isle Royale.	
66	34	21	Northeast quarter	Ridge of trap	361
66	34	20	Southwest quarter	Stream, 10 feet above small lake	126
66	34	30	Southeast quarter	Summit of ridge near southwest corner of southeast quarter	299
66	35	36	Northwest quarter	Northeast corner, summit of ridge	409
66	35	36		Corner of sections 25, 26, 35, 36	99
65	37	24		Line between sections 23 and 24, ridge	596
65	37	36		Line between sections 35 and 36, ridge	288
65	37	36		Lake Desor	215
64	37	36		North corners of sections 11 and 12	309
64	37	36		Camp on stream between sections 13 and 14	76
63	37	1		Ridge of sandstone	294
66	34	15		Highest point on Isle Royale	513
66	34	15		Ridge on line between sections 14 and 15	403
66	34	15		Southeast corner of section	263
66	34	22		Ridge on line between sections 22 and 23	234
64	38	32	Northwest corner	Beaver island	188
64	38	29		Ridge on line between sections 29 and 30	263
64	38	31		Ridge on line between sections 31 and 32	175
64	38	20		Ridge on line between sections 19 and 20	276

NOTE.—For the information of those not familiar with the system of government surveys, it may be stated that the public domain is surveyed into townships, each six miles square, which are subdivided into sections, each one mile square, containing 640 acres. The sections are numbered from one to thirty-six, inclusive, beginning at the northeast corner of the township and counting the first tier of sections from right to left, the second from left to right, and so on, alternately. The townships are numbered north from a base line which starts from Lake St. Clair and runs thence due west to Lake Michigan. The ranges are numbered west from a meridional line which passes through Sault Ste. Marie.

This system, which is an admirable one, was first suggested by Hutchens, who, before the Revolution, belonged to the royal engineers, and subsequently became geographer to the United States. It was early adopted by Congress, and, had it been extended into all the States, would have saved much vexatious litigation as to boundaries, and afforded a vast amount of geographical information, at an inconsiderable expense.

This system is executed with a chain and compass, which, under all the circumstances, is the best which could be devised for this country, where the forests are so dense as to render it impossible to make use of those natural monuments which are essential to connect triangulations. Burt's solar compass is an admirable invention, and ought to be substituted for that in ordinary use in all the public surveys.

CHAPTER II.
CLIMATE.

Objects embraced.—Meteorology.—Effects of the lakes in equalizing the temperature.—Meteorological registers, at various stations.—Mean annual temperature, and that of summer and winter.—Amount of rain.—Course of the winds.—Comparison of the climate in equal latitudes in Europe.—Character of the vegetation.—Range of the cerealia.—Oscillations in the lakes.—The cause.—Periodic rise—Temperature and transparency of the water of Lake Superior.—Evaporation.—Mirage.—Variation of refraction.—Frosts.—Thunder-storms.—Auroras.

Meteorology.—In treating of the climate of this region, we shall use that term in its most extended sense, as comprehending, according to Humboldt, all the changes in the atmosphere which seriously affect our organs—as temperature, humidity, variations in the barometrical pressure, the calm state of the atmosphere or the action of opposite currents of winds, the amount of electric tension, the purity of the atmosphere or its admixture with more or less noxious gaseous exhalations, and, finally, the degree of ordinary transparency and clearness of the sky, which is not only important with respect to the increased radiation of the earth, the organic development of plants, and the ripening of fuits, but also with reference to its influence on the feelings and mental condition of men.*

To this great physicist science is indebted for having first suggested a system of lines, called *isothermal*, *isotheral*, and *isochimenal*, connecting those places where the mean summer, winter, and annual temperatures have been ascertained. These lines are by no means parallel, various causes conspiring to produce divergencies—such as altitude above the sea, the, geographical configuration, of a country, the presence or absence of large bodies of water and of mountain chains, the purity of the sky, and the prevailing direction of the winds.

Isothermal lines define the heat and cold of the earth. The line 59° F. traverses the latitude of 43° in western Europe, but descends to latitude 36° in eastern America. The isothermal line of 41° F. passes from latitude 60° in western Europe to latitude 48° in eastern America.

The presence of so vast a body of water as is afforded by the American lakes modifies the range of the thermometer, lessening the intensity of the cold in the winter and of the heat in the summer. By the freezing of the water, a great volume of heat is evolved, and the intense cold of the northern winds is somewhat mitigated in sweeping over the open lakes. In the summer, when the sun, often with unobscured lustre, shines for sixteen hours in twenty-four, the intensity of the heat is modified by the breezes which are cooled in their passage over the surface of the lakes, the water of which is always at a low temperature.

*Asie Centrale—Tome III.

To show the equalizing effects of the lakes on the climate, we need only refer to the mean temperature of Fort Howard, on Green bay, and Fort Snelling, on the Mississippi:

	Latitude.	Mean T.	Winter.	SummerT.	Range of Ther.
Fort Howard - -	44° 40′	44°.3	20°.5	67°.7	—16 + 99°
Fort Snelling - -	44° 53′	44°.8	16°.3	72°.0	—23 +115°

Thus, during the winter, the mean temperature at the former post is higher; but during the summer it is lower, while the annual temperature Is nearly the same. The former is situated in the proximity of large bodies of water, which essentially modify the temperature; while the latter is in the midst of a vast plain, with no mountain chains to break the force of the winds.

[The following tables have been furnished us from the office of the Surgeon General of the United States army, made in pursuance of an admirable regulation, adopted by the Secretary of War as far back as 1819, requiring meteorological observations to be made at the several posts throughout the United States. Three of these posts are within this district, to wit: Forts Wilkins, Brady, and Mackinac, while Fort Howard is but about half a degree removed from its southern boundary. These tables furnish us with satisfactory information as to the mean temperature of the seasons, the prevailing direction of the winds, the serenity of the sky, the amount of rain, &c. We regret that they do not also embrace the fluctuations of the barometer.]

FORT BRADY.

Years.	Aggregate mean temperature.	Thermometer. Mean temperature. Winter.	Spring.	Summer.	Autumn.	Maximum heat.	Maximum cold.	Range.	Winds. Days. North.	Northwest.	Northeast.	East.	Southeast.	South.	Southwest.	West.	Prevailing.	Weather. Days. Fair.	Cloudy.	Rain.	Snow.	Rain and snow, in inches.
1831..	41.43	14.89	41.49	64.45	44.91	94	20	114	44	61	49	84	46	21	20	40	E..	157	64	79	65	.....
1832..	41.61	17.30	38.35	64.99	55.83	91	28	119	81	59	43	50	47	18	19	49	N..	173	87	76	31	.....
1833..	41.11	21.01	39.36	61.61	42.48	87	16	103	66	74	37	28	80	18	34	28	SE..	164	68	88	45	.....
1834..	41.49	19.38	39.59	63.60	42.67	91	12	103	20	109	22	34	84	19	25	32	NW.	181	68	97	69	.....
1835..	40.07	16.85	38.61	62.81	42.04	87	20	107	26	104	13	30	90	31	38	31	NW.	185	95	71	69	.....
1836..	36.93	16.34	32.71	59.02	39 76	89	25	114	93	99	39	19	127	15	32	12	S	164	74	65	63	.....
1837..	36 66	15.88	31.01	57 37	42 29	90	30	120	24	83	42	44	61	25	19	38	SE.	159	93	91	42	36.92
1838..	37.60	11.71	35.69	62.73	40 29	94	28	122	14	83	95	63	61	25	43	51	NW.	201	89	74	51	34.37
1839..	41.63	21.61	38.11	62.65	44.16	98	24	126	8	138	96	36	98	18	35	26	NW.	200	74	52	39	24.01
1840..	41 14	18.84	42 04	62.15	41.55	90	21	111	20	110	29	49	83	21	32	31	NW.	158	12.4	59	34	33.69
1841..	39.43	18 37	34.02	62.74	42.58	94	26	120	41	71	46	49	44	27	40	47	NW.	146	13.3	55	32	32.74
1842..	38.82	19.48	37.40	57.30	41.12	91	17	108	51.5	42.5	36	39.5	38	76	35	46.5	S...	183	77.5	59.5	45	26.40
Mean.	39.82	17.64	37.39	61.79	42.47	98	30	128	36.37	86.12	33.91	42.12	74	26.6	31	35.1	NW.	168.3	77.2	71.7	47.9	29.58

FORT HOWARD.

Years.	Aggregate mean temperature.	Thermometer. Mean temperature. Winter.	Spring.	Summer.	Autumn.	Maximum heat.	Maximum cold.	Range.	Winds. Days. North.	Northwest.	Northeast.	East.	Southeast.	South.	Southwest.	West.	Prevailing.	Weather. Days. Fair.	Cloudy.	Rain.	Snow.	Rain and snow, in inches.
1831..	44.85	9.04	44.36	70.31	43.69	93	30	123	50	33	45	14	20	90	97	16	SW..	202	79	48	36	.....
1833..	46 62	25 09	45.64	68.99	46.77	99	14	113	49	37	42	98	17	116	42	44	S....	185	84	68	28	.....
1834..	46.88	23.10	46.10	69.98	48.37	96	20	116	46	17	58	98	17	97	34	68	S....	203	139	16	7	.....
1835..	43.94	19.13	44.06	68.33	43.36	96	23	119	60	28	53	36	96	99	45	48	S....	220	122	15	8	.....
1836..	42.58	21.73	40.80	64.61	43.91	97	17	114	63	41	38	37	94	99	36	48	S....	191	73	70	32	.....
1837..	43.31	24 74	37.08	64.19	47.25	92	18	110	59	27	39	38	34	97	36	38	S....	185	61	86	33	40.55
1838..	42.86	16 56	42.97	69.41	42.68	98	30	128	77	27	21	15	29	117	34	35	S	195	54	66	50	37.56
1839..	46.07	23.47	45.66	65 94	47.34	96	16	114	124	23	18	12	26	122	16	24	N....	200	51	74	40	31.98
1840..	44.85	19.92	45.40	67.61	46.49	96	30	126	86	23	14	21	29	132	25	36	S....	208	55	71	32	33.57
Mean.	44.33	20.53	43.66	67.71	45.45	99	30	129	68.22	27.11	33.11	24	24.6	107.6	39.4	40.7	S....	198.7	79.7	57	29.5	35.74

FORT WILKINS.

Year and month.	Mean of thermometer. Sunrise.	9 A. M.	3 P. M.	9 P. M.	Mean.	Mean annual temperature.	Mean clearness of sky. Sunrise.	9 A. M.	3 P. M	9 P. M.	+ Heat.	— Cold.	Rain & snow, in inches.
1844, June.....	50.80	58.04	65.92	59.35	58.35	.....	4.03	4.46	4.40	3.56	59	59	.....
July.....	56.77	64.38	72.03	69.03	64.96	.....	3.77	4.35	5.00	5.22	86	44	.....
August....	57.70	64.49	69.80	65.70	63.90	.....	3.09	3.77	4.54	5.00	84	48	.....
September...	50.43	58.30	62.40	52.16	56.50	.....	3.13	3.83	3.66	5.60	80	34	.....
October	37.16	44.48	46.51	38.41	42.24	.....	1.70	6.29	2.25	4.51	67	21	.....
November...	28.30	30.73	31.30	27.33	26.40	.....	.73	1.10	1.23	1.86	52	9	.....
December ...	20.33	22.45	20.60	22.22	23.06	.....	.41	.96	1.48	1.83	42	6	.....
1845, January	19.96	21.70	23.61	20.32	21.77	.....	1.48	1.29	.74	1.29	42	0	.....
February	20.30	23.03	28.00	22.83	24.10	.....	.96	.28	2.21	1.32	53	0	.....
March.....	22.45	26.87	30.41	24.25	25.83	.....	2.03	1.96	1.90	4.38	42	2	.....
April.....	31.90	36.30	43.46	35.80	37.66	.....	3.13	2.66	4.36	5.06	61	10	.....
May.....	43.67	50.22	59.00	46.32	51.32	41.46	3.87	5.32	5.38	5.64	88	31	.....
June.....	50.76	56.76	62.37	56.56	53.53	.....	5.03	4.63	4.80	5.46	76	42	.....
July.....	58.00	64.57	71.00	61.32	64.48	.....	4.80	5.19	4.93	5.45	94	48	.....
August.....	61.48	62.85	67.41	57.48	66.33	.....	3.97	4.00	4.58	5.67	84	44	.....
September..	51.72	56.23	64.46	52.50	57.16	.....	4.23	4.23	3.23	4.00	78	39	.....
October.....	41.25	44.41	48.67	43.38	45.72	.....	2.25	3.19	3.29	2.67	76	26	.50
November ...	29.33	31.13	33.46	29.33	31.40	.....	1.76	1.86	2.29	2.73	59	5	2.91
December...	16.38	19.06	20.12	18.16	18.97	.....	.93	1.53	1.73	2.50	38	— 4	2.45
1846, January.....	22.29	25.03	28.74	24.54	25.38	. ...	1.96	2.53	2.29	3.64	52	— 2	.89
February...	16.35	18.53	23.32	18.17	19.83	.....	1.46	1.50	2.50	2.60	42	— 9	1.72
March.....	27.64	33.03	36.84	30.29	32.04	.....	2.77	2.96	3.54	3.58	47	12	3.84
April.....	34.26	40.06	45.96	36.76	40.01	... ...	4.40	4.70	4.30	6.16	78	12	2.95
May.....	48.87	53.29	60.19	48.77	53.35	.....	6.70	6.83	7.25	6.67	74	33	1.63

MACKINAC.

Months.	Thermometer. Mean temperature. 7 A. M.	2 P. M.	9 P. M.	Aggregate mean temperature.	Maximum of heat.	Maximum of cold.	Range.	Winds. Days. N.	NW.	NE.	E.	SE.	S.	SW.	W.	Prevailing.	Weather. Days. Fair.	Cloudy.	Rain.	Snow.	Prevailing.
January	16.96	21.19	18.64	18.93	40	—17	57	6	4	2	1	2	8	....	8	S....	8	8	4	11	Cloudy.
February	13.67	21.92	17.59	17.66	38	— 8	46	4	5	....	1	2	4	1	11	W...	14	6	1	7	Cloudy.
March	23.22	29.93	25.83	26.32	41	— 8	49	7	2	10	7	1	2	1	1	NE..	12	11	1	7	Cloudy.
April.....	29.80	36.23	32.53	32.85	66	10	56	4	3	3	5	....	4	2	8	E....	11	7	8	4	Cloudy.
May	48.12	53.45	50.32	50.59	70	32	38	2	1	....	13	....	4	2	9	E....	15	4	12	....	Cloudy.
June.....	57.46	66.39	59.76	61.14	84	48	36	3	2	....	10	....	4	....	11	W..	11	7	12	....	Rain.
July.....	63.54	71.87	64.90	66.74	92	54	38	4	6	2	....	1	6	3	9	W...	20	3	8	....	Fair.
August.....	60.74	68.48	60.61	63.29	82	50	32	3	3	3	3	5	5	3	6	W...	18	2	11	....	Fair.
September.....	53.30	58.16	53.06	54.84	70	40	30	4	1	5	....	3	11	1	5	S....	12	5	13	....	Cloudy.
October	45.83	53.22	46.74	48.63	69	29	40	2	1	2	3	4	8	6	5	S....	11	13	6	1	Cloudy.
November.....	33.76	38.60	35.03	35.80	62	20	42	2	6	1	5	1	4	6	5	SW..	5	15	3	7	Cloudy.
December.....	21.03	25.40	23.80	23.41	42	—16	58	6	3	3	6	4	3	5	1	E....	2	19	1	9	Cloudy.
Mean	38.96	45.35	40.71	41.67	84	17	101	3.9	3.0	2.5	4.5	1.9	5.2	2.5	6.5	W...	11.6	8.3	6.6	3.8	Cloudy.

From these tables we derive the following results: That the mean annual temperature of Fort Brady is nearly two degrees lower than that of Fort Wilkins, although the latter post is nearly a degree farther north. This difference arises from the insular position of Keweenaw Point, which is surrounded on three sides by water.

That, while the annual ratio of rain which falls at Fort Brady is 29.5 inches, at Fort Howard it exceeds 35 inches—an excess which cannot be accounted for by the difference in the mean temperature of the two places, .but results from the prevailing direction of the winds; for while the N. and NW. winds prevail at the former post for more than one-third of the year, the S. and SW. prevail for a longer period at the latter.*

That, while there are more rainy days at the former post—the ratio being as 118 to 86—the showers at the latter are more copious.

The direction of the winds is undoubtedly determined, in some degree, by the configuration of the country, pursuing the courses of the lakes.

The observations at Fort Wilkins and Mackinac do not extend through a sufficient number of years to enable us safely to institute comparisons. So far as relates to the annual amount of rain, they are defective.

In the subjoined table we have given the mean temperature of the year, and of the winter and summer, in corresponding degrees of latitude in western and southern Europe; also, the latitudes of places where the several lines of temperature correspond with those of the stations before given.

The first number in the column of temperature represents the mean annual temperature; that which stands in the place of a numerator, the mean temperature of the winter, while the denominator represents the mean temperature of the summer. The European observations are from Baron Humboldt's tables.

From these observations it would appear that the lines of equal temperature on the western coast of Europe, without reference to the elevation above the sea-level, are about 13° farther north than in the vicinity of the lakes. The climate at Fort Brady, during the whole season, corresponds in a remarkable degree with that of St Petersburg; indeed, the difference of temperature is less than between Fort Brady and Fort Wilkins. While the hills in the region of Fort Brady support a dwarfish growth of terebinthines, (resinous trees,) those in the

vicinity of Nantes, in a nearly corresponding latitude in Europe, are covered with the vine.

*Humboldt has given the following as the proportional quantity of fain in different latitudes:

0.	Mean annual depth	96 inch es.
19.	" " "	80 "
45.	" " "	29 "
69.	" " "	17 "

Table showing the mean temperature of the year, and of winter and summer, in corresponding latitudes in Europe and America.

