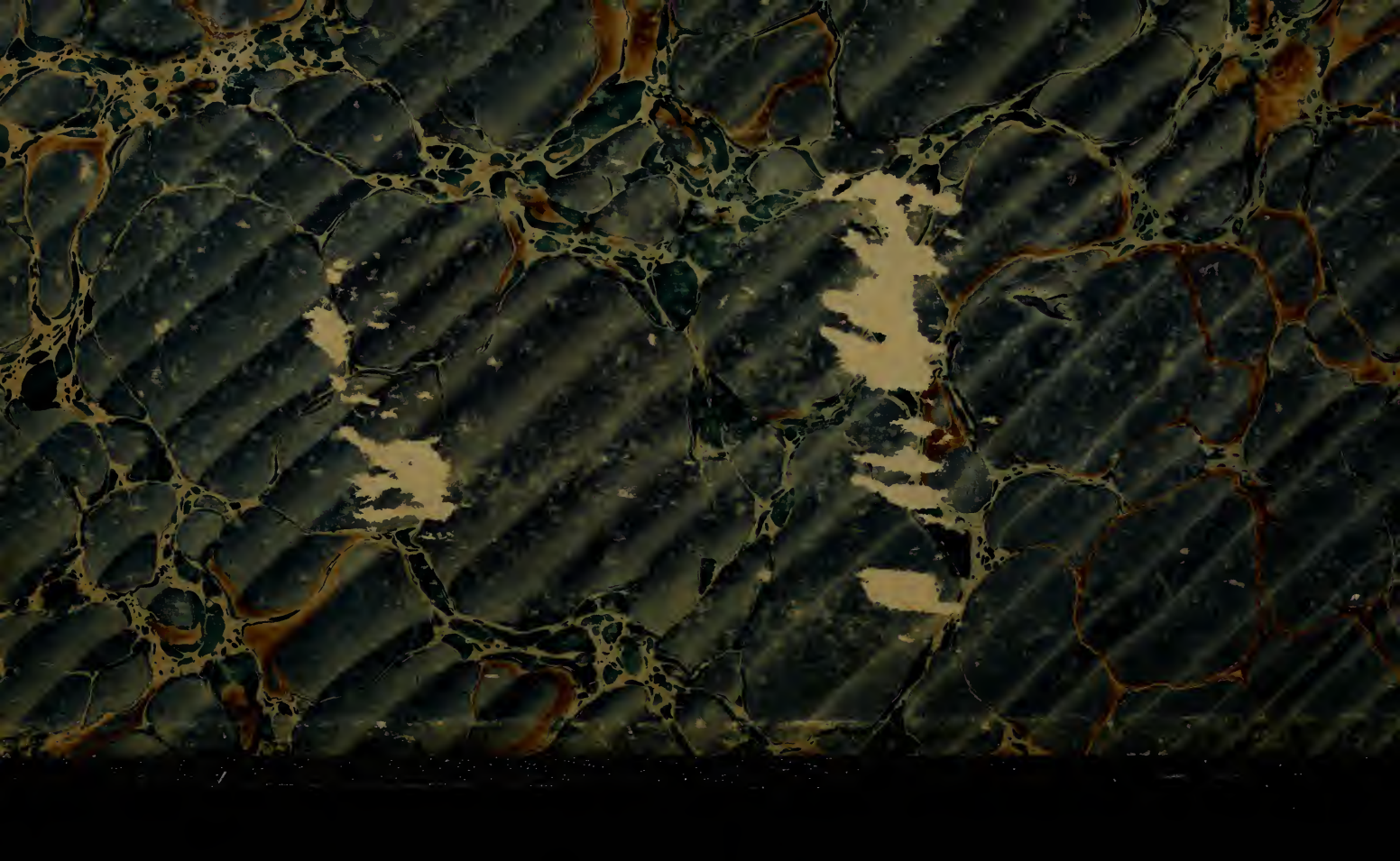

GEOLOGICAL SURVEY

OF

CANADA.

REPORT OF PROGRESS

FOR THE YEAR 1846–7.

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1847.

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MONTREAL, 1*st May*, 1847.

SIR,

I have the honor to request that you will do me the favor to place before His Excellency the Governor General, the accompanying Report of the Progress made in the Geological Survey of the Province, during the past season.

I have the honor to be,

Sir,

Your most obt. servant,

W. E. LOGAN,

Provincial Geologist.

To the Hon. D. DALY,

Provincial Secretary.