Latitude.	Adjoining the great lakes—height above sea.	Europe—height above sea.	Mean temperature of the year, of summer and winter.		Difference.
47° 27′	Fort Wilkins—647		41°.4	21°.1 / 61°.4	10°.2
48° 50′		Paris—222	51°.6	37°.8 / 64°.6	
60° 27′		Abo—0	40°.2	20°.8 / 38°.3	11°.4
46° 30′	Fort Brady—640		39°.8	17°.6 / 61°.7	14°.8
47° 13′		Nantes—0	54°.6	40°.4 / 68°.5	
59° 56′		St. Petersburg—0	38°.8	17°.6 / 62°.6	15°.8
45° 50′	Fort Mackinac—728		41°.6	20°.5 / 63°.7	14°.1
45° 28′		Milan—390	55°.7	36°.2 / 73°.4	
59° 51′		Upsal—0	42°.8	24°.9 / 60°.2	12°.9
44° 40′	Fort Howard—600		44°.3	20°.5 / 67°.7	12°.9
44° 50′		Bordeaux—0	57°.2	42°.8 / 71°.2	
55° 41′		Copenhagen—0	45°.6	30°.7 / 62°.6	11°.6

The *cerealia*, or common grain, such as wheat, rye, oafs, and barley, thrive where the mean annual temperature descends to 28° F., provided that of summer rise to 52° or 53°. The rapid growth of barley and oats adapts them to the short summers of the north; they are found as high as latitude 69° 30', in Lapland, along with the potato. Wheat, which is a precarious crop, and little cultivated above 58° in western Europe, yields good returns in the temperate zone, when the mean heat, while the grain is on the ground, is 55°; but if no more than 46°, none of the *cerealia* come to maturity.* Indian corn is a precarious crop beyond latitude 45°.

From the tables above given it will be seen that the temperature of this climate is favorable to the growth of the *cerealia*.

Annual plants, remarks Sir John Hooker, which require heat during the summer to ripen their seeds, and which pass the winter in torpidity, in the state of grain, indifferent to the intensity of cold, abound most in those regions where the extremities are greatest; whilst the perennial plants, which can better dispense with the maturing of their seeds, and which are injured by the seventies of winter, affect the temperate climates. Of these again, those kinds which have deciduous leaves accommodate themselves best to unequal temperatures; whilst the individuals on which the foliage remains, or *evergreens*, give the preference to districts where the temperature is more constantly equal. Thus, while the shores of the lake are fringed with spruce, balsam, fir, and cedar, the interior of the district produces the maple, the yellow birch, and the ash.

At Fort Brady, the annual ratio of fair days is 168; of cloudy days, 77; rainy days, 71; of snowy days, 47.

The average amount of rain which falls at Fort Brady is 29.5 inches; at Fort Howard, 35.7 inches. These results exhibit a discrepancy which cannot be fully accounted for by the difference in the mean temperature of the two places. The prevailing direction of the winds at the two places may be the true cause. At Fort Brady northwest winds prevail, while at Fort Howard southerly winds predominate.

*Murray's Encyclopædia of Geography, vol. I.

Phenomena of the waters.—Lake Superior possesses all of the sublimity of the ocean. In gazing upon its surface, whether stretched out like a vast mirror, reflecting the varying tints of the sky, or ruffled by gently-curling waves, or lashed by the fury of the storm, the beholder is alike impressed with a feeling of the grand and the infinite. During a residence of several summers on its borders, our attention has been directed to the fluctuations in the level of its waters; and, while we have failed to detect any ebb and flow corresponding with the tidal action, we have, on the other hand, noticed certain extraordinary swells which appear to be independent of the action of the sun and moon.

These risings attracted the attention of the earliest voyageurs, and they have not failed to record their observations with a minuteness worthy of commendation.

In the Relation for 1670-'71, Dablon uses the following language: "As to the tides, it is difficult to lay down any correct rule. At one time we have found the motion of the waters to be regular, and at others extremely fluctuating. We have noticed, however, that at full moon and new moon the tides change once a day for eight or ten days, while, during the remainder of the time there is hardly any change perceptible. Three things are remarkable: 1st, that the currents set almost constantly in one direction, viz: towards the lake of the Illinois, (Michigan,) which does not prevent their ordinary rise arid fall; 2d, that they almost invariably set *against* the wind—sometimes with as much force as the tides at Quebec—and we have seen ice moving against was wind as fast as boats under in full sail; 3d, that among these currents we have discovered the emission of a quantity of water which seems to spring up from the bottom?"

He supposes that this results from an underground discharge from Lake Superior, and asks, if otherwise,

what becomes of the waters of Lake Superior, and whence come the waters of Lakes Huron and Michigan?

In the Relation for the year 1671-'72, Father André thus speaks of the movements of the waters: "I had not partaken of the opinion of those who believe that the lake of the Hurons has an ebb and flow like the sea, because I had not noticed anything very regular during the time I passed on its borders; but I began to suspect that there might be tides in the bay of the Skunks (Green bay) after having crossed Wild Rice river, (Menomonee.) We had left our canoe afloat, the weather being calm. The following morning we were very much surprised to find it on dry ground. I was the more astonished, since I had noticed that the lake had been for a long time tranquil. From that day I resolved to investigate the causes. The first thing I determined was, that the contrary winds, although moderate, did not prevent the flux and reflux. I noticed, besides, that in the river (Fox) which empties into the head of the bay the tide rises and sinks twice in somewhat more than twenty-four hours. The ordinary rise is one foot; the highest tide I saw caused the river to rise three feet, but it was accompanied by a violent northeaster. Unless the northwest winds be very strong, they do not prevent the river from flowing down; so that the discharge is from the middle of the bay—the water rising at each end, according to the hours of the tide.

"We must not be surprised to find this flux and reflux stronger at the head, of the bay than on Lake Huron or Illinois; for, supposing the tide to he only one inch in those lakes, it must of course be more marked in this bay, which is from fifteen to twenty leagues long and from five to six in width, and grows narrower and narrower, whereby the water, being reduced to a small space at the head of the bay, must necessarily rise much more than in the lakes, where the space is the widest."

The late Governor Clinton collected a mass of evidence relating to these sudden risings, which is embodied in a memoir communicated to the New York Literary and Philosophical Society;* but, as it is not generally accessible, we will avail ourselves of the most important facts.

L'Hontan† records the following incident: "On the 29th of May, 1689, we came to a little deep sort of river, which disembogues at a place where the water of the lake (Michigan.) swells three feet high in twelve hours, and decreases as much in the same compass of time. Our tarrying them three or four days gave me an opportunity of making the remark."

*Vol. II, p. 1.

†Voyage to America, vol. II.

Charlevoix,* who traversed the lakes nearly-a century ago, in reference to Lake Ontario, says: "I observed that in this lake, and I am told that the same thing happens in ail the rest, there is a sort of flux and reflux, almost instantaneous—the rocks near the banks being covered with, water, and again uncovered, several times in the space of a quarter of an hour, even if the surface of the lake was very calm, with scarce a breath of wind. After reflecting some time on this appearance, *I imagined it was owing to springs at the bottom of the lake, and to the shock of their currents with those of the rivers which fall into them from all sides, and thus produce those intermitting motions"*

Mackenzie, who wrote in 1789,† remarks: "A very curious phenomenon was observed at the Grand Portage, on Lake Superior, for which no obvious cause could be assigned. The water withdrew with great precipitation, leaving the ground dry, that had never before been visible—the fall being equal to four perpendicular feet—and rushing back with great velocity above the common mark. It continued thus rising and falling for several hours, gradually decreasing until it stopped at its usual height."

The following incident is related as having happened to Colonel Bradstreet, who commanded an expedition against the western Indians in 1764: "In returning by way of Lake Erie, when about to land the troops one evening, a sudden swell of the lake, without any visible cause, destroyed several of his boats; but no lives were lost. This extraordinary event was looked upon as the precursor of a storm; and accordingly one soon occurred, which lasted several days."

The following occurrence is related by Governor Clinton, in the memoir before referred to: "On the 30th of May, 1823, a little after sunset. Lake Erie, on the British side, was observed to take a sudden and extraordinary rise, the weather being fine and clear, and the lake calm arid smooth. It was principally observed at the mouths of Otter and Kettle creeks, which are twenty miles apart. At Otter creek, it came in without the least previous intimation, in a swell of nine feet perpendicular height, as was afterwards ascertained, rushed violently up the channel, drove a schooner of 35 tons burden from her moorings, threw her upon high ground, and soiled over the ordinary beach into the woods, completely inundating all of the adjacent flats. This was followed by two others of .equal height, which caused the creek to retrograde a mile and a half, arid to overflow its banks, where water never before was seen, by seven or eight feet. The noise occasioned by its rushing with such rapidity was truly astonishing. It was witnessed by a number of persons.

"At Kettle creek, several persons were drawing a fish net in the lake, when suddenly they saw the water coming upon them in the manner above described, and, letting go their net, they ran for their lives. The swell overtook them before they could reach the high bank, and swept them forward with great force, but, being expert swimmers, they escaped unhurt. The man who was in the skiff pulling in the sea-line was driven with it a considerable distance over the flat, and grounded on a small eminence, where he remained until the water subsided. There were three successive swells, as at Otter creek, and the effects were the same, with this

difference: the water rose only seven feet. In both cases, the lake, after the swells had spent their force, gradually subsided; and in about twenty minutes was at its usual height and tranquillity."

*Journal Historique d'un Voyage de l'Amerique, LXIII.

†Voyage to the Frozen and Pacific Oceans.

In 1820; Governor Cass instituted a series of observations at the head of Green bay to determine the changes in the water-level. These observations extended from the 15th of July to the 30th of August; and the following are the results: "That the changes in the elevation of the waters are entirely too variable to be traced to any regular, permanent cause; and that, consequently, there is no perceptible tide at Green bay, which is the result of observation. And such, it appears to me, is the result of calculation, when the laws that regulate solar and lunar attraction, and the limited sphere of their operation, are taken into view."*

Professor Mather, who observed the barometer at Copper Harbor during the prevalence of one of these fluctuations; has published the results of his observations in the journal† before alluded to. He remarks: "As a general thing, fluctuations in the barometer accompanied the fluctuations in the level of the water; but sometimes the water-level varied rapidly in the harbor, while no such variations occurred in the barometer at the place of observation. The variations in the level of the water may be caused by varied barometric pressure of the air on the water, either at the place of observation or at some distant points. A local increased pressure of the atmosphere at the place of observation would lower the water level where there is a wide expanse of water, or a diminished pressure under the same circumstances would cause the water to rise above its usual level."

In the summer of 1834; an extraordinary retrocession of the waters took place at Saut Ste. Marie. The river here is nearly a mile in width; and the depth of water over the sandstone rapids is about two and a half feet. The phenomenon occurred about noon. The day was calm, but cloudy. The water retired suddenly, leaving the bed of the river bare, except for the distance of about twenty rods, where the channel is the deepest, and remained so for the space of an hour. Persons went out and caught fish in the pools formed in the depressions of the rocks. The return of the waters is represented to have been sudden, and presented an imposing spectacle. They came down like an immense surge—roaring and foaming; and those who had incautiously wandered into the river-bed had barely time to escape being overwhelmed. Our informants were unable to state whether this occurrence was succeeded by a violent wind or storm; but they all concurred in representing the day as calm.

A similar phenomenon occurred twice the same day, in the latter part of April; 1842. The lake was free from ice; and no wind was prevailing at the time. A few years previously—the precise period our informants could not designate—the current between the foot of the rapids and Fort Brady; which usually flows at the rate of two and a half knots an hour, was observed to set back, and the water rose two feet or more above the usual mark. Some of the soldiers at the fort, in order to satisfy themselves as to the backward flow; jumped into a boat and rowed into the stream, when they found that the boat floated towards the foot of the rapids. These facts are given on the authority of Messrs, Ashmun, Peck, and Bingham—old residents of Saut Ste. Marie.

*Remarks on the supposed tides and periodical rise and fall of the North American lakes, by Major (now Brigadier General) Henry Whiting, Silliman's Journal, vol 20, p. 2.

See, also, a paper by General H. A. S. Dearborn in the same journal, vol 16.

†Second series, vol. 6, July, 1848.

We have witnessed numerous instances of these ebbings and flowings, which will serve to corroborate the above facts. In the month of August, 1845, while coasting in an open boat between Copper Harbor and Eagle river, we observed the water rise up, at a distance of a fourth of a mile to the northwest, to the height of twenty feet. It curled over like an immense surge, crested with foam, and swept towards the shore, diminishing as it advanced. The voyageurs paused on their oars, having first headed the boat so as to cut the advancing wave. It passed without doing us any injury, and spent its force on the shore. It was succeeded by two or three swells of less magnitude, when the lake resumed its former tranquillity. The cause of this uplift was apparently local, and operated but for a few moments. It could not, like the *bore* at the mouth the Amazon, have been produced by opposing currents. It was late in the afternoon when this phenomenon was observed. The lake was calm; but to the northwest the clouds indicated that different currents of air were moving in opposite directions. Mirage was beautifully displayed, and imaginary islands were seen along the horizon.

While at Rock Harbor, Isle Royale, in the summer of 1847, we witnessed the ebbing and flowing of the water, recurring at intervals of fifteen or twenty minutes, during the entire afternoon. The variation was from twelve to twenty inches; and we took advantage of their recession to catch some of the small lake fish which were left in the pools. The day was calm and clear, but before the expiration of forty-eight hours a violent gale set in.

On the 23d of July, 1848, we went from Copper Harbor to Eagle river, where we arrived in the evening. The day had been calm—so much so, that we were unable to avail ourselves of our sail. In the evening there sprang up an off-land breeze, but we observed a strong current setting in to the river from the lake. The water rose and fell rapidly. The next day a storm commenced and continued for four days.

On the 29th of July, 1849, we were at Rock Harbor, Isle Royale. The wind was light, and a drizzling rain fell all day. The next day, however, a heavy northwester set in—so heavy, indeed, that the propeller then lying in the

harbor did not venture out. On the opposite side of the lake, at Copper Harbor, (July 29,) the water was observed to fluctuate at intervals, varying from ten to twenty minutes, and rising higher and higher at each return, until the wharf, placed above the range of the highest stage, as was supposed, was overflowed, as well as the road leading to the warehouse. This continued throughout the day. At Eagle river, twenty-five miles distant, the same fluctuations were observed. The wind, which was not heavy, came from off shore, and was therefore opposite to the current from the lake. The next day, as at Rock Harbor, there was a heavy blow from the northwest, the tendency of which would be to accumulate the water on the south shore; but it did not rise as high as on the preceding day, when the wind came from an opposite quarter. These facts show conclusively that these swells, although they precede the winds, do not owe their origin to this source.

This will appear more satisfactorily by consulting a map as to the relative position of the points above mentioned. Isle Royale is about 3d miles distant from the northern and western coast of Lake Superior. Copper Harbor is about 50 miles distant from Rock Harbor, in a south southeast direction. Thus, while these fluctuations were observed at the latter point, the storm had not struck the lake on the Canada side.

Similar occurrences have been noted in other parts of the world. The fluctuations in the Lake of Geneva, which are there called seiches, undoubtedly belong to the same class of phenomena.

The intelligent traveller, Von Tschudi,* thus speaks of. a singular phenomenon which has in later times often occurred at Callao, and which, in 1841, he had an opportunity of observing: "About two o'clock in the morning, the sea flowed from the shore with greater force them in the strongest ebb; the ships farthest out were left dry, which is never the case in ebb-tide. The alarm of the inhabitants was great, when the sea instantly rushed back with increased force. Nothing could withstand its fury. Meanwhile, there was no commotion of the earth, nor any marked change in the temperature."

The great wave frequently observed off Cape Horn and the Cape of Good Hope by mariners may belong to the same class of phenomena.

We have already given Charlevoix's theory to account for these fluctuations. It may be ingenious, but is not even probable. Governor Clinton was disposed to regard them as the result of earthquake movements. If so, a commotion of the land would have been noticed. The facts adduced seem to connect these phenomena with a disturbed state-.of the atmosphere, since they are, for the most part, succeeded by violent gales. Humboldt remarks that the regularity of hourly variations of the magnetic needle and the atmospheric pressure is undisturbed on earthquake days within the tropics. Von Tschudi says, that in seventeen observations which he made during the earthquakes of Lima, with a good Lefevre barometer, he found in fifteen instances, the position of the mercury quite unaltered. On one occasion, shortly before a commotion, he observed it 2.4 lines lower than it had been twenty-lour hours before. Another time he observed, also on the approach of the shock, a remarkable, rising and sinking.

We may regard the earth as surrounded by two oceans—one aerial, the other aqueous. By the laws which regulate two fluids thus relatively situated, a local disturbance in the one would produce a corresponding disturbance in the other. Every rise or fall of one-twentieth of an inch in the mercurial column would be attended with an elevation or depression of the surface of the ocean equal to one inch.† Again, as has been remarked by De la Beche,‡ a sudden impulse given to the particles of water, either by suddenly increased or diminished pressure in the atmosphere, would cause a perpendicular rise or fall, in the manner of a wave, beyond the height or depth strictly due to the mere weight itself. This sudden impulse would give rise to a series of aqueous waves, which would propagate themselves from the centre of disturbance, like the circles which are observed when a stone is cast into the water. These undulations are perceived in the liquid before the gale sets in. It is not to be expected that the oscillations in the barometer, in all instances, will correspond with those of the water; for Mr. Redfield has shown that storms have sometimes been preceded by an unusual pressure of the atmosphere, the barometer standing remarkably high, and hence he has inferred that there existed around the gale an accumulation of air, under a great degree of pressure, forming a margin. It may frequently happen, that while the *effects* are perceived at the place of observation, the *cause* may be far removed.

*Travels in Peru.

†Whewell on Tides.

‡De la Beche, (Survey of Cornwall,) quoting from the manuscripts of Mr. Walker, who has devoted much time to the observation of tides, says: "He has found that changes in the heights of the water's surface, resulting from changes in the pressure of the atmosphere, are often noticed on a good tide-gauge *before* the barometer gives notice of the change. * * * If tide-gauges at important dock-yards show that a sudden change of sea-level has taken place, indicative of suddenly decreased atmospheric weight, before the barometer has given notice of such a change, all that time which elapses between the notices given by the tide-gauge and barometer is so much gained; and those engaged with shipping know the value of even a few moments before the burst of an approaching hurricane."