TO HIS EXCELLENCY

THE RIGHT HONORABLE

JAMES BRUCE, EARL OF ELGIN AND KINCARDINE,

BARON BRUCE OF KINROSS AND OF TORRY,

ONE OF HER MAJESTY'S MOST HONORABLE PRIVY COUNCIL,

GOVERNOR GENERAL OF BRITISH NORTH AMERICA,

AND

CAPTAIN-GENERAL AND GOVERNOR-IN-CHIEF IN AND OVER THE PROVINCES OF CANADA, NOVA SCOTIA, NEW BRUNSWICK, AND THE ISLAND OF PRINCE EDWARD, AND VICE-ADMIRAL OF THE SAME,

&c. &c. &c.

MONTREAL, 1*st May*, 1847.

MAY IT PLEASE YOUR EXCELLENCY,

Having, in compliance with the instructions I had the honor to receive from the Commissioner of Crown Lands on the 12th May last, by command of His Excellency, Earl Cathcart, the late Governor General, geologically examined the British Shores of Lake Superior, as part of the task those instructions directed me to perform, I now have the honor to place before Your Excellency the results of my examination, the relation of which will at the same time constitute the Report it is my duty annually to present of the Progress made in the general Geological Survey of the Province.

Leaving this on the 1st day of June, and joining my Assistant Mr. Murray at Detroit, where he had been engaged in completing arrangements for our expedition, we proceeded to Sault Ste. Marie, accompanied by Mr. McNaughtan, the Provincial Land Surveyor appointed by the Government to survey topographically the various mining locations, the mineral veins of which it was another portion of my task to inspect, with a view to aid in determining the direction most consistent with the general interest, to be given to their bounding lines, in cases of collision between the

lots of neighbouring claimants. Subsequently visiting Copper Harbour in Michigan, on the south side of the lake, for the purpose of gathering information regarding the nature of the copper lodes which had been opened in that vicinity, we crossed over to Fort William on the north, and entered upon the work assigned us, commencing our examination in the neighborhood of the British boundary at Pigeon River.

Mr. Murray's attention was devoted to the examination of the Kamanitiquia and Michipicoten Rivers, both of which he ascended to near the height of land, in addition to the inspection of several sections of the coast, his Report upon all of which, I have now the honor to transmit to Your Excellency. My own time was bestowed upon an examination of the mining locations and the coast generally; and finding it was in my power to work in advance of the land surveying party, I was happy to avail myself of the obliging offer of Mr. W. N. McLeod, who put at my service his canoe and eight voyageurs to transport me round the shores of the lake, by which I was enabled to make a more extended inspection than it would otherwise have been possible for me to effect in the limited time one season could afford. With the exception of Mr. Murray's excursion up the two rivers mentioned, the examination has necessarily been confined to the coast, and cannot be considered more than a *reconnaissance* of the district, to be carried into farther detail at a future period as occasion may serve.

The Canadian shores of Lake Superior in general present a bold and rocky coast, diversified in the character of its scenery in accordance with the distribution of its different geological formations. Cliffs and eminences rise up to heights varying from 300 to 1300 feet, close upon its margin, and this, deeply indented in some parts with extensive bays, and in others presenting extensive clusters of islands, is in a multitude of places carved out into well sheltered coves and inlets, affording innumerable harbours of a safe and commodious character, destined greatly to facilitate whatever commerce may hereafter be established on the lake, whether in the produce of its mines or its fisheries. The timber of the district does not seem to promise much encouragement to traffic; it is not of the size nor of the kinds most esteemed in commerce, though there is much useful wood capable of being rendered available for mining or house-building purposes, as well as for fuel. Hard-wood is scarce, red pine is not

often seen, and white pine not abundant. The trees most common are spruce, balsam fir, white birch and poplar, with cedar in moist places. On the immediate coast, many of the hills are nearly denuded of trees, particularly where granite and gneiss prevail. The hills composed of trap are better clothed; but it is in the trappean valleys and on the surfaces underlaid by sandstone, which are usually flat, that the largest growth is met with. It is chiefly in these localities also, and at the mouths of some of the principal rivers, that is to be found whatever land may be fit for cultivation; and although of this, in comparison to the area of the district, the extent cannot be called great, nor such as even less remotely situated, would tempt settlement, sufficient would probably be found to supply many of the wants of a mining population, should the metalliferous minerals of the region be found on trial to exist in sufficient abundance to be worked with profit.