Many persons who have resided on the borders of the lakes maintain that, aside from the annual variations in the height of their surfaces, there is a more extended one recurring at intervals varying from five to seven years, while others extend the period to fourteen. The greatest height of water heretofore observed is about six feet. The statistics which have been published* in reference to this rise indicate that the variations in the water-level in a series of years are considerable, but that they do not recur at regular intervals. The meteorological registers kept at various stations show that the annual amount of rain which falls over a given

area is extremely variable. Thus, at Port Brady, where the mean of five years' observations is 29.58 inches, the extremes are 36.92 and 22.44.

Again, the season in the basin of Lake Superior may be rainy, while that in the region of the tributaries of the lower lakes may be dry. and *vice versa;* and thus the lower lakes might be on the rise, while their tributaries failed to discharge their usual volume of water. In proof of this diversity of humidity, it may be mentioned, that during the year 1848, an unusual quantity of rain fell in the basin of Lake Superior, and all of its tributaries were swollen. The lake was gradually rising when we left in September, and at that time had attained a point higher than had been observed for three years previously. Do reaching Lake Michigan, in October, we found that that lake began to be sensibly affected by the increased volume of water discharged through the St. Mary's river. On arriving at Cincinnati, the Ohio river was observed to be contracted to less than half its usual volume, so that only the smallest class of boats could navigate its waters.

If meteorological observations were kept at different stations extending through the entire region drained by the great lakes, it would undoubtedly be found that the variations in the water level corresponded with the variable amount of rain over that area. †

A larger portion of .the tributaries of Lake Superior have their origin in a region covered for two-thirds of the year with ice and snow. Late in May the icy fetters are unloosed, and the lake commences rising, and continues to rise until the last of September, when it attains its maximum It then recedes gradually until the streams begin to discharge their floods.

*Vide, the memoir of Governor Clinton before referred to; Michigan Geological Reports; Ohio Geological Reports, 1838.

†The surface of Lake Superior, on the 12th of August, 1849, was 23½ inches higher than in May, 1847.

Snow usually commences falling as early as the middle of October, and the ground is covered before the frost has penetrated to a great depth. The amount of snow during the season has been represented as high as thirty feet; but, in consequence of its evaporation, and its change from a crystalline to a granular form, known as *nevé*, it settles, and the actual depth on the ground rarely exceeds four feet. Trappers, in crossing the inland lakes in midwinter, often break through, so slight and unstable is the covering.

The temperature of the water of Lake Superior during the summer, a fathom or two below the surface, is but a few degrees above the freezing point. The following observations show the temperature of the water at different times in different parts of the lake. In the western portion, the water is colder than in the eastern— the surface flow becoming warmer as it advances towards the outlet. The water in these experiments-was taken from the surface.

	Fahrenheit.	
	Water.	Air.
June 30, 1849.—To the south of Caribou Island -	37°.0	43°.5
July 8, 1849.—In Sand Bay - - -	37°.5	52°.0
July 28, 1849.—Between Keweenaw Point and Isle Royale - - -	39°.5	45°.0
Aug. 13, 1849.—Midway in Keweenaw Bay -	49°.0	

During the severe winters, the surface of the lake becomes congealed. When a gale sets in, the ice is seen to undulate and break, and the water to gush through the fissures, until finally the whole mass is set in motion— the fragments clashing against one another, accompanied by loud reports, like volleys of musketry. Long parallel ridges of ice, fifteen or twenty feet in height, are piled up along the shores. We can readily conceive how masses of rock thus entangled might be carried for considerable distances when the ice becomes detached and floats off, and how a cliff might be scratched and grooved.

The waters of the lake possess great transparency, and a tin cup may be seen to the depth of ten fathoms. Coasting along the shores in a calm sunlight day, and looking over the gunwale of the boat, the voyageur seems to be suspended over the floor of the lake, and every fissure in the rock, and every glittering pebble is revealed with wonderful clearness. The light streaming through the transparent medium tinges every object with a brilliant hue.

The evaporation from the surfaces of the lakes must be immense. The combined area of Lakes Superior, Huron, Michigan, and Erie is, about 87,000 square miles, and of their basins not less than 335,515 square miles.

It has been estimated that the quantity of water passing into the Niagara river at Black Rock is 22,440,000 cubic feet per minute, or about 80⅛ cubic miles per annum.* This is equivalent to fifteen inches perpendicular depth of water spread over the area of the whole country drained. The annual amount of rain which falls within this area is about thirty inches. One-half, therefore, of the water which fails within the basin of the upper St, Lawrence is taken up by evaporation, amounting to 11,800,000,000,000 cubic feet.†

At Saut Ste. Marie, the outlet of Lake Superior, the spectator beholds a river nearly a mile in width, and of sufficient depth to float the largest vessel. In its onward progress, it winds among innumerable islands, and ultimately discharges itself, by several mouths, into Lake Huron. At Fort Gratiot, he sees the same river, under another name, after having revived all of the tributaries of Michigan and Huron, contracted to a width of little more than three hundred yards, but of increased depth, and he finds it difficult to realize that it is the same river which he saw three hundred miles above.

So, too, the voyageur who has coasted around Lake Superior and gauged the streams which pour their

annual floods into the great reservoir, when he stands on the brink of Niagara, and witnesses the fearful plunge of the cataract, is induced to inquire what has become of the superfluous water.

The difference between the temperature of the air and the lake gives rise to a variety of optical illusions, known as mirage. Mountains are seen with inverted cones; headlands project from the shore where none exist; islands, clothed with verdure or girt with cliffs, rise up from the bosom of the lake, remain a while, and disappear. In approaching Keweenaw Point. Mount Houghton is the first object to greet the eye of the mariner. Its dome-shaped summit serves as a landmark to guide him In his course. Once or twice, in peculiar stages of the atmosphere, we have observed its summit inverted in the sky long before the mountain itself was visible.

On the north shore, during the summer months, hardly a day passes without witnessing illusions of this kind. The Paps, two elevated mountains near the entrance of Neepigon bay, would at one time appear like hour-glasses, and at another like craters, belching forth long columns of smoke, which gradually settled around their cones.

Thunder cape assumed shapes equally grotesque: at one time resembling a huge anvil with its handle projecting over the lake, at another it appeared as though traversed from summit to base by an immense fissure.

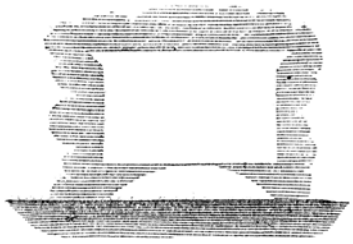
These phenomena are more common on the lakes than on the Atlantic coast, since hardly a day passes during the summer without a more or less striking exhibition of this kind. The amount of refraction, dependent on the state of the atmosphere, is, during the greater part of the summer, extraordinarily variable. The greatest difficulty is experienced in making astronomical observations, from this cause. Observations taken in the afternoon, and generally during the night, are almost invariably worthless. The varying refraction may often be noticed in meridian observations of the sun with the artificial horizon, when the two images will be seen to lap over and then separate from each other a great number of times during the few minutes, while the apparent motion of the sun is almost imperceptible. These variations amount to several minutes of altitude; and, of course, on such occasions, no use can be made of the observations. Observations taken in the morning, when a steady brisk breeze was blowing, and the sky free from clouds, were found to be the only ones on which any dependence could be placed.

*Vide M. Z. Allen's article in Silliman's Journal, January, 1844.

†Dalton found that an evaporating surface of six inches yielded in calm, dry air, at 65° Fahr., 2.62 grains of vapor per minute, and 4.12 a high wind.

The same phenomena of rapidly-varying refraction may often be witnessed at sunset, when the sun, sinking into the lake, undergoes a most striking and rapid variety of changes. At one moment, it is drawn out into a pear-like shape; the next, it takes an elliptical form; and just as it disappears, the upper part of its disk becomes elongated into a ribbon of light, which seems to float for a moment upon the surface-of the water and then disappear.

Fig. 2.



The annexed cut represents the outline of the appearance of the sun as it went down in the waters of Lake Michigan, June 19, 1849.

The cause of these phenomena can readily be found in the ever varying movement of bodies of differently heated air charged with different amounts of moisture. Those who navigate the lake not unfrequently notice that they pass instantaneously from a current of air blowing briskly in one direction into one blowing with equal force from an opposite direction. The lower sails of a vessel are sometimes entirely becalmed, while a brisk breeze fills the upper.

Frosts, of sufficient severity to turn the leaves, usually occur as early as the middle of September. Snow commences falling by the middle of October, and for more than six months the ground is covered with a fleecy mantle. The streams become locked with ice and remain so until May. The ground does not become frozen to a great depth, and, so soon as the snow disappears, vegetation shoots into life, and the air swarms with myriads of insects. During the long days the sun shines with undiminished splendor, and the influence of its direct rays compensates for the low mean temperature. Spring and summer are mingled. The forest becomes clothed with leaves, and its solitude is enlivened by the song of birds and the hum of insects, before all traces of snow have disappeared.

Notwithstanding the proximity of the lake, the thermometer has a range of 120° in the course of the year. Often in midsummer, when, for several days, the winds come from the southwest, the voyageur experiences a suffocating heat—an enervating depression. The perspiration rolls from him even when unemployed and protected from the glare of the sun by the forest's shade. But, fortunately, these suffocating heats are of short continuance.

In the valley of the Ontonagon, on the 11th of June last, the thermometer rose to 96°.* The wind was blowing from the SW., but brought with it no refreshing coolness. A little after midday, a dark cloud, emitting from its edges a pale phosphorescent light, rose from the lake, and advanced against the wind. Its approach was indicated by a loud roaring, and, when it reached our encampment, the trees swayed to and fro, and many were prostrated around us. The air was tilled with flying

leaves and branches. Voyageurs and men instinctively rushed into the river, and remained until the fury of the storm had abated.

*Humboldt remarks that the thermometer nowhere rises higher than 104° F., unless exposed to the influence of bodies which radiate heat. The extraordinary heats of the desert, as indicated by the thermometer, are caused by particles of sand carried through the atmosphere.

Thunder-storms of great violence are not unusual; and the large tracts of prostrate, timber frequently met with in the forests, and known as "windfalls," indicate the path of the tornado.

Sudden gusts of wind spring up on the lake, and hence the oldest voyageurs are most inclined to hug the shore.

Instead of seeking for a solution of these phenomena by a resort to natural causes, they ascribe them, like the Scandinavians of old, to the freaks of a crazy old woman, who is endowed with ubiquity:

"Now here, now there, and everywhere."

Before the middle of September, a change in the elements becomes observable. The light and sportive breezes are succeeded by heavy gales, which sweep over the lake, and render coasting exceedingly hazardous.

Auroras, even in midsummer, are of frequent occurrence, and exhibit a brilliancy and extent rarely observed in lower latitudes. The commonest phenomena are these: A dark cloud, tinged on the upper edge with a pale luminous haze, skirts the northern horizon. From this, streaks of orange and blue-colored light flash up, and often reach a point south of the zenith. They rapidly increase and decrease, giving to the whole hemisphere the appearance of luminous waves, and occasionally forming perfect coronas. They commence shortly after sunset, and continue through the night. The voyageurs regard them as the precursors of storms and gales, and our own observations have confirmed the result. Occasionally broad belts of light are seen spanning the whole arc of the heavens, of sufficient brilliancy to enable one to read.

In the winter these phenomena are much more frequent, and the ground appears tinged with a crimson hue. The aurora indicates a disturbance of the equilibrium in the distribution of terrestrial magnetism, and, according to Dové, may be regarded, not as an externally manifested cause of this disturbance, but rather as a result of telluric activity—manifested on one side by the appearance of light, and on the other by the vibrations of the magnetic needle.*

On one or two occasions we have witnessed the rare and beautiful phenomenon of *parhelia*, or mock suns.

*For a full exposition of these phenomena, consult Humboldt's Kosmos, vol. I.

CHAPTER III.
GEOLOGY OF THE COPPER REGION.

Maps.—Classification of the rocks.—Their composition.—Keweenaw Point.—Range and extent of the trap,—Local details.—District between Portage lake and the Montreal river.—Range and extent.—Metallic contents, and the association of copper.—Porcupine mountains. —Isle Royale.—Its similarity in geological structure to Keweenaw Point.—Range and extent of the trap.—Metallic contents.

That portion of the Lake Superior land district whose geology we purpose to delineate in the following report is represented on the accompanying maps, entitled—

1. A geological map of Keweenaw Point.

2. A geological map of the region between Portage lake and the Montreal river.

3. A geological map of Isle Royale.

These maps comprise the territory known as the *copper region.*

The iron region, though of less extent, but of equal economical value, will form the subject of a subsequent communication.

The rocks which constitute the solid framework, so to speak, of this district, are divisible into two classes, widely different in their origin and composition—the *igneous* and *aqueous*.

Under the first division may be included the several varieties of trap—using this term as a generic one—such as greenstone, granular and amygdaloidal trap, basalt, &c. These rocks appear to have been generated within the bowels of the earth by the action of fire, and in some cases to have been protruded in vast irregular masses, forming conical or dome-shaped mountains; at other times in continuous lines of elevation; while in others they appear to have flowed like lava-currents in sheets over the sands then in the progress of accumulation. The mineral substances which compose these ancient lavas are very various in their nature, but in general it may be said that the predominating rock is one composed of an intimate mixture of labrador, hornblende, and chlorite, though the latter is not an invariable accompaniment.

To the second class, or aqueous formation, may be referred the sandstones, shales, and limestones of this district. They occur in stratified beds, divided into layers, strata, laminæ, &c. The materials appear to have been transported by currents and deposited on the floor of the ocean, where they subsequently became consolidated.

In addition to these, there is another class of rocks which have undoubtedly resulted from the joint operation of igneous and aqueous causes. The materials appear originally to have been ejected through rents and fissures in the crust of the earth to the surface, where

they were subsequently transported and ground up by currents and deposited in stratified beds. This class of rocks is termed by M. Prevost* *pluto-neptunean*; and to this division may be referred the conglomerates and chlorite beds associated with the trap.

*Article "Formation," *Dictionnaire Universel d'Histoire Naturelle*.

The *metamorphic* rocks, or those which were supposed originally to have been deposited by water and subsequently modified by heat, causing them to resemble igneous products, are developed only to a limited extent in the copper region; but in the iron region they are displayed on a scale of vastness, and form the most interesting feature in the physical history of the district.

The mineralogical character of the trappean rocks, being a complex and difficult subject, will be separately described in the chemical part of the report. At present it may, however, be briefly stated that they are in general made up of an intimate mixture of labrador and hornblende, forming a dark-colored homogeneous mass, in which the separate minerals cannot be distinguished by the eye. Chlorite, though not an invariable accompaniment, is often present in a considerable quantity. Magnetic oxide of iron is also a very common ingredient, and sometimes in visible particles, though generally its presence is only betrayed by the action of the rock on the magnetic needle. The variable proportion and nature of the mineral ingredients give rise to a great diversity in the external characters of the mass, which diversity is still further increased by the different circumstances under which different portions of a rock identical in mineral character may have passed from the fluid to the solid state.

The same rock may be found in every shape of transition, from the most compact and homogeneous structure to a light porous mass, filled with cavities, or amygdules, which have often, posterior to the cooling of the rock, been filled with various mineral substances.

For the sake of convenience in describing the local details, and in order to adhere, as much as possible, to the terms already familiarly used by those engaged in mining explorations in this district, we shall include, under the name of trap range, or trappean rocks, all the different varieties of igneous rocks which form the great belt extending from the extremity of Keweenaw Point to the Montreal river, and which also form the greater portion of Isle Royale. When the rock is vesicular in its structure, it is called amygdaloid; when compact, crystalline, or homogeneous, the hornblende predominating, it is called greenstone; when columnar or jointed, as on Isle Royale, it is called basalt. If the homogeneous base contain distinct crystals of feldspar disseminated, it becomes a true porphyry; and the largely crystalline and feldspatic varieties are known as sienitic.

These and many other varieties occur abundantly throughout the district, in belts imposed one upon another. Their position and the changes they have caused in the contiguous detrital rocks will be noticed in describing the detailed geology.

Range and extent.—Commencing at the head of Keweenaw Point, we find the trappean rocks, with the associated conglomerates, emerging to the surface in bold stair-like cliffs, affording many scenes of wild and picturesque beauty. This peculiar physiognomy is characteristic of the whole trap region. Humboldt long ago remarked that each zone had its particular types of animal and vegetable life, but that the inorganic crust of the globe showed itself independent of climatic influences. Everywhere, basalt rises in twin mountains and truncated cones; everywhere porphyritic trap appears in grotesquely arranged masses, and granite in rounded summits.*

The outer belt of trap, occupying the extreme northern portion of Keweenaw Point, (see map,) is less than a mile in width, and preserves a great degree of uniformity throughout its entire course. It forms a segment of a circle, of which the Bohemian mountains may be regarded as the centre. The southern points of Manitou island are dotted with patches of this igneous rock, while the greater portion of the belt has crumbled beneath the action of the lake surf. From the extremity of Keweenaw Point, it extends westerly for about eighteen miles in a curvilinear direction, and passes into the lake at the eastern point of Sand bay. Throughout most of this distance it is protected from the action of the surf by a thick belt of conglomerate, but at several points the water has broken through this sea-wall and excavated spacious harbors in the igneous belt. Copper, Agate, Grand Marais, and Eagle Harbors are included in. this belt, and owe their origin to a common cause.

This belt is composed of the varieties of igneous rock known as amygdaloid and brown granular trap. The amygdaloid is best developed in the upper portion of the belt, where it comes in contact with the conglomerate, presenting a dark scoriaceous mass, full of vesicles, somewhat compressed, and bearing a close resemblance to certain modern volcanic; products. These vesicles are, for the most part, filled with carbonate of lime, chlorite, agates, carnelians, and amethysts, and minerals of the zeolite family. As we penetrate deeper into the belt, the vesicular structure disappears, and the rock passes into a dark brown granular trap, consisting of an intimate union of hornblende and Labrador. This is its general character; and to cite the numerous places where it has been observed, would be to encumber the report with unnecessary detail.