Several considerable streams fall into the lake, the chief of which are the Kamanitiquia, the Neepigon, the Pic, the Michipicoten, and the Montreal. The first three flow in on the north, and the other two on the east side; and the whole, taking their origin in the height of land separating the waters of Hudson Bay from those of the St. Lawrence, may pass through 100 to 200 miles of country before yielding their tribute to the grand head reservoir of the latter, which, with a rim of 500 leagues, comprises an area of 32,000 square miles, its greatest length being 300 miles, and its greatest breadth 140 miles. Its greatest depth is supposed to be 1,200 feet, which would make its bottom 603 feet below, while its surface is 597 feet above the level of the sea; and its mean depth, being taken at 600 feet, would give about 4,000 cubic miles of water.

The frosts of winter are not sufficiently long continued to cool, nor the heats of summer to warm this great body of water to the temperature of the surrounding surface, and the lake in consequence considerably modifies the temperature of the country on its banks, which is neither so low in the one season, nor so high in the other, as it is both to the east and to the west. In the middle of the lake, on a calm day of sunshine, on the 7th of July, it surprised me much to find that the temperature of the water at the surface was no more than 38° Fah. For this fact, which was ascertained by repeated trials, it appears difficult to account, even allowing a degree or two for inaccuracy in the construction of the thermometer; as it is known

that water attains its greatest density at 39½°, and hence it might be expected that the body of the lake having once attained such a density, the stratum of particles at the surface would maintain its place, and be readily either cooled or heated. But whatever might have been the cause, a consequence was that the temperature of the atmosphere above the lake was no more than 51°, while in the interior of the country it may probably have been between 70° and 80°, or more. The result of such differences is the great prevalence of fogs on the lake, the vapour, brought in warm currents of air from the interior land, becoming condensed over the cool water of the surface. These fogs, as was to be expected, appeared to diminish in frequency as the summer passed away; but it is probable they would increase again in winter by a reverse of the process, the lake giving the vapour and the land the condensing currents of air.

SUCCESSION AND DISTRIBUTION OF ROCKS.

Lake Superior appears to be situated in a geological depression which presents formations of a similar character on both the north and south sides, dipping to the centre. The series on the north, in ascending order, consists of the following:—

1. Granite and syenite.
2. Gneiss.
3. Chloritic and partially talcose and conglomerate slates.
4. Bluish slates or shales, interstratified with trap.
5. Sandstones, limestones, indurated marls, and conglomerates, interstratified with trap.

1. *Granite and Syenite.*

The rock at the base of the series is a granite, frequently passing into a syenite by the addition of hornblende, but the hornblende does not appear to be often present wholly without the mica. Both the mica and the hornblende are in general black, the quartz either opaque or translucent white, or colourless and transparent. The colour of the feldspar is usually some shade of red, either pale or deep, and this being the prevailing constituent mineral, gives in most cases a reddish tinge to the mass. To this, however, there are exceptions, and both the quartz and the feldspar being occasion-

ally white, while the mica and hornblende are black, the rock has sometimes a speckled aspect. In general the rock, except where cut by granite dykes, is not very large grained. It sometimes, however, happens in the red variety, that crystals of feldspar, larger than the average size, will be disseminated through the mass, giving it a porphyritic aspect; and in some cases epidote appears to be diffused through the rock as a constituent mineral. Occasionally the rock presents a double system of joints, very regularly parallel for considerable sections of the coast, giving it in some degree the appearance of stratification; but it was not observed that the joints were always in parallel directions in sections distant from one another.

2. *Gneiss.*

The granite appears to pass gradually into a gneiss, which seems to participate as often of a syenitic as a granitic quality. In general the layers are corrugated, sometimes so much so, that it is difficult to ascertain their average strike or dip, but they are sometimes beautifully regular. Each layer was not in general observed to be monopolized by one mineral, but was usually made up of several, some one strongly predominating. The feldspathic beds are often a perfect granite or syenite with precisely the character of the massive granite beneath, and are sometimes many feet thick. The micaceous beds usually present the form of mica slate, and the hornblendic of hornblende slate. All of these occur interstratified with one another in various relations; and when the beds are thin and regular, and the feldspar deep red, this colour alternating with the gray micaceous and the black hornblendic bands, forms a ribbon-like rock of great beauty.

Both the gneiss and the granite are very often traversed by an ancient system of dykes or veins of a granitic character. They are in general large grained, very feldspathic or quartzose, sometimes wholly the one or the other, and they frequently so cut up one another as well as the rock, forming a complete net work on its surface, as to present relations of a very complicated description. In the gneiss this complication is enhanced by the stratification, particularly when this is in a contorted condition. These dykes or veins are usually firmly soldered to their walls, from which they have no peculiar tendency to split off, and they sometimes appear to

constitute for limited areas, nearly as much of the mass they cut as the original rock itself. There do not appear to be any metalliferous minerals associated with these veins.