This belt is traversed by veins containing copper and silver, several of which have been mined, but in every instance unsuccessfully. At Eagle Harbor, a company wrought a vein, which, for a time, yielded a rich per centage of copper. Between 5,000 and 6,000 pounds were taken from, the vein within a comparatively limited space; but as the miners sank deeper, the copper disappeared. The range of the vein was limited on the south by the conglomerate, and on the north by the lake.

At the surface it was two feet in width, and filled in with laumonite and native copper. The shaft was commenced about two hundred feet north of the junction of the rocks, and extended to the depth of ninety seven feet. At that depth the vein had contracted to three inches, and was barren of copper. The best mining-ground is undoubtedly beneath the bed of the lake; but to reach it would require a deep shaft, a long gallery, and an. expensive apparatus for ventilation. The company were not disposed to embark in an undertaking, the labor of which was certain, while success was precarious. Several other veins in the northern range were explored by the company, with no better results.

At Hawes's island, near Agate Harbor, a vein was opened by the Cypress River Company, which yielded rich specimens of copper and silver, but, in the downward progress, they disappeared.

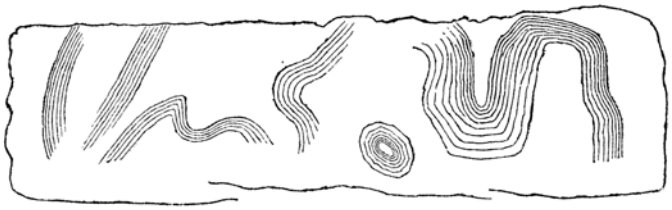
With a single exception, (northwest quarter of section 58, range 30,) we have excluded every tract within this belt from the list of mineral lands, believing that it contains no veins which will be permanently productive.

*Aspects of Nature, vol. II,

To the west of Sand bay about ten miles, and north of the first trappean range, narrow belts of trap have been observed in two places, to wit: on section 28, township 58, range 32; and on sections 1 and 6, between ranges 32 and 33, township 57. The nature of the ground is such that they can be traced but a short distance inland. Whether they are a prolongation of the belt just described, or detached, intercalated masses, it is impossible to determine. The character of the rock is highly amygdaloidal, and chlorite enters largely into its composition. Imperfect indications of veins exist, one of which was explored by the Lake Shore Mining Company yielding little or no copper.

In the more compact varieties, a concretionary structure is sometimes observable. Parallel bands of different colors, a few inches in width, traverse the mass in waving lines, or are arranged in circular forms. This same arrangement is seen more strikingly illustrated in the trap on Hays's Point, near Copper Harbor. The direction and arrangement of these lines is illustrated in

Fig. 3,



the above wood cut. This structure is occasionally found in all igneous rocks, and undoubtedly results from chemical affinity, by which the particles assume a concretionary arrangement.

About a mile south of this trap belt, and separated from it by a deposit of conglomerate and coarse sandstone, which, in places, expands to a thickness of more than 3,000 feet, occurs the northern trap range of Keweenaw Point. It will be seen, by inspecting the map, that these two belts of igneous rocks, in their westerly prolongation, preserve a remarkable parallelism.

This range does not appear to have been the result of one, but of successive overflows, for we not only find the igneous materials arranged in parallel bands, arid exhibiting great diversity in external characters, but we also find numerous intercalations of conglomerate of inconsiderable thickness, but extending for miles in a linear direction—these mixed products being associated in regular beds, having a common bearing and inclination, so that the inexperienced observer is inclined to refer the whole to a common origin. This deception is still further increased by observing lines of pseudo stratification in the trap conforming to those of the associated sedimentary rocks.*

This range starts from the head of Keweenaw Point, below Manitou island, and, sweeping round in a crescent form nearly conforming to the trend of the coast, crosses the western arm of Portage lake, where it seems to lose its distinctive character. Towards the valley of the Little Montreal river, it crops out in bare precipitous cliffs; but the northwestern slope is gentle, the rock rarely emerging to the surface.

*This, pseudo-stratification has been observed by De la Beche in the granite of Cornwall, and is supposed by him to result from a tendency in the materials of a cooling mass to arrange themselves in beds, particularly near the surface.—*Geology of Cornwall*.

The following are the elevations of this range at different points, as approximatively determined by the barometer: On section 13, township 58, range 28, 467 feet. On the line between sections 15 and 16, township 58, range 29, about three miles inland from Grand Marais Harbor, 730 feet. Between the Copper Falls and the Northwestern mines, section 24, township 58, range 31, 630 feet. This range skirts the valley of Eagle river on the west, and rises in overhanging cliffs to the height of two or three hundred feet. The Albion cliff, near the northwest quarter of section 10, township 57, range 32, may be regarded as the culminating point, attaining an altitude, as determined by Mr. Hodge, of 800 feet above the level of Lake Superior. Between the Albion mines and Portage lake, the hills present for the most part a rounded outline, and the underlying rocks are covered over with accumulations of water worn materials.

Interstratified with this belt, throughout its entire range, we observe numerous lenticular masses of conglomerate, which appear to affect the courses of veins, as well as their productiveness. The phenomena exhibited by the passage of a vein through different belts of rock will be described in detail under another head.

Local details.—The trap at the eastern extremity of Keweenaw Point (sections 15 and 22, township 58, range 27) is more compact and crystalline than the northern belt before described, and is traversed by small veins containing native copper. Near the centre of section 22, a band of conglomerate from fifty to one

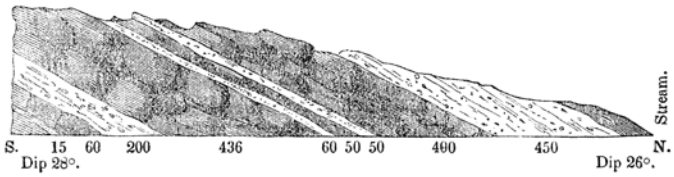
hundred feet in thickness is observed, dipping to the north; but it can be traced only for a short distance inland, in consequence of the drift which there reposes on the rocks. A few yards south of the extremity of the point, and near the north line of section 27, a band of conglomerate is observed, attaining a thickness of sixty feet, bearing N. 70° W., and dipping NE. 16°. The underlying trap differs from that which overlies the detrital rocks, being more amygdaloidal, and offering less adhesion between the particles. This is supposed to be a continuation of the great metalliferous belt, as developed at the Cliff, North American, and Northwest mines.

In this township (58) numerous explorations were made by the Boston and Lake Superior Mining Company; and, although they found native copper at several points, they did not succeed in developing a valuable vein. In the adjoining township west (range 28) and north of the Little Montreal river, four alternations of trap and conglomerate were observed. Near the conglomerate ridge, the trap is low; but, north of the Montreal river, it rises in elevated cliffs, which continue through the township, ranging in an easterly and westerly direction. These cliffs are composed of hornblende, in large acicular crystals, imbedded in a paste of labrador. Near their base is seen a band of conglomerate from twenty to fifty feet in thickness, dipping north at an angle of 40°, which can be traced almost uninterruptedly for a distance of twenty-five miles. At the Cliff and North American mines there is a bed of chlorite rock, corresponding in position to this band. The trappean rocks above and below this belt exhibit great differences in lithological character—the upper being highly crystalline, while the lower are amygdaloidal. This belt, lying below the conglomerate, is abundantly stored with copper; but; being more destructible than the cliffs of overlying greenstone, it is rarely exposed on the surface.

In township 58 the Massachusetts Mining Company opened several veins in the vicinity of the Montreal river, none of which proved productive. The Alliance Company tested to a limited extent a vein on section 8. The Pittsburg and Boston Company also held a location, which they subsequently abandoned.

This ridge extends in an easterly and westerly direction through ranges 29 and 30. In the latter range (township 53, section 15) is situated the Northwest mine. The thin band of conglomerate before described is here exposed on the southern slope of the hill, with greenstone above and amygdaloid and compact trap below. In its passage through the adjoining ranges 36 and 35, (townships 58 and 57,) the trap chain curves rapidly to the southwest, and is prolonged in that direction. The following section represents the relative position of the bedded trap and sandstone on the northern slope of the ridge (section 12) at the Copper Falls mine:

Fig. 4.



The first rock seen in the stream is amygdaloid, resting on sandstone, which bears north 78° west, and dips 26° to the north. The thickness of this trap belt could not be determined, the northern portion of it being concealed by drift. The sandstone is composed of coarse materials, and. contains, in places, rounded pebbles. Near the line of junction it exhibits the effects of metamorphism, being dark-colored and firmly cemented. Receding from the line, we find it variegated in color and less compact. To this succeeds another belt of trap, conformable in bearing and inclinaton, below which is another belt of sandstone. Thus there are no less than five repetitions of sandstone and trap within the distance of 2,000 feet. As a general observation, the *upper* portions of these sandstone belts are much more changed by heat than the lower—an important fact, which will be considered in discussing the origin of these rocks and their mode of formation.

The sandstone, where thus exposed, presents a compact texture, breaks with a ringing sound and a conchoidal fracture, and exhibits many of the external characters of jasper. It is traversed by numerous divisional planes, which are quite as distinct as the original lines of bedding. The workings of the Copper Falls Company are in the 436-foot belt.

Between the mouth of Eagle river and the Phœnix Company's works, eleven of these belts, thus intercalated, are noticed within the distance of a mile. Beyond the Albion range these belts cannot be traced, the rocks being no longer exposed in bare ledges, but covered beneath accumulations of sand, gravel, and clay.

The trap beds thus intercalated are amygdaloidal or granular, but on their upper portions often exhibit a brecciated appearance. They afford numerous examples of veins yielding native copper and silver, but do not expand to a sufficient width to allow extended subterranean workings.

The upper portion of the crystalline belt described as occurring in range 28, township 58, and thence traced through the intervening townships west, is exposed a few rods south of the upper shaft at the Phœnix mine. Here the feldspar predominates over the hornblende, giving the rock a light color. The vein is observed to be disturbed and otherwise affected as it approaches this mass.

The Albion range is capped with this rock, which appears in abrupt precipices two or three hundred feet in height. At the Cliff mine, the upper portion of the precipice is composed of a dark crystalline greenstone—the hornblende largely predominating, which exhibits a

mottled or varioloid appearance. At the Albion mine the feldspar again predominates, and the rock becomes in some degree porphyritic. Beneath this is a bed of chlorite rock of a slaty structure, varying in thickness from six to ten feet, below which we meet with a belt of amygdaloid and granular trap. Proceeding along the trend of the Albion range in a southwesterly direction, the amygdaloid is found to dip beneath the surface. At the Cliff mine it is struck near the base of the precipice; but at the Albion mine, three miles distant, it is reached at the depth of ninety-seven feet.

This belt, the position and range of which we have endeavored to delineate, is the most metalliferous of any on Keweenaw Point. Throughout its entire extent, it seems to be characterized by well-defined veins. In it are situated the Cliff, North American, Albion, Northwest, and Northwestern mines; and it is reasonable to suppose that others equally valuable will be developed along the line of its outcrop.

Southern trap range.—Returning to the head of Keweenaw Point, we find another range of trap, forming the southern boundary of the valley of the Little Montreal river, arid stretching westerly in a line nearly parallel with the northern chain. This is known as the Bohemian range, and differs from the northern both in lithological character and in the mode of its occurrence. While the former, before described, is composed of numerous beds of trap, in the main of the amygdaloid and granular varieties, interstratified with the detrital rocks, the southern range consists of a vast crystalline mass, forming an anticlinal axis, flanked on the north by the bedded trap and conglomerate, and on the south by conglomerate and sandstone.

The contour of the imbedded trap is also very different from that of the bedded trap. We nowhere recognise the stair like structure in the hills; they are either dome-shaped or rounded.

The protrusion of so vast a mass of heated matter has changed in a marked degree the associated sedimentary rocks, causing them to resemble igneous products. Thus, on section 30, township 58, range 27, by the lake shore, is seen a metamorphosed sandstone resembling jasper. Its general bearing is east and west. In places it assumes a vesicular appearance, while other portions are brecciated, and take into their composition chlorite and feldspar. In some hard specimens the lilies of stratification can be recognised. The mass is about 100 feet thick; and surmounted by alternating bands of porphyry and a chlorite rock known as rotten trap, which may be regarded as a volcanic ash. These veins attain a thickness of only a few feet. Proceeding along the southern coast of Keweenaw Point in a westerly direction, at the old fish station (section 35) we again observe this metamorphosed rock forming one of the jutting points of the bay; but here it assumes a different character, as though it had been subjected to a heat more intense and longer continued. All traces of stratification have disappeared, and the rock has become transformed into a red, compact jasper, breaking with a conchoidal fracture, and traversed by numerous divisional planes. Where it comes in contact with the trap below it presents a homogeneous texture. All traces of its mechanical origin are obliterated, and it is difficult to determine where the igneous rock ceases and the aqueous begins.

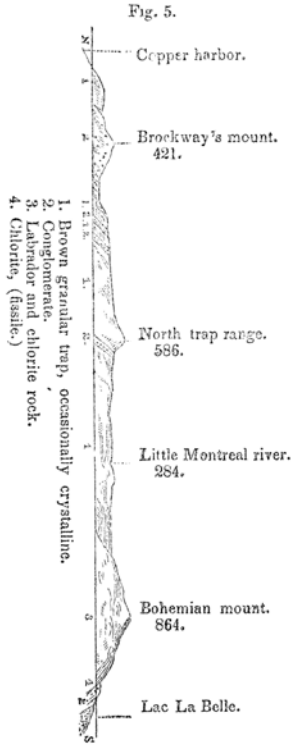
In section 30, township 58, range 27, west of the Little Montreal river, it is seen again on the coast. The Bare Hills here approach the coast and rise up in overhanging cliffs to the height of 80 feet, and jasper appears to be the prevailing rock. From this point it can be traced inland in a westerly direction, through sections 29 and 30, in the same township and range, to the west line of section 24, township 58, range 29, expanding to a width of about half a mile. The west line of this section passes over Mt. Houghton, an isolated and dome-shaped mountain, rising to the height of 884 feet above the lake, and forming the culminating point in this portion of the region. Its summit is jasper for the distance of 150 feet, and it is difficult to trace any well-characterized lines of stratification in the mass. On the southern flank the mass apparently dips to the SSW. On the northern slope a perpendicular ledge, 20 feet in height, is observed, dipping slightly to the east; to the northeast two low ridges of jasper are seen bearing nearly east and west, and connecting with the Bare Hills by the lake shore. The rock is extremely fissile—so much so, that it is difficult to procure good specimens. In tracing it west, it gradually passes into a compact trap, with here and there an almond-shaped cavity, filled with quartz or calc-spar.

This rock we suppose originally to have been sandstone, and the peculiarities which we have described to have resulted from contact with the mass of trap beneath.

Unsuccessful attempts at mining near the summit of this mountain were made by the Alliance Company.

Near Lac la Belle the Bohemian range attains the height of 864 feet; at its base, arid between the trappean and detrital rocks, is a belt of chlorite in foliated masses which expands to about 150 feet in thickness. The occurrence of a bed or mass of this mineral between trap and sandstone is not unfrequently observed in this district. The lower portion of the elevation is here made op of a peculiar rock composed of chlorite and labrador in nearly equal proportions. These two minerals are each in a distinctly crystalline condition, and the feldspathic portion is of a light-reddish color. The mass is filled irregularly with crystals of magnetic iron ore, which occasionally form a large portion of the rock. Particles of copper pyrites are also scattered through it. This variety of rock seems to pass gradually into the dark-colored, fine grained greenstone which occurs on the summit of the mountain.

Fig. 5.



The following section, from Copper Harbor to Lac la Belle, not only the contours of the country, but the relative association of the detrital rocks and the bedded and imbedded trap:

The Bohemian range, as before remarked, forms the line of upheaval of the bedded trap and conglomerate on the north, and the conglomerate and sandstone on the south. The conglomerate, north of the axis of elevation, rarely attains a greater inclination than 45°; but on the southern slope, the sandstone is observed dipping at an angle of 78°. This is beautifully exhibited by the lake shore, on section 36, township 58, range 29. The sandstone is seen in the bottom of the bay, composed of alternating bands of white and red, sweeping round in curves, conformable to the course of the trappean rocks. As we recede a few miles to the south, the strata are observed to be nearly horizontal. In the two adjoining townships west, this range preserves its distinctive character; but beyond, it sinks down into sloping hills two or three hundred feet in height. It exhibits some lithological changes in its course: thus, at the Suffolk mine, now abandoned, (section 16, township 57, range 31,) the rock becomes beautifully porphyritic—crystals of red labrador are scattered through a dark feldspathic base, with sulphuret of copper disseminated in irregular masses.

This range, like the northern one, is traversed by veins for the most part at right angles to the direction of the formation; but, unlike the veins of the northern range, they yield the *sulphurets* of copper, instead of native copper. The only mines now wrought are the Bohemian and Lac la Belle, which will be particularly described under another head. Numerous explorations have been made along the southern boundary of the trap, but in no instance successfully. The abandoned mines are indicated by an appropriate symbol on the accompanying map.

The fissile chlorite rock described as occurring at the base of the Bohemian mountain is found to continue almost uninterruptedly to Portage lake, and always preserving the same relation to the trap and sandstone. The prevailing color is green, but in places it acquires a reddish tinge. The trap, however, in the lower part of township 57, range 33, assimilates more to that of the northern range. At the Forsyth Company's works, (section 33,) a band of greenstone is observed forming the crown of the hill, with amygdaloid resting beneath. In the adjoining township south, the trap is seen to occupy low parallel ridges, and is exposed in the beds of the water-courses. Much of it is amygdaloidal, intermixed with the greenish and reddish fissile rock before described. Indications of copper exist, but the veins are not well defined.

In the southwest quarter of section 8, the Trap Rock Company perforated the rock to the depth of seventy feet, then drifted sixty-six feet from the vein for the purpose of discovery. The veinstone here consisted of small strings of quartz, calc-spar, and chlorite, arranged in parallel layers, to the width often inches, with some copper disseminated; but the indications were not sufficiently encouraging to induce them to continue the work. This vein ranges and dips with the formation—its course being-north 50° east; inclination to the northwest 60°.

On the southeast quarter of section 19, township 56, range 32, are the abandoned works of the New York and Michigan Company. Their exploitations were prosecuted on the left bank of a small stream, near the junction of the trap and sandstone. The trap here consists of the reddish and greenish chlorite rock, with imbedded amygdaloid. The surface exhibits few indications of a vein; but, according to the report of Messrs. Grout & Douglass, who explored this location, native copper was found in the small veins and adjoining fissures. A drift was extended 45 feet into the rock; a shaft was also sunk on the opposite bank to the depth of 18 feet, intersecting a belt of the green rock, according to the above authority, highly charged with copper. Although the workmen met with much to encourage, they did not succeed in developing a valuable vein.

On one of the affluents of Torch river, (section 36, township 36, range 33,) the junction of the trap is beautifully displayed. The stream is precipitated over a wall of trap 80 feet in height, and thence winds its way through a deep gorge which it has excavated in the sandstone. The conglomerate differs from the lenticular bands described as occurring with the bedded, trap, consisting of arenaceous particles loosely aggregated, and containing, near the base, quartzose pebbles. Patches of green and red ochrey clay occur in different parts of the mass, in a concretionary form.

The red and green chlorite rock, fissile, but not stratified, enveloping masses of amygdaloid, is seen on the left

bank of the stream, traversed by seams of quartz and calc-spar, underlying to the NW. 50°. Above this the rock is greenstone, presenting a wall-like appearance, and rising in overhanging cliffs.

The precipice was perforated with a gallery, where the quartz seams are observed near its base, to the distance of one hundred feet. Several seams were crossed in the progress of the work which yielded native copper, but nowhere did the vein, concentrate with sufficient power and richness to warrant the expenditure of much capital. This work was prosecuted by the Douglass Hough ton Mining Company, under the direction of Messrs. Grout & Douglass, and their report to the company contains a detailed account of their explorations and the character of the rocks.

The trap in this vicinity has not that firmness and liveliness of color which belong to the truly metalliferous belts. Evidences of copper exist in the shape of small strings and leaders, but they nowhere concentrate arid form what miners call a "champion lode."

The Quincy mine, (section 26, township 55, range 34,) near the west arm of Portage lake, affords as good a prospect for mining enterprise as any which we have observed in this vicinity, although this cannot be regarded as among the best mining-ground.

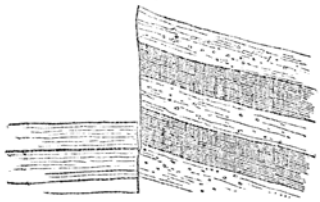
The rock here consists of a dark-brown chlorite trap, with beds of amygdaloid. Between the junction of these rocks native copper is observed in sheets, and disseminated in a vein-stone of calc-spar and chlorite.

The veins, or rather the main lodes, range and dip with the formation, and send off branches at nearly right angles.

The culminating point of the trap here does not exceed 400 feet. The northern flank is covered with detritus, and the rock at rare intervals emerges to the surface. Hence there is really a small portion of the trap range in this vicinity which is adapted to mining.

In the region of Portage lake,, the shock by which the bedded trap and conglomerate were elevated does not appear to have been attended with the protrusion of vast crystalline masses, forming a long range, like the Bohemian mountains, or rounded groups, as in the vicinity of the Ontonagon, but simply to have caused a vertical dislocation, lifting up the beds on one side of the fissure, while the corresponding beds on the opposite side remained comparatively undisturbed. There can be no doubt that there existed a deeply-seated and powerful fissure, extending from the head of Keweenaw Point to the western limits of the district, along the line of which the volcanic forces were, at different times, powerfully exerted—similar in character to those in Guatemala, Peru, and Java—the seats of modern volcanic action.

Fig. 6.



The only instance observed in this part of the district, of trap occurring remote from the line of the fissure is in the northest corner of township 49, range 36, fourteen miles southwest of the head of Keweenaw bay. It is known as Silver mountain (*lueus a non lucendo*,) which rises up isolated and dome-shaped to the height of a thousand feet, and occupies an area equal to three sections. The surrounding plain is covered with deep deposites of clay, resting on sandstone, in nearly horizontal strata. The rock on the summit of the mountain consists of labrador and hornblende, the former largely predominating, and arranged in distinct crystals, with nodules of quartz and chalcedony scattered through the mass. The flanks of the mountain exhibit nearly the same lithological characters. Mining operations were prosecuted there a few years since by the National Company. The hill was perforated by a gallery to the distance of one hundred feet, along the course of a fissure, dipping 63° to the northwest. The attle which lay about the opening was minutely examined, but we failed to detect any traces of copper; nor did the appearance of the wall-rock or the fissure afford any well-founded hopes of the presence of metalliferous deposites. The rock at the entrance of the adit appears to have been broken by the elevatory movement, or successive movements, to which the mass had been subjected; for we found the enclosing walls, ground and polished. In other places rounded fragments of the wall-rock were included in the fissure. Near the mouth of the adit the rock was compact, but, on penetrating further, it became highly crystalline. Scoriæ and amygdaloidal patches were observed in the fissure, as though they had been injected after the upheaval of the mass. Near the summit a dike is seen pursuing a zig-zag direction.

Boulders of granite a foot in diameter and fragments of sandstone are strewn over the summits. Deep grooves and scratches, bearing north 20° east, are seen in this firm and crystalline rock.

Although this is the only instance observed of the protrusion of the igneous rocks through the sedimentary strata in this vicinity, yet evidences of volcanic disturbance exist: and we have reason to believe that eruptive masses have approached near the surface, without breaking through the exterior crust.

Thus, about one-half of a mile from the southern boundary of township 50, a conical knob of sandstone, having a quaquaversal dip, is observed, the strata being much fractured and disturbed. These explorations were conducted by Mr. Hill.

RANGE OF THE TRAP BETWEEN PORTAGE LAKE AND THE MONTREAL RIVER.

External characters.—Between Portage lake and the Fire-Steel river, the trappean rocks are less distinctly marked than on Keweenaw Point. They appear in rounded groups, rather than in parallel chains; but beyond this point they again rise in bold cliffs, which attain an elevation of nearly fourteen hundred feet near Agogebic lake, when they again sink, down into a nearly level plain, with an occasional isolated knob. This is their character between the last-mentioned point and the Montreal river. The Porcupine mountains form a lateral branch of the main trap range, and constitute nearly the highest points in the district. The trappean rocks are extremely variable in their lithological character, and among them the following varieties may be recognised:

1. *Compact trap*—varying in color and. texture, and occasionally taking into its composition a large proportion of chlorite and a greenish magnesian mineral. Some varieties are exceedingly fine-grained and close in their texture, so that they break, almost with a conchoidal fracture; others contain a very large percentage of magnetic oxide of iron, and, if the block have an angular, prismatic form, and remain for some time on the surface, it acquires magnetic polarity. To the presence of so large a proportion of iron is undoubtedly due the irregular variation of the needle so well known to the linear surveyors in the districts underlaid by this class of rocks. The fluctuations of the needle often indicate the presence of the trappean rocks where they are effectually concealed by a thick covering of detritus and soil.

2. *Amygdaloid*.—This variety is found irregularly scattered through the trap, but by no means so abundantly as west of the Ontonagon river. The base of the amygdaloidal trap is generally a fine-grained, homogeneous, dark-colored mixture of hornblende and labrador, with numerous amygdules—some of which are an inch in their longitudinal direction—filled with different mineral substances. Between the Algonquin location and Agegebic lake, epidote frequently accompanies the amygdaloidal trap; west of the last-named place, it resembles more nearly the trap of Keweenaw Point, and is associated with large quantities of the zeolites. Where epidote fills the cavities of the trap, it presents a radiated, crystallized texture, and specimens of great beauty are frequently obtained. Generally the vesicles of the epidote are occupied by quartz, often radiated. The quartz is frequently colored green by the presence of epidote, and in such cases affords beautiful cabinet specimens.

The zeolitic minerals often form so large a portion of the rock that it disintegrates and falls to pieces after a short exposure. At the Atlas Mining Company's location, (section 18, township 50, range 44,) now abandoned, they are so abundant that they are found not only in all of the vesicles of the trap, but are distributed through it in large vein-like sheets.

3. *Porphyritic trap*.—The base of this rock consists of fine-grained trap, through which are diffused long and distinct crystals of feldspar, which, being white, standout against the dark base in bold relief. This variety is found in loose blocks south of the trap range; but it has not been observed in place in this portion of the district.

4. *Trap breccia*.—This is a mixture of amygdaloidal trap and quartzose fragments resembling altered sandstone, and seems to have been the product of the interfusion of the two rocks; it is seen at the Cushman location, near the forks of the Ontonagon, (section 36, township 50, range 40,) and also a rock somewhat similar in character is observed at the United States Company's location, a mile or two west.

5. *Epidote trap*.—This variety occurs at many points, especially in the vicinity of the Ontonagon river, occupying a space of several miles in length. The compact trap often passes gradually into it, the epidote replacing the hornblende. The seams of quartz and calc-spar containing copper are almost always accompanied by epidote, which graduates on either side into compact trap.

The varieties of epidote rocks are as numerous as those of the greenstone trap. Both, in fact, occur together over a considerable portion of the district; and though the proper trap is by far the predominating rock, yet there are sections where the epidote forms almost mountain masses. The epidote, however, is rarely pure, but generally mixed with quartz, forming nodules of considerable size. Where the former occurs in seams, or veins, it is much more pure, and possesses a crystalline structure, though distinct crystals of this mineral are of rare occurrence. Like the proper trap, it often becomes amygdaloidal, the amygdules being filled with quartz and calc-spar. On the United States location the trap and epidote are seen in alternating hands, the cavities of the former being filled with epidote and quartz, and those of the latter with quartz and calc-spar.

6. *Compact quartz, or jasper*.—This rock occurs abundantly in mountain masses, the highest summits of the Porcupine mountains being composed of it. It varies in structure considerably at different points. The greater part of it, however, is a homogeneous compact jasper of a deep, brick-red color, sometimes traversed by thin seams lined with crystals of quartz. The jasper is occasionally divided by fine lines or bands, waved or contorted, so as to form an imperfect ribbon jasper, but at other points particles of white quartz are mingled with the red jaspery mass. The compact variety of quartz rock sometimes shows a gradual passage into quartzose porphyry, with occasional imbedded crystals of feldspar.

The quartzose porphyry occurs in very large masses, forming the highest points of the trap range in townships 49 and 50, range 42, on the head-waters of Iron river. It is of a brick-red color, and contains small crystals of white feldspar, not generally exceeding an eighth of an inch in length. Almost in variably 5 fine rounded particles of vitreous quarts are found distributed with the

feldspar through the jarpery base. It forms an eruptive mass, and often Includes fragments of the pre-existing igneous and sedimentary rocks. This porphyry has generally a trappean structure, breaking by natural joints into blocks more or less prismatic.

A singular nondescript rock occurs in a low ledge which crops out on section 33, township 49. range 43. It has a feldspathic base of a light reddish color, through which irregular crystals of red feldspar and small rounded particles of quartz are discernible, intermixed with a greenish mineral, which appears to be epidote. It differs entirely in external characters from any rock found elsewhere in the district.

Range and extent—associated metals.—The trappean range between Portage lake and the Ontonagon river divides the country into two parts—the portion lying on the north being drained by streams which flow at nearly right angles to the formation, while in that portion lying south the streams flow nearly parallel with it. The trap range crosses Portage lake In township 55, ranges 33 and 34—its width being about three miles—and continues in a southwest course nearly parallel with the lake. In township 52, range 36, it contracts to less than a mile in width. Between this point and Portage lake, trap is seen in the beds of the water-courses, and along the water-shed line. Low rounded hills occur, with few exposures of the rock. Within this distance there is no valuable mining-ground, and only one attempt at exploration has been made. The Old Settlers' Company explored a vein, or seam, on section 6, township 52, range 35, the course of which is north 65° east, parallel with the course of the trap. This seam in no place exceeds four inches in width, and is filled with quartz and epidote, with particles of native copper disseminated. The drift was extended for 30 feet. On section 36, township 53; range 36, a shaft was sunk upon a seam of similar character; but the nature of the rock gave little assurance of a valuable vein.

West of township 52, range 33y the trap again expands, occasionally emerging in bold precipitous cliffs. Between this point and the Ontonagon river the rock is in many places metalliferous, and affords good mining-ground. It does not range in continuous chains, but appears in rounded groups or isolated knobs.

At the Algonquin mine (section 36, township 52, range 35) the trap is rather compact, and much mixed with epidote. The ridge here bears northeast, and the escarpment is to the northwest—forming an exception to the general rule found to prevail in this region. At the Douglass Houghton mine, four miles southwest, the trap appears in numerous knobs and short broken ridges, and affords good mining-ground. Masses of veinstone, consisting of quartz colored rose-red by the sub-oxide of copper, are found in the streams, indicating the proximity of veins. On section 15, township 51, range 37, this company have explored an east-and-west-vein which promises to yield a profitable return. The rock is a dark-colored, compact trap, occasionally amygdaloidal, traversed by numerous joints, the intervening spaces of variable width, being occupied by quartz and calc-spar. A detailed description of the works will be found under the head of *Mines*.

On the neighboring section, 21, the New York and Michigan Company have made merely surface explorations. There are here two well-defined and abrupt ranges of trap crossing the line between sections 16 and 21, in which several veins of metallic copper and blue carbonate of copper were discovered by Messrs. Grout and Douglass, who explored the location. We found the same appearances here as at numerous other points in the trap range in this vicinity, to wit: epidote occurring massive and intermixed with the trap rock, and containing a small amount of copper. Nothing, however, was found worthy of particular notice. The ridges of trap are elevated about a hundred feet above the general level of the country, while the intervening ground is low and swampy.

About 10 rods southwest of the cabin there is a trap knob which rises to the height of 660 feet—the most elevated point in the immediate vicinity. On the line between 29 and 30 the ground was found to be 633 feet. The trap here is amygdaloidal, with few indications of copper.

In the adjoining township west (township 51, range 38) the trap rises in broken ridges to the height of 150 feet above the surrounding country, presenting mural faces to the south. It consists for the most part of hard, crystalline greenstone, and is traversed by numerous contemporaneous fissures, which are filled with quartz and calc-spar, and contain copper, disseminated, and in masses weighing 15 and 20 pounds. We saw in the northern portion of the belt no well-defined veins; and, altogether, the character of the rock is unfavorable for mining.

The epidote arid quartz are occasionally observed in beds, associated with native copper, having a course and dip corresponding with the adjacent stratified rocks.

The Adventurers' Mining Company and the Ridge Mining Company are located in this township—the former on the southeast quarter of section 35; the latter on the southwest quarter of the same section.

In the southwest quarter of section 25 a vein was observed in a ridge which extends across that quarter section, bearing north 55° east, and dipping to the northwest 45°. The veinstone was prehnite and calc-spar, and contained traces of native copper. The foreign matter would not exceed one foot in width, but the brecciated rock occupied three feet.

The Aztec Company are also working a small force in the southeast quarter of section 25, in this township. In the southeastern portion of this township the rock appears more favorable for metals, but the explorations have not been carried sufficiently far to develop the true character of the veins.

The trap range in the adjoining township southwest is highly metalliferous—as much so as any in this portion of the district.

Township 50*, range* 39.—As this is an interesting township in regard to its topographical features, and one in which perhaps more mining and exploring have been done than in any other, we will give a somewhat general description of its geology and topography before entering into a particular description of the several explorations and attempts at mining which have been made. The Ontonagon river runs diagonally across the township in a winding course, separating it into two unequal portions. The three main branches of the stream, called respectively the East, West, and Middle forks, unite in sections 27 and 28, and form a broad river, which, however, is much broken by rapids, and can only be ascended by boats forced up against the current by setting poles. The banks of the liver are generally of red clay, sometimes rising one hundred feet above the stream, and worn into precipitous ravines, commonly called “hogbacks," which succeed each other many times in the course of a mile. To travel over them is a task at once laborious and vexatious. The trap range enters the township at the northeast corner, and pursues nearly a northeast and southwest direction diagonally through it. On the east and west line of section 12, there are two distinct ridges: the northernmost and highest is 736 feet above the lake, at the point of intersection. These ridges continue tolerably distinct and parallel in direction nearly to the Ontonagon, when they gradually break off; and where the river cuts through the range no rock is seen in place, but high clay banks hem in the channel. The terminating knobs of these ridges are conspicuous objects from a distance, and are known as the "Three Brothers." The North and Middle Brothers are the proper terminations of the two parallel ridges; but the South Brother is a spur of the southern ridge. The height of the Middle Brother above the lake is 758 feet; the other knobs and ridges in the township are from 650 to 670 feet.

Prom the summit of the northern ridge the ground verges very gradually to the lake, there being no other breaks than ravines worn by running water. South of the trap range there is a beautiful level plateau of land, finely timbered with maple and hemlock; then succeeds a broken and uneven country, intersected by numerous gullies. In the beds of the streams sandstone may be seen in place occasionally, though they are mostly excavated in red clay. The current is generally sluggish. The west branch of the Ontonagon flows along the line of junction between the sandstone on the south and the trap on the north; and it was on the left bank of this stream, near the water's edge, in section 31, of this township, that the famous "copper rock," now at Washington, was found. To facilitate its removal, a road was constructed to the main branch of the river on section 20, which is known as the "Copper-rock road."

The trap is flanked on the north by a belt of conglomerate which bears west-southwest, and occupies a width of one-fourth of a mile. Numerous alternating bands of igneous and aqueous rocks are observed in this township, or rather in the northern portion of it.

The trap ranges differ somewhat in lithological character. The northern range, as exposed on section 10, is somewhat porphyritic. Between this and the second range there is a belt of sandstone 100 feet in thickness, which is well exposed on section 16.

The middle range is capped with greenstone, while its base consists of a granular trap, with occasional amygdules dispersed through, it, composed of hornblende, feldspar, and chlorite—forming the most metalliferous belt in the region. At the base of this belt a thin band of conglomerate is observed about 10 feet in thickness, dipping north 52°. Between the middle and southern ranges there is probably another band of conglomerate concealed by the soil. The southern range is composed of a dark brown trap, more compact than the former, but likewise metalliferous.