3. *Chloritic and partially Talcose and Conglomerate Slates.*

The gneiss is succeeded by slates of a general exterior dark-green colour, often dark-gray in fresh fractures, which at the base appear occasionally to be interstratified with beds of a feldspathic quality, of the reddish colour belonging to the subjacent granite and gneiss; sometimes they are a combination of feldspar and quartz, occasionally with the addition of hornblende, making syenitic beds; and in some the hornblende preponderating, will give the syenite a general green colour. Some of the beds have the quality of a greenstone, others that of a mica slate, and a few present the character of quartz rock. Rising in the series, these become interstratified with beds of a slaty character, holding a sufficient number of pebbles of various kinds to constitute conglomerates. The pebbles seem to be of various qualities, but apparently all derived from hypogene rocks. They greatly vary in size in different places, and occasionally measure a foot in diameter. Where the conglomerate slates have been worn by the action of the water, the pebbles are generally worn equally down with the rest of the surface; and though a very distinct picture of them is presented on such a surface, where the water or weather appears to have had an influence in bringing out a distinct relief in colours between that of the pebble or boulder and the slate, at the same time producing a contrast of parallel lines on the terminal edges of the laminæ of this, it sometimes happens (unless the pebbles are of white quartz) that they are very obscurely distinguishable on fracturing the rock, both the pebbles and the matrix giving a gray colour, in which very little difference of mineral quality is perceived. On some of these pictured surfaces, small opaque-white feldspathic crystals will occasionally spot the whole rock, the pebbles equally with the slaty matrix. The rock nowhere within my observation displayed true slaty cleavage independent of the bedding; but it often exhibited a jointed structure, and the divisional planes resulting cut clean through the pebbles, where any were shewn, without the smallest deflection.

A considerable thickness of these conglomerate or pebbly slates is exposed at the mouth of the River Doré, near Gros Cap, about five

miles from the mouth of the Michipicoten River. The strike of the rock is very regular, being about E. and W., while the dip is very highly inclined, the beds being not more than ten to fifteen degrees removed from a vertical attitude; but the slope is for part of the distance to the north, and for the remainder to the south. There is not, however, supposed to be any repetition of the measures, which are here given in descending order:—

	Feet.	*In.*
Green slaty rock with a few scattered pebbles through some parts of it, which in other parts become sufficiently abundant to entitle the rock to the name of a conglomerate slate; the sedimentary layers are not distinctly marked; the rock has a jointed structure and the planes of division, which are very even, cut clean through the pebbles without any deflection,.....	40	0
Green pebbly slate: the edges of the laminæ are better marked than in the preceding by different shades of green and gray or black, giving the rock a ribbon-like aspect; the pebbles, which appear chiefly of primary rock, are worn smooth with the rest of the surface; they are more numerous at the top than at the bottom,.....	300	0
Green slaty rock, with a considerable number of pebbles towards the top and less in the lower part; several hollows are worn at intervals, running with the strike, which are covered by sand; the rock is probably softer in those parts, and may be partially talcose,.....	550	0
Green pebbly slate with large and small boulders of the same quality as before; some of the boulders may be a foot in diameter; iron pyrites is disseminated in some parts of the mass,.....	170	0
Measures not seen, being covered by sand,.....	90	0
Green slaty conglomerate with large primary pebbles; the colours of the edges of the slaty layers are green, black and red, and are very distinctly marked,.....	15	0
Green slaty rock with many pebbles; the arrangement of the different colours of the thin edges of the slaty layers sometimes partially conforming to the pebbles, and running round them, gives to to the smooth surface a ligneous aspect, like a planed surface of wood, shewing its fibres and knots,.....	30	0
Green slaty rock with fewer pebbles,.....	40	0
Green slaty rock with scattered large pebbles, ...	10	0
Green slaty rock of the same quality as before, with sometimes a greater and sometimes a smaller number of pebbles, but all shewing some,.....	130	0
Green conglomerate slate, containing a collection of boulders, some of them a foot in diameter, in the same slaty green matrix as before,.....	5	0