The "South Brother" is somewhat isolated, and may be regarded the most recent in geological age, since the sandstone dips from it on the south, and the bedded trap and conglomerate dip from it on the north.

The principal workings in this township, east of the river, have been prosecuted on sections 15, 16, 21, and 22. The Minnesota Company, on section 16, have a valuable mine, a detailed description of which will be given under the appropriate head.

The Ontonagon Mining Company sank a shaft on section 22 to the depth of 40 feet; which afforded indications of little value. The rock brought to light consisted of a mingled mass of epidote and trap, traversed by seams of calc spar and quartz, with traces of native copper. Associated with it were particles of oxide of iron, having a metallic lustre, which were mistaken for gray sulphuret of copper.

Another shaft was commenced near the northwest quarter of section 11, but soon abandoned.

The principal shaft sunk by the company was on section 16, near its eastern boundary, and was carried to the depth of 60 feet, through trap which afforded no evidence of a vein.

On the west side of the river, explorations were made on the northeast quarter of section 19, under the direction of Mr. Randolph. The hill was perforated to the distance of 30 feet along the course of a supposed vein, when he found it cut off, as the miners termed it, by a wall of hard, compact trap. Near the seam, and against it, the rock is amygdaloidal, the cavities of which are filled with calc spar, epidote and quartz. In the space of six or eight feet from the seam, the rock graduates into a hard, compact trap, and every trace of a vein is obliterated. The quantity of copper found at this locality was exceedingly small, though some specimens yielded as high as 15 or 20 per cent., and was finely interspersed through the rock.

The Forest Mining Company are exploring some veins west of the river, with very flattering prospects, a description of which will be found under the head of *Mines*.

The mining attempts on section 31, by the Ontonagon Company, will be alluded to in connexion with their operations on the adjoining section in range 40.

In addition to these explorations, numerous shafts have been sunk and adits driven into the clay banks which border the river, by sanguine adventurers in search of mineral wealth. Near the spot where the copper rock was found, numerous attempts of this kind were made. The true sources from which the loose masses of copper have been derived are now fully understood, and fruitless explorations of this kind have long since been abandoned.

Township 50*, range* 40.—The trappean rocks west of the Ontonagon pursue a course which varies but a few degrees south of west. They here expand to a width of little more than four miles, and crop out north of the west branch in bold, overhanging cliffs. About one-third of the northern portion of this township is occupied by the detrital rocks; while the middle, occupied by the igneous rocks, is low, and affords no valuable mining ground. In the southern portion, numerous explorations have been made by the United States and Ontonagon Companies. Those of the latter have been principally confined to section 36. Here a vein-like mass of epidote can be traced from the bottom to the top of a hill, and for a considerable distance along the course of the formation, which bears north 76° east. This mass is nearly vertical, and is one of the largest and best defined which we have seen. It has no perceptible walls, and on either side it may be seen graduating into the trap. A shaft has been sunk about half-way down the hill, and a drift extended to intersect it below. Other openings have been made at various points. Although some masses of native copper weighing fifty pounds were extracted, yet the results, on the whole, could not be deemed satisfactory, for the copper is diffused too sparingly to render the workings profitable. This company also commenced explorations on section 31 in the adjoining township east. A vein-like mass of similar character, bearing nearly east and west, and dipping northwardly, was observed near the base of a cliff, into which a level was driven, without affording much encouragement to continue the work.

The United States Mining Company were located on sections 34 and 35. A superficial examination was made at the base of a trap cliff perhaps one hundred feet in height, where the rock consisted of trap mingled with epidote and quartz, presenting a singular brecciated appearance. No copper was found. Beds of epidote may be seen in this ridge, having an approximate bearing, east and west, in which traces of copper exist, but nowhere has it been observed in sufficient abundance to justify mining operations.

On section 35, is a high cliff made up of irregular alternating bands of amygdaloidal trap and amygdaloidal epidote. Surface explorations have only been made here; in fact, there is nothing to warrant extended mining.

Township 49*, range* 40,—The trappean rocks occur only in the extreme northern portion of this township. They rise in isolated knobs and broken ridges, north of the west branch of the Ontonagon, to the height of three hundred and even four hundred feet. Mining operations are for the most part restricted to the upper portions of the bluffs, so that, if systematically pursued, drainage can be effected with ease by means of adits.

The Ohio Trap Rock Company are located on section 5, but most of their explorations have been made on section 12 in the adjoining township west.

Township 49*, range* 41.—The geological features of this township do not differ essentially from that last described. Bold cliffs border the river on the north, through which are distributed, vein-like masses of epidote containing copper. The cliffs extend through the township, not continuously, but in broken ridges, and form the principal mining ground. The trap continues northward about five miles, occupying about one half of township 50, but rarely emerges to the surface, and affords few facilities for mining.

Sections 17, 18, and 19, in the western limits of the township, were respectively occupied by the Hope, Ural, and Astor Companies. A bluff, occasionlly broken through by ravines, rises to the height of three hundred or four hundred feet above the west branch of the Ontonagon river, in which masses of epidote and quartz, containing considerable copper, are arranged somewhat in the form of veins. In places they were observed to expand to the width of five or six feet, and afterwards contract to a mere seam, and sometimes run out altogether, or re-appear at a higher level in the cliff. There were no well-defined walls observed, and frequently the epidote was seen to pass imperceptibly into compact trap.

These tracts are now abandoned; but if these deposites are found productive after more extended exploitations, mining operations will undoubtedly be resumed at this point.

The Ohio Trap Rock Company have performed much work in a bluff of a similar character on section 12, and at one time their prospects were regarded as highly flattering.

Dr. Gibbs visited this tract in 1848, and from his notes we extract the following information:

"The general character of the rock is a compact trap, containing much epidote mineral, with quartz and calcareous spar. The epidote generally assumes the form of veins, intersecting the trap in different directions, but perhaps chiefly north and south or east and west. The copper is found principally in those veins which have an easterly and westerly direction. In one of these, which dips about 35° to the north, two shafts have been sunk, one of which was 60 and the other 40 feet in depth

at the time of our visit, and large quantities of epidote mineral, with quartz and spar, had been raised. The epidote frequently is rich in metallic copper, though as yet it has not been found in large masses. The copper is also disseminated, though sparingly, through the quartz, and affords specimens resembling those from the Cliff mine. The epidote is often beautifully radiated, and, when mixed with the white quartz and bright metallic copper, affords singular and beautiful specimens. At the bottom of the hill, a drift is in progress to meet the two shafts. The hill is about 130 feet in height, and the distance to be driven is about 300 feet, following the apparent course of the vein. Other openings have been made on the location and in this hill. They all present the same general character—namely, a vein-like seam of epidote, containing seams of quartz and calcareous spar, with particles of metallic copper. The fragments of epidote are often covered with a coating of carbonate of copper, evidently derived by decomposition from the metallic copper. Sometimes the decomposed epidote and earthy matter form seams in the rock, which are regarded by the miners as a rich ore. On the whole, the quantity of copper obtained at the locality is sufficient to justify further exploration in proving the real nature of these deposites, though the occurrence of the metal in pseudo-veins will render the ultimate success of the operation a matter of some uncertainty. The appearance of the vein seemed, however, more promising as they descended upon it.

The adit-level has since been constructed, but the vein-like mass did not prove as rich, where intersected, as was anticipated.

The Boston and Lake Superior Company have made explorations on section 11, about one-fourth of a mile further west. The general character of the deposites of copper is similar to that of the Ohio Trap Rock Company. Two vein-like masses of epidote, mixed with quartz and calc-spar, meet at right angles—the one running nearly north and south, the other east and west. Two inclined shafts were sunk to the respective depths of thirty and sixty feet. The bed pitched to the north about 48°, and was thought to become richer in its downward course. This mine is temporarily, if not permanently, abandoned."

This portion of the trap range appears to be richer than any other in the district west of the Ontonagon. It is characterized throughout by these "epidote veins," as they are provincially termed, which in many places offer flattering inducements to miners; but it must be confessed that the explorations thus far have not demonstrated that they can be profitably wrought.

Township 49*, range* 42.—The trap adjoins Agogebic lake on the north, and expands to the width of eight miles. The range of bluffs before described is continued through the southern portion of this township, and presents the same geological features. In the northern portion are numerous high knobs of quartzose porphyry, in which no traces of copper have been detected. These extend in an east-northeast direction for about six miles, and vary in width from one to two miles. On section 24, known as Boyd's location, explorations to a limited extent have been made.

Near the bed of the stream, by the cabin, occurs a mass of epidote, passing into trap, and containing specks of metallic copper. A small quantity of rock has been thrown out here, but the percentage of copper is very light indeed. At the southeast corner of the location, near the summit of a trap cliff 200 feet in height, occurs another mass of epidote rock, which has been explored in search of copper. This mass is about six feet in breadth by ten in length, and presents superficially some of the characters of a vein, but passes gradually into the trap both above and below, so as to be no longer distinguishable at the distance of a few inches. A few particles of copper are found in the epidote; but appearances, upon the whole, are unpromising.

About one-fourth of a mile east of the cabin is the locality known as the "Red oxide vein." The trap is very hard and compact, and contains epidote, which is sometimes stained by carbonate of copper. The seams of the trap are filled with thin plates of a red crumbly substance—probably decomposed laumonite. The epidote has, as usual, some resemblance to a vein. Considerable masses of ore have been obtained from this place, being mostly native copper incrusted with the red oxide, which is probably an after-product from the oxidation of native copper. Near this place is another opening of the same kind; but no copper nor signs of a vein could be discovered. On the whole, there is no reason to suppose that mining operations at this point will be attended with success.

The trap occupies only portions of the first tier of sections in the adjoining township (48) south. On section 6, the Charter Oak Company erected buildings and made surface explorations. The copper bearing rock is similar to that which is characteristic of the whole of this range, and to describe it more in detail would be superfluous. The location is now abandoned.

From this range west to the Montreal river, (we speak not now of the Porcupine mountains,) the country is low and swampy, affording few facilities for mining operations. The rocks rarely emerge to the surface, and, when observed, are in isolated knobs, instead of continuous ranges.

The bed of the Presqu' Isle was examined by us with great care, as well as the country lying west of the river, before the organization of the survey. The conglomerate is seen flanking the trap on the north, as well as intercalated with it in lenticular bands. The junction between the two classes of rocks occurs in section 26.

Township 49*, range* 45.—The trap resembles that of Keweenaw Point, and, near the junction of the different mineral planes, is highly amygdaloidal. The zeolites, so rare in the Ontonagon region, are here very abundant.

A bed of quartz slightly tinged with the sub-oxide of copper is seen in the trap on section 26, near its

northern limits. Numerous and apparently contemporaneous fissures traverse the mass, which are filled with prehnite, laumonite, and calc-spar, through which native copper is diffused in small specks. Fissures of greater power, and apparently of a later age; cut the mass in a north and south direction, but they are rarely metalliferous. Between Presqu'Isle and Black rivers, occasionally, detached knobs of trap are observed, which afford no inducements to mining.

The Cypress River Mining Company erected cabins on section 26, which were subsequently abandoned.

The bed of Black river, above the point where the conglomerate and trap meet; exhibits few exposures of rock. On section 5, township 48, range 46, the Chippewa Mining Company explored a vein in the bed of the stream to some extent, but developed nothing valuable, there being an ill-defined vein through which native copper is sparsely disseminated. The trap here rises in hills two or three hundred feet in height, occasionally exhibiting mural escarpments. Beyond these hills southward the country sinks down into a nearly level plain, covered with deep deposites of drift.

Between the Black and Montreal rivers a low range of trappean hills runs parallel with the coast, but in no instance intersects it. To the south the country is low and swampy, but occasionally a trap knob rises up to diversify the monotony of the scene.

The Montreal, a rapid, brawling stream, affords a good section of the rocks. For four miles above its mouth, it dashes through a deep gorge which it has excavated in the rocks, laying bare the bedded trap, conglomerate, and sandstone. The trap is both compact and amygdaloidal. The belt in proximity to the conglomerate is decidedly vesicular and, contains an abundance of the zeolitic minerals, in which occasional traces of copper are observed. There are numerous irregular veins of a hard, quartzose material, occasionally stained with copper, bearing north 55° west, with a dip of 45° or 50° northwardly. They are very limited, and we do not consider them as affording any possible indication of valuable lodes.

The Montreal River Mining Company occupied sections 23, 24, 25, and 26, township 48, range 49. The exploitations of the company were very limited, and the locations are now abandoned.

PORCUPINE MOUNTAINS.

These mountains, as will be seen by an inspection of the map, are an off-shoot at nearly right angles from the main range, and form the culminating points in the district, if we except a few points near Agogebic lake. They assume a crescent form—a peculiarity in the trappean rocks, which has been noted by Dr. Percival in his description of the geology of the State of Connecticut. The great mass consists of quartzose porphyry and jasper, though in other portions the amygdaloid is not wanting. Copper has been observed at numerous points, but no valuable lodes have been, nor probably will be, developed. To show the character of the rocks, and the association of the copper, we will advert to the principal points where explorations have been made.

Township 51*, range* 42*, section* 27.—The Union River Company have here made quite extensive explorations—more so than any other company in the region. The seat of their mining operations is about two miles from the mouth of Union river, and is elevated 309 feet above the lake. A bed of trap, 500 or 600 feet in thickness, is included between parallel planes of sandstone, and dips northwest at an angle of 25°. Along the line of junction between the sandstone above and the trap below, and occupying a thickness of about 5 feet, is a bed of amygdaloidal chlorite, containing copper in bunches and disseminated. On this bed two shafts have been sunk to the respective depths of 100 and 128 feet, and a gallery extended between thorn. Two vertical shafts were also sunk to intersect-the inclined ones. The intention of the company was to make use of the hydraulic power afforded by the stream to raise the attle. Subsequently another shaft was sunk farther north, through sandstone, which intersected the bed at the depth of 120 feet; but the attle thrown out disclosed only a trace of copper. The hanging-wall of sandstone afforded several very good specimens of silver. In contact with the foot-wall there was a thin seam of clayey matter, called by the miners *flucan*, consisting of decomposed chlorite. Near the surface copper was found in considerable masses, some of which weighed 50 pounds; but we could not gather that these occurred in the downward progress of the shafts. The copper here often forms a thin envelope around the exterior of the vesicles of the trap, while the middle is replaced by chlorite or calc-spar. The mass brought to the surface was very meagre in copper, not exceeding one per cent.

In the bed of the stream, a few miles above the mine, is a large mass of quartzose and sparry material in the trap, with chlorite interspersed, which has been, explored to some extent. It has a reddish tint, communicated by the sub-oxyde of copper. The workings are now abandonded.

Township 51*, range* 42—On sections 22 and 27 the Boston Mining Company have made surface explorations, which resulted unfavorably, in a trap belt, which is an extension of that last described. There is a vein of quartz and silicate of lime, containing traces of metallic copper, which bears NE. and SW., and dips NW. at an angle of 30° or 40°, and varies from eight to ten feet in width. The trap here is very much fractured, and contains seams of highly polished chloride matter (slickensides.) At the junction of the trap and sandstone, no signs of the bed wrought by the Union River Company are observable.

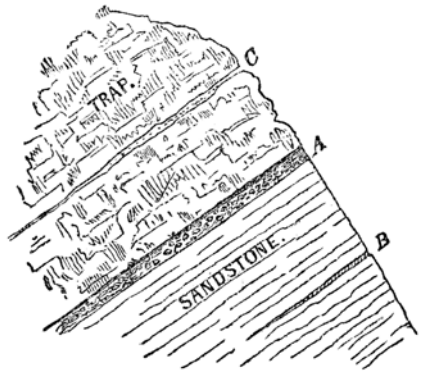
Township 51*, range* 42*, section* 32.—Near the correction line, a shaft has been sunk to the depth of fifteen or twenty feet into the hard jasper, which remains a monument both of persevering industry and misdirected

effort, since the difficulty of boring and blasting the close grained arid tough silicious rock could only be equalled by the absurdity of attempting to mine a seam of clay in perfectly barren wails.

Township 51*, range* 43.—This township has been the site of much mining exploration, and therefore deserves more than a passing notice. It is much broken by ranges of the Porcupine hills, and mural precipices extend from the centre of section 13 to 30. The highest point is 975 feet above the lake, and on the side opposite the coast presents a vertical face of several hundred feet, with a steep talus of angular fragments at the bottom. The trap, which attains a thickness of several hundred feet, is included within parallel planes of detrital rocks. This range bounds the valley of the Carp river on the north; while to the south, and within the distance of a mile, a second range is observed, composed of amygdaloid, having rounded summits. Still beyond occurs the elevated range of quartz and jasper rocks, in which no trace of copper has been detected. Almost all of the explorations in this township have been made in the first range, near the junction of the trap and sandstone.

On section 14, the Isle Royale Company explored a deposite of copper in some respects similar to that of the Union Company. The sandstone masses of metallic copper, one of which weighed 55 pounds, were found here dips at an angle of 30° to the north, and has been much altered by contact with the igneous rock. A seam, about a foot in width, consisting of blue plastic clay and chlorite, with rounded fragments of sandstone, is interposed between the two formations. In this seam directly in contact with the trap. An inclined drift was carried on the bed to the depth of 20 feet, but the traces of copper became more indistinct. Several feet above was a seam of calc-spar, from one to four inches in width, and in some places expanding to a foot, intermixed with fragments of the walls, forming a breccia; several feet below, a narrow seam, carrying metallic copper was observed, but it gave no evidence of being valuable. The annexed wood-cut is a section of the cliff at this point. About one-fourth of a mile west, the same company explored one of the vein-like masses of epidote, associated with native copper, like those west of the Ontonagon, bearing north and south, but it afforded little encouragement to persevere.

Fig. 7.