	Feet.	In.
Measuers concealed by sand,.....	30	0
Green slaty rock with many primary pebbles, some of them six to eight inches in diameter; some of the granitic quality have a reddish hue; the stripes of the slate are green, black and red; many of the pebbles are of the same green as the slates; they appear to be of various shades of gray when fractured,.....	30	0
Green slaty rock containing a larger number of pebbles in the middle than at the top or bottom,.....	30	0
Measures concealed by the sand,.....	20	0
Green slaty rock of a more pebbly character; some of the pebbles are six to eight inches in diameter; the sedimentary layers are finely waved, and the surface of the rock near the water's edge is very much pitted, yielding in some parts to the action of the water more readily than others,.....	30	0
Green slaty rock, the bedding is very even and regular, and well marked by different shades of black and green; the quality is somewhat talcose towards the top, but harder towards the bottom, and when unweathered, the laminæ are very difficult to separate,.....	20	0
Green slaty rock of much the same quality as the above, but perhaps still harder,.....	15	0
Green slaty rock with even and regular bedding, slightly talcose in several of the divisions; the general quality, however, is very hard, and the rock splits with difficulty in the direction of the laminæ,.....	20	0
Green slaty rock, some parts of which have a few scattered pebbles that are in general flat or elongated in the direction of the strata; the ribbon-like stripes are very regular, and in some parts the rock splits into rude slates, but on the whole it is very hard and close; some plates are talcose on the surfaces; the dip is S. <75,.....	90	0
Green slaty rock with large pebbles and small boulders of granite, quartz and a cherty looking stone; the general colour is of a greenish chloritic or epidotic hue; crystallized epidote appears in some of the cracks in the rock,.....	35	0
	1700	0

At the Doré, a much larger amount of the slate formation than is here given, comes in behind the preceding section, but it was so covered over by moss and trees, that it was found impossible to follow out the details. Towards the lower part, it assumes more the character of the gneiss, which usually succeeds it, and becomes interstratified with reddish-yellow feldspathic layers; but sufficient data have not yet been ascertained to determine what the total

thickness of the formation may be, though it must probably attain several thousand feet. In some parts, these slates appear to come upon the granite without the intervention of any great amount of the gneiss.

Reddish-yellow feldspathic dykes occasionally traverse the slate as they do the granite and gneiss beneath; but the veins which more peculiarly appertain to the formation, are composed of translucent white quartz: they vary in thickness from a few inches to several feet, and are found running both with the strike and transverse to it. They were not observed on Lake Superior to carry any great amount of metalliferous mineral. Iron pyrites was sometimes associated with them, but not in large quantity.

4. *Bluish Slates or Shales, interstratified with Trap.*

The formations which succeed, rest unconformably upon those already mentioned. The base of the lower one, where seen in Thunder Bay in contact with the subjacent green slates, presents conglomerate beds probably of no great thickness, composed of quartz pebbles chiefly, with a few of red jasper, and some of slate in a green arenaceous matrix, consisting of the same materials in a finer condition. These are followed by a set of very regular even layers of chert, sometimes approaching a chalcedony, varying in colour from nearly white, through different shades of gray, to black, and in thickness from half an inch and less, to six inches, and sometimes even a foot. The plates are separated from one another by thin layers of a calcareous quality, weathering rusty-red, and present a striking ribbon-like appearance. Occasional thicker calcareous beds occur, sometimes highly crystalline, separating aggregate bands of the ribbon-like strata, and these calcareous beds, as well as the chert bands, are sometimes interstratified with argillaceous layers. In the vicinity of the disturbed parts, the chert sometimes passes into chalcedony and agate, and small cracks are filled with small quantities of anthracite. Some of the chert bands appear to be made up of a multitude of minute irregular closely aggregated sub-globular forms floating as it were in the siliceous matrix, and anthracite appears to be present in the centre of some of these, leading to the supposition that the colour of the black chert, even where the sub-globular forms are not detected, may be owing to the presence of carbon. In some parts of these oolitic chert

layers, small blood-red jaspery spots occasionally become intermingled with the black, and in pebbles scattered along the shores of Thunder Bay, probably derived from such beds, the red spots become so thickly numerous as to produce a very finely mottled or spotty jasper, in which the spots are crowded together, but do not run into one another. In some instances these oolitic layers exhibit small rounded grains of argillite in a matrix of crystalline quartz. Higher in the formation, argillaceous slates become interstratified with argillaceous sandstones in such an altered condition that it is often difficult at first sight to say whether the latter may not be trap layers. They are sometimes slightly micaceous, and they are rather lighter in colour than the slates or shales; and while these sometimes exhibit the structure called *cone-in-cone*, the harder bands display spherical concretions, varying from a few inches to two and six feet in diameter. In some parts of the vertical thickness, calcareous layers appear to be occasionally interstratified among the slates, some few of which are pure enough to be entitled to the appellation of limestone. Iron pyrites occurs disseminated in the deposit, and it frequently characterizes the cherty portion of it, where it is sometimes present in nodules and thin irregular and partial layers. Trap bands conformable with the stratification are interstratified in several parts of the vertical amount, but they occur in greatest thickness towards the bottom, not far above the cherty beds, and at the summit overlying the whole formation. This trap has a distinct crystalline texture, and was in no instance that came under my observation, of an amygdaloidal quality. It appeared to be composed of black hornblende and greenish-white horny-looking feldspar, which unfrequently occurred in large crystals, giving it a porphyritic character. Magnetic oxyd of iron in minute grains was generally a constituent part of the rock, and seemed occasionally to compose several per cent of it, while quartz in small quantity was often present. The only imbedded accidental minerals met with in it, were highly crystallized Prehnite, accompanied by calcareous spar, occurring in the beds overlying the chert, and iron pyrites, which was seldom wholly absent from any considerable mass of it. In all cases it presents a very striking sub-columnar structure at right angles to the plane of the stratification, and the crowning overflow gives a peculiar aspect to the whole region occupied by the formation to which it belongs. The overflow is from