Township 51*, range* 43.—The Delavan Company explored on sections 27 and 28. There are no regular veins or appearances of veins on either of these sections. The rock is epidote, passing into amygdaloidal trap, so intermixed that it is impossible to draw the line of demarcation between them. The amygdules are often filled with epidote, both pulverulent and crystalline—the bright green of the former forming a striking contrast with the dark brown of the latter. A shaft was sunk a few feet in the rock, which here presents a very brecciated appearance, traversed by numerous seams containing calc-spar and the zeolitic minerals. Traces of the gray sulphuret of copper were here observed, and also on section 21; on the adjoining section 32 the Croton Company sank a shaft in a similar rock, but found nothing to induce them to persevere.

On section 30, the Isle Royale Company mined pretty extensively. The character of the rock is similar to that on section 14, before described.

With regard to the Porcupine mountains it may be said, without hesitation, that there are no indications of copper of sufficient promise to warrant mining enterprises. There are no true, well-defined lodes, but irregular seams promiscuously scattered through the trap.

We have endeavored to give, briefly, a synopsis of what has been done in the way of exploitation by the several companies. Originally, all of the trap belt was secured by permits, and even portions of the sandstone. It will hardly be necessary to say that these permits were located at a time when the speculative fever ran high, and when the mere presence of trap was regarded as a sure index of the proximity of valuable lodes of copper. Before the expiration of 1848, nearly all of the companies in this region had abandoned their locations, regarding them as worthless; and, at the end of the succeeding season, there was not, to our knowledge, a white man left.

ISLE ROYALE.

Ill many respects, Isle Royale may be regarded as the counterpart of Keweenaw Point. On both, the lines of upheaval are nearly parallel, exhibit the same banded structure, and yield the same metallic products.

There are, however, minor differences. The conglomerates here are riot developed on so grand a scale—different systems of fracture are found to prevail; but on both shores, the lines of inclination converge towards a common centre, forming a synclinal valley several hundred feet below the ocean-level, which is occupied by the waters of the great lake.

We have seen that the Jesuits formed the most extravagant notions with regard to the mineral wealth of this island; and those notions, though greatly modified, prevailed among the explorers at a later day. Nothing, however, has been revealed to justify those expectations; and the island, for mining purposes, may

be regarded as infinitely less valuable than Keweenaw Point, or the region in the vicinity of the Ontonagon.

In an agricultural point of view, it is less valuable than any portion of equal extent in the district. The soil is scanty, and the timber which it sustains is dwarfed and stunted.

Range and extent—metallic contents.—The trappean rocks range through the island in a northeasterly and southwesterly direction, forming numerous ridges, which seldom attain an elevation five hundred feet above, the level of the lake. Almost everywhere they present a bedded structure, and the beds display marked lithological differences. The lines of bedding almost invariably are found to be coincident with the lines of stratification in the detrital rocks which occur on the southern portion of the island.

A line drawn from the western extremity of the island, and cutting midway between Siskawit lake and the bay of the same name, would represent the junction between the two formations—the igneous occupying the northern, the aqueous the southern portion. From the eastern point the line curves abruptly, and approaches the shore on the south. There is evidence of a powerful lateral dislocation here, by which one portion of the mass has been forced beyond the corresponding portion, thus interrupting the continuity of the strata. Other evidences of the same phenomena have been observed on other portions of the island, which will be described in the detailed geology. The length of the line occupied by the trap, from Phelps's island, in Washington Harbor, to Passage island, which is an extension of Blake's Point, is fifty one miles; its breadth varies from four and a half to seven miles. The physical obstructions to a successful exploration of the interior of the island are greater than we have encountered in any other portion of the mineral district.

The shores are lined with dense but dwarfed forests of cedar and spruce, with their branches interlocking and wreathed with long and drooping festoons of moss. While the tops of the trees flourish luxuriantly, the lower branches die off and stand out as so many spikes, to oppose the progress of the explorer. So dense is the interwoven mass of foliage that the noonday sunlight hardly penetrates it. The air is stifled; and at every step the explorer starts up swarms of musquitoes, which, the very instant he pauses, assail him. Bad as this region is by nature, man has rendered it still worse. Fires have swept over large tracts, consuming the leaves and twigs and destroying the growth, while the heavy winds have prostrated the half-charred trunks, and piled them up so as to form almost impenetrable barriers.

As we ascend the ridges, the maple and the birch replace the cedar and the spruce, and the physical obstructions become less formidable. These ridges occur at short intervals, and preserve a great degree of parallelism—bearing, northwest and southeast, and are uniformly precipitous on the north, and gently sloping on the south. The valleys between are occupied by swamps, clothed with a dense growth of resinous trees, or with small lakes arranged in chains. The coast of the island is rock-bound, and, like Iceland, intersected by numerous *feiords*, or narrow and deeply indented bays.

In describing the detailed geology, we commence at the eastern extremity of the island, and thence proceed west.

Range 32.—Passage island occurs within this range. It is three miles from the nearest point of the main land, and was fabled as possessing rocks of pure copper, so that when a stone was cast against them a sound like that proceeding from brass was emitted. It is two miles in length, and its shores are rock bound, but indented with numerous bays, which afford excellent boat-harbors. The prevailing rock is a dark varioloid trap, which rises near the centre of the island to the height of more than one hundred feet, intersected by numerous veins running north and south, but nowhere affording much inducement for mining enterprise.

Range 33*, townships* 66 *and* 67.—Within these townships are numerous projecting headlands and deeply indented bays, known as the Fingers of Isle Royale. The southern portion of Hock Harbor is bounded by a reef of islands, twenty-four in number, arranged in a linear direction. The rock is a dark-gray trap, not very firm, and occasionally contains amygdules, filled with agate, chlorite, chlorastrolite, calc-spar, &c. A narrow belt of conglomerate is seen intercalated in the trap, bearing northeast and southwest, and dipping southeast 12°, and good exposures occur on Caribou and Mott's islands. A seam of calc-spar, about eight inches in thickness, conforming' in course and inclination to the conglomerate, runs through several of these islands, which, in a region remote from masses of limestone, may ultimately prove of economical value. On Mott's island and Shaw's island there are veins of considerable power, but owing to the proximity of the lake, it was thought that they would never prove valuable, since it would be impossible to free the mines from water.

Fig. 8.

Scovill's Point.—A cap of dark-gray trap, breaking into cuboidal blocks, and well adapted to the purpose's of construction, is here seen, forming the northern boundary of Rock Harbor. It rises in cliffs thirty and even fifty feet in height, forming an excellent sea-wall. From the head of the harbor to the extremity of the point there

is not a pebble beach of any extent. Beneath the compact trap is a thin band of amygdaloid: below this a bed of columnar trap, which gradually rises as we northward. The columns are arranged in prisms of five, six and sides, broken by joints, at short intervals; but we nowhere observed the structure known as ball and socket. The adjoining sketch, taken, oil the north side of Scovill's Point, will convey a correct idea of the appearance of the columnar trap.

In the compact trap a well defined vein of considerable power is seen, bearing north of east and south of west, and extending almost uninterruptedly from Ransom to the extremity of the point—a distance of nearly nine miles. This has been explored at different points by the Ohio and Isle Royale Company, by the Siskawit Company, and by Messrs. Shaw and Scovill. The vein stone consists of chlorite, quartz, and calcspar, with native copper in thin sheets and in bunches, and in the compact trap presents favorable indications, but, on entering the columnar trap, it rapidly contracts and becomes worthless. A more detailed description of this vein will be found under the head of Mines.

The columnar trap is also seen on Blake's Point and on Silver island. The amygdaloid before described crops out on the southern side of the point. It is of a dark-brown color, and. contains numerous agates and vein-like masses of pitch stone. On Blake's Point, the trap attains an elevation of 250 feet, and consists of a dark-gray varioloid greenstone, traversed by numerous belts of sienite, (crystalline feldspar and hornblende,) arranged in strataiform masses. Copper is generally found disseminated through these belts.

On section 33, township 66, a vein can be traced, bearing north 50° east, containing quartz, chlorite, and spar, with considerable copper. It is in the varioloid trap, but, at the depth of 15 feet, one of the sienitic bands occurs, in which the vein is ill defined.

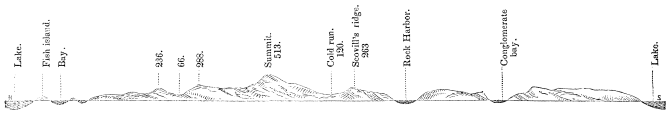
On the northwest quarter of section 33 is one of those natural monuments which instantly attracts the eye of the observer, known as "The Cloven Tower."

The varioloid trap here rises in two columns to the height of about sixty feet, which are separated from one another by an interval of only a few inches in width. They are very symmetrical, resembling obelisks, and altogether form one of the most pleasing features in the scenery of the island.

The varioloid trap skirts the southern coast of Duncan's bay, in bold overhanging cliffs. From their summits, the eye has an almost unlimited range. To the north, the Canada coast can be traced for more than a hundred miles: all of the prominent points—St. Ignace, the Paps, Thunder cape, Pie island, McKay's mountain, and Prince's bay—are distinctly visible. The many inlets around the island, fringed with evergreens, are seen almost beneath the feet. To the east and south, a boundless expanse of water stretches out, unenlivened by sail or other evidence of man's works. In peculiar stages of the atmosphere, the outlines of Keweenaw Point may be traced, resting like a cloud upon the verge of the horizon. The amygdaloid emerges from the base of these cliffs, and, for the most part, forms the underlying rock on Locked Point. It is of a dark-brown color, arid very soft, dipping southerly at an angle of 40°.

Range 34*, townships* 65, 66*, and* 67.—The following section, across the island, nearly through the centre of these townships, north and south, will show the contours of the country and its geological structure.

Fig. 9.



Section of the rocks on Isle Royale.

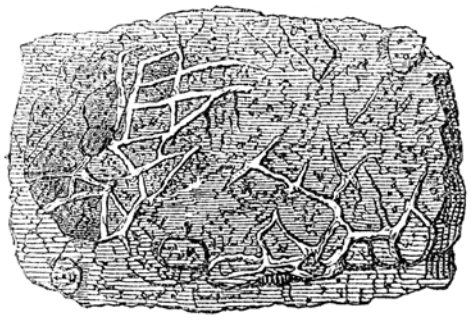
1. Amygdaloid.
2. Compact trap.
3. Crystalline greenstone.
4. Conglomerate and sandstone.

The southern coast in this range is rock-bound, the rocks often rising in rounded, irregular masses to the height of fifty feet. Numerous coves occur, bounded by high cliffs at the entrance, with pebbly beaches at the extremity, which are secure places of refuge in a storm, come from what quarter it may.

The entrance to Chippewa Harbor affords a beautiful section of the intercalations of the sandstone and trap, there being no less than five in the distance of less than a mile. These beds bear SW. and NE., and dip from 12° to 20° to the SE., and respectively vary from a foot to 80 feet in thickness. When traced across the harbor a few rods only in extent, they are found to have been subjected to a powerful dislocation, extending in a NW. and SE. direction, and amounting to 971 feet in a linear direction.

At and near the junctions of these different rocks, marked changes in their lithological characters are observed, which throw much light on their origin.

Fig. 10.



The *upper* portions of the sheets of trap are highly vesicular, resembling pumice. Fragments of amygdaloid, sometimes rounded, at others angular, are found enclosed in the pumice-like trap, as though they had become detached and afterwards reunited to the mass, while in a molten state. Numerous short and irregular fissures, extending to no great depth, are observed on the upper surface of the trap, in which sandstone has been deposited. The following sketch will explain the nature of the fissures and the position of the included fragments of amygdaloid. Between the

sandstone above and the *trap below*, it is extremely difficult to determine where the one begins and the other ends. Fragments of amygdaloid, angular or partly rounded, are included in the sandstone—more numerous near the base than at the top of the deposites. Where the sandstone is imposed *on* the trap, there is little evidence of its having been metamorphosed; but, on the other hand, where the trap rests *on* the sandstone, the line of junction is clear and well defined. The trap is less vesicular; and the upper portion of the sandstone belt, for the distance of three or four feet, is converted into a ribbon jasper, having a compact texture. These phenomena have been observed at numerous places both on Isle Royale and Keweenaw Point. The beds of sandstone are not shattered, nor does the igneous rock penetrate in the form of dikes or ramifying veins. All the phenomena indicate that the igneous rocks were not protruded in the form of dikes between the strata, but that they flowed like lava sheets over the pre-existing surface; and that the sand was deposited in the fissures and depressions of the igneous belt, in some cases, while the mass was in an incandescent state.

A bed of crystalline calc-spar, varying in thickness from six inches to two feet, is observed in Chippewa Harbor, and is well adapted to making quicklime. Thin beds of epidote, containing native copper, are also observed, having a bearing and dip conformable to the sandstone.

Such is the nature of the country, that it is impossible to trace these conglomerate bands to any considerable extent; but they probably wedge out in short distances; forming in fact lenticular bands.

A thin, belt of conglomerate lines the northern shore of Conglomerate bay, with a dip of 6° to the southeast, and is protracted thence along the southern shore of Rock Harbor. A thin belt of sandstone occurs about a fourth of a mile north of Ransom and this is the farthest point north along the line of the section at which the purely detrital rocks have been observed.

Between the lake shore and Rock Harbor, embracing the fractional township 65 and the extreme southeast portion of 66, the rock is a dark compact trap, occasionally amygdaloidal, consisting of hornblende, chlorite, and feldspar. The stratiform appearance in places is very marked, particularly near Conglomerate bay, resembling in some respects a sedimentary rock altered by heat. Occasionally a band of crystalline greenstone is found included in the softer rock.

The ridges which form the Fingers of the island, before described, extend through township 66, and present few differences in external characters. The crystalline greenstone which characterizes the middle range, and of which Blake's Point may be regarded as the prolongation, forms tile culminating point on this part of the island. In the southwest quarter of section 15 it rises to the height of five hundred and thirteen feet. In crossing the island from Rock Harbor to Amygdaloid island, the traveller encounters a series of sharp ridges, with intervening swamps. The escarpments are in variably, on the north side, while on the south the slope is gradual. The clusters of islands and headlands on the northern portion of this township consist of amygdaloidal and compact trap, but afford little encouragement for mining enterprise.

The best mining-ground in this range is near the junction of the two systems of rocks in township 65. The trap is traversed by numerous veins, some of which appear to be metalliferous. The main veins pursue an easterly and westerly course parallel with the formation, but dip to the northwest, thus forming nearly a right angle to the inclination of the sedimentary rocks. Datholite, in many cases, forms nearly the entire gangue. Numerous explorations have been made in this vicinity by the Ohio and Isle Royale Company, which will be noticed under the head of *Mines*.

Range 35*, townships* 65 *and* 66.—Sandstone and conglomerate forms the projecting points by the lake shore in the southwest quarter of township 65. Along the line of junction the same phenomena are observed as at Chippewa Harbor. The coast is lined by heavy masses of trap, with occasional indentations, which afford excellent boat-harbors. Powerful fissures traverse the rock in a northerly direction, and occasionally afford indications of copper. On section 34 a vein of this kind has been explored to a limited extent. Stratiform masses of epidote, containing copper, are also observed, included in the trap.

Receding from the lake shore, the country becomes low, and the rock rarely emerges to the surface. In the south part of the northwest quarter of section 24, amygdaloidal trap was observed, containing the zeolite minerals. It is exposed in the bed of the stream which connects Siskawit lake with the bay, almost in contact with the conglomerate, and is traversed by numerous and apparently contemporaneous fissures, occasionally affording traces of copper.

After crossing the first chain of lakes, the country is intersected by many sharp ridges, sloping from the summit to the southeast, but breaking off abruptly in perpendicular cliffs to the northwest. The rock is a hard crystalline greenstone, with belts of porphyry similar to those before described.

At the head of McCargoe's cove, the rock is amygdaloidal trap; but between this point and the lake shore., on either side, high cliffs of greenstone occur. The same rock bounds the coast from the outlet of this cove to Todd's Harbor, intermingled with bands of porphyritic trap, having the regularity of sedimentary deposites. This appearance is particularly marked on the main shore, opposite Hawk island. The outer reef consists of amygdaloid which is also seen underlying the greenstone at the eastern extremity of Todd's Harbor. Occasionally veins running north and south traverse the greenstone, but are for the most part pinched and unproductive. The best vein of this class hitherto observed occurs on section 12, in the adjoining range

west, and is wrought by the Pittsburg and Isle Royale Company, with a good prospect of success.

Range 36*, townships* 64 *and* 65.—The northern coast of the island in this range is lined with high cliffs of greenstone, so little indented as to afford hardly a boat-harbor. It breaks into cuboidal blocks, and occasionally presents the banded structure before described. Numerous north -and-south veins are observed, and the gangue almost invariably exhibits traces of copper. In the interior, the main range of trap courses through the township in a northeasterly and southwesterly direction, but the subordinate ridges are less clearly marked. The southeastern portion of township 65 is low, and the rock rarely emerges to the surface. The same remarks will apply to the fractional township 64. Near the southern border of Siskawit lake, the linear surveyors are said to have discovered a vein of some promise; but it escaped our notice. They also found on the shores of this lake a mass of native copper weighing about twenty pounds. The southern coast in this range consists of conglomerate and sandstone.

Range 37*, townships* 64 *and* 65.—A line drawn from the southwest quarter-of section 13, in township 64, to the centre of section 31, will indicate very nearly the junction of the two systems of rocks. In following up the small stream which flows into the northern arm of Siskawit bay, the trap is exposed for the first time on the northwest quarter of section 23. Numerous parallel ridges are intersected in crossing the island, which attain no great elevation. The highest range lies immediately north of Lac Desor, and consists of greenstone, affording no evidence of veins. The northern coast in this range is so girt with rocks that in rough weather it is impossible for the voyageur to elect a landing.