200 to 300 feet thick, and the whole associated rocks to the base of the formation may possess a volume of between 1,500 and 2,000 feet. Where the formation comes upon the lake, it usually presents bold cliffs, sometimes attaining the height of 1,000 and even 1,300 feet, in which the upper part, occupied by the trap, exhibits a vertical columnar face, from the foot of which the slates, assisted by fallen fragments of the trap, offer a talus, sloping down to the water's edge at an angle of about forty-five degrees.

The dykes and mineral veins of the formation, being related to those of the succeeding rocks, will be noticed farther on.

5. *Sandstones, Limestones, Indurated Marls, and Conglomerates, interstratified with Trap.*

Reposing on the formation which has just been described, the first rock met with in Thunder Bay, where the best development of the lower part of the succeeding series occurs, is a white sandstone; the strata are in general of a fine grit, and appear to be composed almost entirely of minute grains of quartz in some parts, and in others small rounded white grains of a calcareous quality are sparingly intermingled with them. Some beds are coarser than others, and in these rounded pebbles of quartz and occasional jasper are seen, seldom exceeding the size of buckshot; of these white grits there may be a thickness of about 200 feet. They are followed by sandstones consisting of red and white layers interstratified with one another, and associated with conglomerate beds composed chiefly of pebbles and boulders of coarse red jasper, held in white, reddish, or greenish sand, as a matrix. Rising in this part of the deposit, the beds appear to hold rather more calcareous matter than those below, and some of the conglomerates enclose patches of limestone with fragments of chert. It is difficult to estimate the thickness of these beds from the difficulty of truly determining the dip, but it appears to me that at a very moderate computation they cannot be less than 500 feet. They are succeeded by limestones of a reddish-white colour, and very compact texture, some of which would yield good material for burning, interstratified with calcareo-argillaceous shales and reddish-white sandstones, the whole giving probably not under eighty feet, with an addition of fifty feet of reddish indurated marl at the top. Succeeding these calcareous strata, after an interval of which the amount is uncertain, not improbably filled with an addi-

tional quantity of the indurated marl, red and white sandstones occur with conglomerate layers. The red sandstones are often very argillaceous; they are usually variegated with green spots, and ripple-marks and crack-casts are displayed on the surfaces of many beds. The sandstones and conglomerates become interstratified with trap layers, and an enormous amount of volcanic overflow crowns the formation.

There appears to be some variation in the thickness of this overflow in different parts of its distribution, as well as some diversity in the arrangement in regard to the interstratification of conglomerate layers. But sections examined in places widely asunder, would not make the total volume fall far short of 6,000 to 10,000 feet. The trap taken as a whole is a greenstone. It is in general of an amygdaloidal character, less so at the bottom than higher up, while at the top, in addition to the amygdaloid, there are are met with extensive masses of a more solid and more highly crystalline quality, sometimes passing into well marked columnar basalt, associated with others of a vitreous aspect, exhibiting the forms of pitchstone-porphyry and pitchstone. The stratification of the amygdaloidal layers is usually well marked, and they do not in general appear to be individually so thick as the more solid and crystalline rocks.

The minerals filling the cavities usually consist of calcspar, quartz in various forms, and abundant in that of agate, together with Prehnite, epidote, native copper, specular iron, and various zeolites. The zeolites observed were red and white Heulandite, stilbite, mesolite, Laumonite and analcime; chlorite often occurs lining the walls of the cells. The epidote and mesolite were met with associated with quartz and frequently with specular iron, in the cells of the amygdaloid of Mamainse, the epidote being occasionally superimposed on the mesolite; and in one instance, two perfect but minute dodecahedrons of cinnamon-stone garnet were observed resting amidst the crystals of epidote. The cavities are of various sizes and shapes; some, often containing agate, were seen of six or eight inches in diameter, and instances were occasionally met with where the cavities presented the shape of irregular vertical tubes of about a quarter of an inch in diameter running up several inches, sometimes as many as twelve, into a bed from the bottom. The tubes were more

closely aggregated at the bottom where they often approached to within half an inch of one another, than higher up, two of them often joining into one, and this one again joining another which came up singly from the bottom, or was the result of the combination of other two or more, and so on; the combined tubes appeared to be a little larger than the original separate ones. None of the tubes divaricated upwards.

On the surface of some of the beds, partially concentric wrinkles resulting from the flow of the volcanic matter when in a viscid condition, were strongly marked. In one instance on the north shore, the courses indicated by these were N. 65° E. and N. 45° E., in two forms, which inosculated on the same surface; and on another and rather lower surface near the same place, the direction of a third form was S. 65° E. From the several directions, the parallelism of the separate beds, and the character of the wrinkles, it appears probable the general surface on which the volcanic flow occurred, was not far removed from horizontality. Another instance was met with on the east side of the lake, where the direction of the flow indicated by the form, was about east, which was exactly contrary to the dip of the highly inclined surface presenting it.

Trap Dykes.

Though the two last described formations, and indeed all along the coast, the whole of them down to the granite are traversed by a vast collection of trap dykes, yet in no one instance were any of the overlying or interstratified volcanic layers traced to a connexion with them of such a nature as to display to the eye that the one had its source in the other. There was often, however, a great similarity in the quality of some of the dykes, and some parts of the stratified trap; but these resemblances were not always confined to the dykes and beds that were near to one another; and in some cases while the dyke was found cutting one formation, the quality of the stratified trap most resembling it, was met with at a distance in another.

The qualities of the trap of the dykes may be ranged under the denominations applied to such volcanic products in their relation to greenstone, porphyry and syenite, but those of a porphyritic and syenitic character bear but an insignificant proportion to the green-

stone dykes, to which, in part at least, the others are closely allied. The trap of the greenstone dykes is in general more or less fine-grained, often approaching to compact; and its usual constituents are black hornblende, and greenish-white feldspar, with in most cases a greater or smaller quantity of magnetic oxyd of iron, and a small irregularly disseminated amount of iron pyrites. One of the porphyritic varieties arises from crystals of the feldspar of a larger than usual size, being disseminated through the greenstone; and in such cases the feldspathic crystals often appear spotted with small specks of hornblende. Another of the porphyritic qualities partakes also of the character of syenite. In this, a dark-gray mixture of hornblende and feldspar, with magnetic oxyd of iron and iron pyrites, similar to the greenstone already mentioned, incloses a multitude of irregular patches, composed of red feldspar and quartz generally of a hyaline transparent quality, and infrequently of an opaque-white, resembling chalcedony; the quartz is occasionally also disseminated throughout the matrix without the red feldspar; more rarely red feldspar patches occur without the quartz, and still more rarely small quantities of calcareous spar are met with. The whole mass of the dyke, however, sometimes passes into a uniform small-grained mixture of red feldspar and green hornblende with very little quartz, and ceases to have either a porphyritic or syenitic aspect. A third variety of porphyritic trap, constituting some of the dykes, consists of a very fine-grained mixture of red feldspar and quartz, holding distinct and not very large crystals of the same minerals, the quartz crystals being colourless and transpaent hexagonal prisms, terminated by a pyramid at each extremity, and rather uniformly disseminated through the mass. No dyke of an amygdaloidal character was observed.

The greenstone dykes, without a single observed exception, possessed a well marked transverse columnar structure, which was in general so truly at right angles to the plane of the dyke, that the underlie could always be correctly determined by it. This structure belonged equally to them whether their dimensions were small or great, but the size of the columns increased with the breadth of the dyke, which sometimes attained the measure of 200 feet. The number of these dykes was very great; thirteen of them of good size have been counted in the width of two miles,

and their parallelism for great distances was as remarkable as their number.

The directions of the greenstone dykes, as well as those of the other qualities which have been mentioned, were in general two, one with the stratification of the upper formations, and the other transverse, changing with any important change in the general strike; and they appeared to maintain what might be considered a continuation of these courses into the older rocks, with a less precise relation to their strike when stratified. In one instance the intersection of two greenstone dykes was met with, and that coincident with the stratification, cut the transverse dyke. Both possessed the columnar structure. The porphyritic greenstone dykes were also characterized by this structure, but it was not observed in those of syenitic trap.