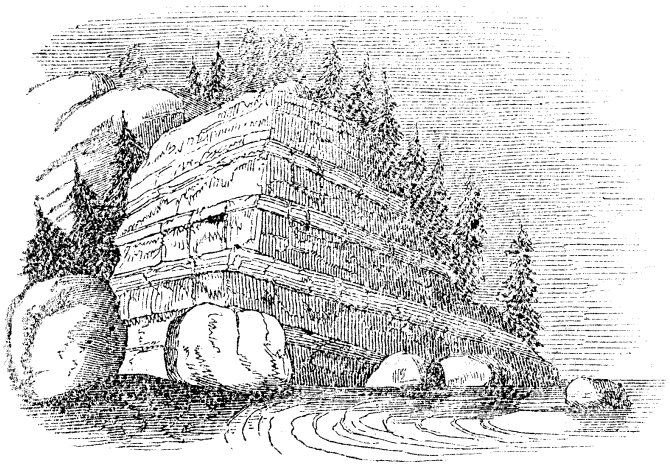
Range 38*, townships* 64 *and* 65.—But a small portion of township 64 is embraced in the trap range, and the heavy accumulations of drift effectually conceal the rock. A ridge of hills, two or three hundred feet high, skirts Washington Harbor on the south, which are so covered with debris that the. rock cannot be well explored. Loose masses of veinstone have been observed on the flanks of the hills, which would seem to indicate the presence of veins.

Another elevated ridge occurs between Washington Harbor and the lake shore on the north. The rocks rise in bold, perpendicular cliffs, and from their summits the eye has an almost unlimited range.

The shore is rock-bound, the cliffs ranging in almost unbroken lines, and presenting a wall-like face towards the lake in many places a hundred in height. Hugennin's cove is the only harbor in this vicinity in the voyageur can take refuge.

The cliffs along the shore exhibit numerous alternations of different rocks. The following sketch was taken on section 28. Thin bands of porphyry are found imbedded in dark compact trap. They hear northeast and southwest, and dip southeast 21°. Whether these alternating bands are due to successive overflows of igneous matter, or are the result of different affinities while the entire mass was in an incandescent state, we are not prepared to say; but are inclined to the former opinion, since the lines of bedding are found to correspond with those of the detrital rocks.

Fig. 11.



At another point on the coast the following section was observed:

	Feet.	Inches.
Compact trap, breaking into cuboidal blocks	15	0
Porphyritic trap	0	3
Compact trap	4	0
Porphyritic trap	0	2
Compact trap	1	6
Porphyritic trap	1	0
Compact trap	1	6
	23	5

These alternations exhibited well-defined lines of junction, and preserved their parallelism along the face of the cliff, as far as exposed. The bearing and dip were the same as in the section before described. The lines of division pursued an undeviating course through the several bands.

A small vein was observed at one point cutting vertically through these bands, and the veinstone exhibited marked changes in its passage through the different belts.

At a point about one-half of a mile to the west, numerous alternations of compact trap and amygdaloid were observed, having the same regularity in bedding and inclination.

We have observed this banded structure in the igneous rocks, at short intervals, from Blake's Point nearly to Washington Harbor, a distance of forty-five miles; and throughout the entire extent of the island they present a remarkable uniformity in bearing and inclination. They were, undoubtedly, deposited at first in nearly horizontal sheets, and owe their present inclination to the same upheaval which uplifted the associated sedimentary rocks. We regard them as purely igneous products, and not as the result of metamorphism.

Range 39*, townships* 63 *and* 64.—Between Hugennin's cove and Washington Harbor, the trap lines the coast in overhanging cliffs a hundred and fifty feet in height. In

rounding the end of the island, where the different beds of unequal firmness have been exposed to the action of the surf, numerous coves are observed walled up on either side, and skirted at the extremities by agate beaches. Rounded masses of prehnite containing copper are abundant on all of the islands, and several beautiful specimens of silver have been picked up in the same association.

Phelps's island, on the southern side of the harbor, holds out strong inducements for mining enterprise. On the southeast shore (section 10) is a vein, bearing south-southeast, 18 inches wide, containing calc-spar, prehnite, and native copper. Still further to the east is another vein of great power, bearing nearly north and south, and thirty inches in width. The veinstone consists of quartz, laumonite, and prehnite, with native copper disseminated.

On the southeast quarter of the same section is another copper-bearing vein, well defined, and seven inches in width.

Appended to this chapter will be found a tabular list of the tracts in this district supposed to contain copper.

In designating such lands as were regarded as mineral, we have been governed by the following considerations:

All of that portion underlaid by sandstone and conglomerate has been excluded—experience having demonstrated that, although they contain traces of copper, no valuable lodes need be expected.

We have restricted the mineral lands to such portions of the trap ranges as were sufficiently elevated for mining purposes, where the rock was exposed on the surface, and, from its external characters and proximity to veins of known value afforded evidence of productive lodes.

Although the Porcupine mountains afford good exposures of the rock, and contain abundant traces of copper, neither the character of the veins nor of the containing rocks affords a reasonable prospect for successful mining. For this reason, we have included no portion of it in the list of mineral lands. The same remarks will apply to the trap range in the vicinity of the Montreal river.

In designating the mineral lands on Isle Royale, we have encountered much difficulty. The metalliferous bands, as we have seen from the detailed geology, are extremely narrow, particularly in the northern portion; but the physical obstructions were such as to prevent a successful exploration inland. We have accordingly designated such tracts as were sufficiently elevated above the lake for mining purposes, and gave evidence of being metalliferous, without reference to the thickness of the belts.

List of the mineral lands of Keweenaw Point, Lake Superior land district.

Section.	Part.	Township north.	Range west.
7	SW. ¼	58	27
17	W. ½	58	27
18	All	58	27
19	N. ½	58	27
20	NW. ¼	58	27
4	S. ½	58	28
5	S. ½	58	28
6	S. ½	58	28
7	All	58	28
8	All	58	28
9	All	58	28
10	All	58	28
13	All	58	28
14	N. ½ and SE. ¼	58	28
15	NE. ¼	58	28
16	S. ½	58	28
17	S. ½	58	28
18	SE. ¼	58	28
19	NE. ¼	58	28
20	N. ½ and SE. ¼	58	28
21	All	58	28
22	W. ½	58	28
24	N. ½	58	28
27	NW. ¼	58	28
28	N. ½	58	28
1	S. ½	58	29
2	S. ½	58	29
7	All	58	29
8	All	58	29
9	All	58	29
10	S. ½	58	29
11	All	58	29
12	All	58	29
13	N. ½	58	29
14	N. ½	58	29
15	N. ½	58	29
16	N. ½	58	29
17	N. ½	58	29
18	N ½	58	29
19	S ½	58	29
20	S. ½	58	29
21	S. ½	58	29
22	S. ½	58	29
23	All	58	29
24	N. ½	58	29
25	N. ½	58	29
26	N. ½	58	29
27	All	58	29
28	All	58	29
29	All	58	29
30	All	58	29
31	N ½	58	29
32	N ½	58	29
6	NW. ¼	58	30
7	E. ½ and SW. ¼	58	30
8	All	58	30
9	All	58	30
10	All	58	30
11	All	58	30
12	All	58	30

List of the mineral lands of Keweenaw Point—Continued.

Section.	Part.	Township north.	Range west.
13	N. ½	58	30
14	N. ½	58	30
15	All	58	30
16	All	58	30
17	All	58	30
18	All	58	30
19	N. ½	58	30
20	NW. ¼	58	30
25	All	58	30
26	S. ½	58	30
27	S. ½	58	30
28	S. ½	58	30
29	SE. ¼	58	30
31	All	58	30
32	All	58	30
33	All	58	30
34	All	58	30
35	N. ½	58	30
36	N. ½	58	30
4	NW. ¼	57	30
5	N. ½ and SW. ¼	57	30
6	All	57	30
11	SE. ¼	58	31
12	S. ½	58	31
13	All	58	31
14	All	58	31
15	S. ½	58	31
19	S. ½ and NE. ¼	58	31
20	All	58	31
21	All	58	31
22	All	58	31
23	All	58	31
24	All	58	31
28	NW. ¼	58	31
29	W. ½ and NE. ¼	58	31
30	All	58	31
31	NW. ¼	58	31
36	S. ½	58	31
1	N. ½ and SW. ¼	57	31
2	E. ½ and SW. ¼	57	31
3	S. ½	57	31
4	S. ½	57	31
8	NE. ¼	57	31
9	N. ½	57	31
10	N. ½	57	31
11	NW. ¼	57	31
25	S. ½ and NE. ¼	58	32
35	S. ½ and NE ¼	58	32
36	All	58	32
1	N. ½	57	32
2	All	57	32
3	S. ½ and NE. ¼	57	32
10	All	57	32
11	W. ½	57	32
15	W. ½	57	32
16	SE. ¼	57	32
21	All	57	32
22	S. ½	57	32
26	W. ½	57	32
27	All	57	32
28	N. ½ and SW. ¼	57	32

List of the mineral lands of Keeweenaw Point—Continued.

Section.	Part.	Township north.	Range west.
29	E. ½	57	32
31	E. ½ and SW. ¼	57	32
32	W. ½	57	32
33	E. ½ and SW. ¼	57	32
34	W. ½ and NE. ¼	57	32
35	S. ½ and NE. ¼	57	33
36	SW. ¼	57	33
4	W. ½	56	32
5	S. ½ and NW. ¼	56	32
6	E. ½	56	32
7	N. ½ and SE. ¼	56	32
8	N. ½ and SW. ¼	56	32
17	W. ½	56	32
18	E. ½	56	32
19	All	56	32
20	W. ½	56	32
30	W. ½	56	32
2	W. ½	56	33
3	SE. ¼	56	33
10	SW. and NE. ¼	56	33
11	N. ½	56	33
25	SE ¼	56	33
35	SE. ¼	56	33
36	All	56	33
1	NW. ¼	55	33
2	S. ½ and NE. ¼	55	33
3	SE. ¼	55	33
10	S. ½ and NE. ¼	55	33
11	NW. ¼	55	33
15	NW. ¼	55	33
16	All	55	33
20	S. ½ and NE. ¼	55	33
29	NW. ¼	55	33
30	N. ½	55	33
23	SE. ¼	55	34
24	N. ½ and SW. ¼	55	34
25	N. ½ and SW. ¼	55	34
26	All	55	34
27	SE. ¼	55	34
35	SE. ¼	55	34
36	S. ½	55	34

List of the mineral lands in the region between Portage lake and the Montreal river.

Section.	Part.	Township north.	Range west.
25	SE. ¼	52	37
35	E. ½ and SW. ¼	52	37
36	All	52	37
1	NW. ¼	51	37
2	N. ½ and SW. ¼	51	37
10	E. ½ and SW. ¼	51	37
11	W. ½	51	37
15	N. ½ and SW. ¼	51	37

List mineral lands between Portage lake and Montreal river—Continued.

Section.	Part.	Township north.	Range west.
16	S. ½	51	37
21	All	51	37
22	NW. ¼	51	37
29	SW. ¼	51	37
30	S. ½	51	37
31	N. ½	51	37
32	NW. ¼	51	37
25	W. ½ and SE. ¼	51	38
26	N. ½	51	38
34	E. ½ and SW. ¼	51	38
35	All	51	38
36	N. ½ and SW. ¼	51	38
6	N. ½ and SW. ¼	50	38
7	NW. ¼	50	38
1	SE. ¼	50	39
10	S. ½	50	39
11	S. ½	50	39
12	N. ½ and SW. ¼	50	39
13	NW. ¼	50	39
14	N. ½ and SW. ¼	50	39
15	All	50	39
16	E. ½	50	39
21	NE. ¼	50	39
22	NW. ¼	50	39
29	All	50	39
30	All	50	39
31	N. ½	50	39
32	NW. ¼	50	39
25	S. ½	50	40
33	S. ½	50	40
34	S. ½	50	40
35	N. ½	50	40
36	All	50	40
4	N. ½	49	40
5	All	49	40
6	All	49	40
7	N. ½	49	40
1	E. ½ and SW. ¼	49	41
2	S. ½	49	41
3	SE. ¼	49	41
10	NE. ¼	49	41
11	N. ½	49	41
12	N. ½	49	41

List of the mineral lands of Isle Royale, Lake Superior land district.

Section.	Part.	Township north.	Range west.
3	N. ½	67	32
4	E. ½	67	32
21	SE. ¼	67	33
22	SW. ¼	67	33
23	S. ½	67	33
24	N. ½ and SW. ¼	67	33
26	N. ½	67	33
27	All	67	33
28	All	67	33
31	All	67	33

List of the mineral lands of Isle Royale—Continued.

Section.	Part.	Township north.	Range west.
32	All	67	33
33	All	67	33
34	All	67	33
35	N. ½	67	33
3	NW. ¼	66	33
4	N. ½ and SW. ¼	66	33
5	All	66	33
6	All	66	33
7	All	66	33
8	N. ½	66	33
18	NW. ¼	66	33
33	SW. ¼	67	34
34	E. ½ and SW. ¼	67	34
35	SW. ¼	67	34
36	SE. ¼	67	34
1	All	66	34
2	All	66	34
3	S. ½	66	34
4	NW. ¼	66	34
5	NE. and SW. quarters	66	34
8	All	66	34
9	All	66	34
10	All	66	34
11	SE. ¼	66	34
12	N. ½ and SW. ¼	66	34
13	All	66	34
14	NW. and SE. quarters	66	34
15	S. ½ and NE. ¼	66	34
16	N. ½	66	34
17	All	66	34
18	All	66	34
20	SE. ¼	66	34
21	All	66	34
22	All	66	34
23	W. ½ and NE. ¼	66	34
24	NW. ¼	66	34
26	All	66	34
27	S. ½	66	34
28	All	66	34
29	N. ½ and SE. ¼	66	34
30	S. ½ and NE. ¼	66	34
31	NE. and SW. quarters	66	34
33	E. ½	66	34
34	N. ½ and SE. ¼	66	34
35	All	66	34
2	W. ½ and NE. ¼	65	34
3	All	65	34
7	SE. ¼	65	34
8	NW. ¼	65	34
9	All	65	34
10	N. ½ and SW. ¼	65	34
16	NW. ¼	65	34
17	All	65	34
18	All	65	34
19	N. ½ and SW. ¼	65	34
20	NW. ¼	65	34
13	S. ½ and NE. ¼	66	35
22	S. ½	66	35
23	All	66	35
24	N. ½ and SW. ¼	66	35
25	NW. and SE. quarters	66	35
26	NW. ¼	66	35

List of the mineral lands of Isle Royale—Continued.

Section.	Part.	Township north.	Range west.
27	All	66	35
28	All	66	35
29	SE. ¼	66	35
32	E. ½ and SW. ¼	66	35
33	N. ½	66	35
34	E. ½ and SW. ¼	66	35
35	SE. ¼	66	35
36	E. ½ and SW. ¼	66	35
1	All	65	35
2	All	65	35
3	All	65	35
4	E. ½ and SW. ¼	65	35
5	N. ½	65	35
6	E. ½ and SW. ¼	65	35
7	S. ½ and NW. ¼	65	35
8	All	65	35
9	All	65	35
10	S. ½ and NW. ¼	65	35
12	S. ½ and NW. ¼	65	35
13	N. ½ and SE. ¼	65	35
14	N. ½	65	35
15	NW. ¼	65	35
16	All	65	35
17	NE. and SW. quarters	65	35
18	All	65	35
21	NE. ¼	65	35
22	NW. ¼	65	35
24	SE. ¼	65	35
25	N. ½	65	35
26	S. ½ and NE. ¼	65	35
27	All	65	35
28	S. ½	65	35
29	S. ½ and NE. ¼	65	35
31	All	65	35
32	All	65	35
33	N. ½ and SW. ¼	65	35
1	S. ½	65	36
9	S. ½	65	36
10	All	65	36
11	All	65	36
12	N. ½ and SE. ¼	65	36
13	All	65	36
14	NW. and SE. quarters	65	36
15	NE. ¼	65	36
16	N. ½ and SW. ¼	65	36
17	SE. ¼	65	36
19	All	65	36
20	All	65	36
21	S. ½ and NE. ¼	65	36
22	All	65	36
23	N. ½	65	36
24	NW. ¼	65	36
27	SE. ¼	65	36
28	NW. ¼	65	36
29	NE. and SW. quarters	65	36
30	SE. ¼	65	36
31	N. ½ and SW. ¼	65	36
34	NW. ¼	65	36
35	S. ½	65	36
36	All	65	36
2	NW. ¼	64	36
3	N. ½ and SW. ¼	64	36

List of the mineral lands of Isle Royale—Continued.

Section.	Part.	Township north.	Range west.
4	S. ½	64	36
7	SE. ¼	64	36
8	S. ½ and NE. ¼	64	36
9	NW. ¼	64	36
18	N. ½	64	36
23	SE. ¼	65	37
24	NE. and SW. quarters	65	37
25	N. ½	65	37
26	S. ½ and NW. ¼	65	37
27	NE. and SW. quarters	65	37
28	SE ¼	65	37
31	SE. ½	65	37
32	NE. and SW. quarters	65	37
33	S. ½ and NW. ¼	65	37
34	N. ½ and SW. ¼	65	37
36	SE. ¼	65	37
1	SW. ¼	64	37
4	S. ½	64	37
5	N. ½	64	37
6	NW. ¼	64	37
8	SE. ¼	64	37
9	S. ½ and NE. ¼	64	37
10	N. ½	64	37
17	N. ½ and SW. ¼	64	37
18	S. ½ and NE. ¼	64	37
19	N. ½ and SE. ¼	64	37
20	W. ½	64	37
1	All	64	38
2	SE. ¼	64	38
10	S. ½ and NE. ¼	64	38
11	N. ½	64	38
14	NW. ¼	64	38
15	NE. and SW. quarters	64	38
16	N. ½ and SE. ¼	64	38
17	S. ½	64	38
19	S. ½ and NE. ¼	64	38
20	All	64	38
21	NW. and SE. quarters	64	38
23	SE. and NW. quarters	64	38
24	S. ½	64	38
25	S. ½ and NE. ¼	64	38
26	S. ½ and NE. ¼	64	38
27	N. ½	64	38
28	S. ½ and NE. ¼	64	38
30	S. ½ and NW. ¼	64	38
31	SE. ½	64	38
32	N. ½ and SW. ¼	64	38
34	NE. ¼	64	38
35	NW. ¼	64	38
6	NW. ¼	63	38
24	SE. ¼	64	39
25	S. ½ and NE. ¼	64	39
26	SE. ¼	64	39
35	E. ½	64	39
36	All	64	39
1	N. ½	63	39
2	N. ½	63	39
9	SW. ¼	63	39
10	All	63	39
11	SW. ¼	63	39