The dykes in general appear to be more durable than the rocks they cut, from which results a peculiarity in the geographical features of the country. The destructive action of the water upon the coast is partially arrested in its progress upon meeting with them, and the dykes which run with the strike are in consequence often found to shield the shore for considerable distances. They sometimes run out into long prongs or promontories, with deep recesses behind them, or present a succession of long narrow islands, which act as break-waters in defending the neighbouring main land; and it frequently happens that a narrow breach having been effected in a dyke, it will be found to be the entrance to a spacious cove worn out on each side in the softer rock behind it. In almost all these instances, commodious harbours are the result, and it is mainly owing to the presence of these dykes, that so many such harbours exist on the Canadian side of the lake.

Mineral Veins.

In addition to the dykes, a vast collection of mineral veins intersect the formations of Lake Superior. A very large number of these contain a greater or smaller amount of various metalliferous ores, and the indications which they present, are such as to render it probable that some part of the country characterised by them, will sooner or later rise into some importance as a mining region. The metals whose ores are met with are copper, lead, zinc and silver.

As in the case of the dykes, the mineral veins belong to two systems; one coincident with the range of the rock masses, and the other transverse to it. They are therefore parallel to the dykes. The cracks, however, which the veins occupy, appear to be of an age subsequent to that of the dykes. They sometimes run along side of them, having the dyke for one wall and the rock of the country for the other, while at other times they are wholly independent of the dykes. As far as my observation went, the transverse veins cut those coincident with the range of the rock, when the strike ran about S. W and N. E., and from that to about W. and E.; but on the east side of the lake where the volcanic strata dip to the west or a little south of it, a sufficient number of facts to establish a rule in regard to their intersection was not ascertained. The displacements connected with the transverse or northward and southward veins appeared to be of greater amount than those related to the eastward and westward; but it is not so certain that the dislocations connected with the dykes, follow the same rule. Some very important disturbances were observed associated with those coincident with the strike of stratification.

In respect to the mineral contents of the veins, some difference exists in the different formations. In the upper formation, which is so much associated with amygdaloidal trap, the mineral veins vary in breadth from a few inches to four or five feet. They are in general composed of calcareous spar and quartz, holding together in greater or smaller quantities, entangled fragments of the wall rocks, and dark green steatite is seldom absent as one of the constituents. Laumonite was very often abundantly present with these minerals, and sometimes exceeded them in quantity; associated with the vein-stones, fluor spar occasionally occurred. Heulandite with heavy spar was not unfrequently met with, and in some districts, the heavy spar occasionally formed the chief earthy mineral in transverse or north and south veins. Prehnite with and without Thomsonite and stilbite was frequently encountered, chiefly in east and west veins; and dysclasite and datholite are to be enumerated among the minerals that occur. Some of the veins, both with the strike and transverse to it, were almost entirely composed of chalcedony and agate, when the rock of the country was of the qualities allied to pitchstone, or the porphyry associated with it; but these were seldom found to hold metalliferous minerals.

When metals were present in the mineral veins, they occurred chiefly in the form of sulphurets, with the exception of the silver, which appears to be usually in a native condition even when mixed up with the ores of other metals, unless in the case of galena, with which it is probably united as a sulphuret. The copper also was frequently met with in a native state; it usually, however, occurred in the forms of vitreous copper, variegated copper and copper pyrites; but it was found also as a carbonate resulting from the decomposition of the other ores where acted on by the weather at the outcrop of a lode. The gangue in those lodes which carried vitreous copper, had usually a predominating quantity of calcareous spar or of Laumonite, and sometimes of heavy spar, while in those possessing pyritous and variegated copper ores, it appeared to be more of a quartzose character. Native copper was usually accompanied by Prehnite. The silver was found associated with vitreous copper, native copper, and galena, the last of which with blende and iron pyrites, occurred in company with the sulphurets of copper, and was sometimes met with in calcareous spar by itself.

The courses of the metalliferous veins of this formation appear to be different in different parts of the lake, although they preserve uniformity over considerable areas. On the north shore, they run with the system of veins coincident with the range of the rock masses, partaking of an east and west bearing. On Michipicoten Island they belong to the transverse system, and run northward and southward; while at the east end of the lake, with the principal lodes running eastward and westward, transverse to the stratification, there are exceptions, running northward and southward with the strike.

In the succeeding formation, or upper slates, the most conspicuous system of veins consists of those transverse to the stratification. They vary in breadth from a few inches up to twenty feet and more, and they are in general composed of calcareous spar, heavy spar, and amethystine quartz. Apophyllite is occasionally associated with the heavy spar in some of the veins, and dark-green steatite occurs more or less in almost all. Several of them are characterized by small quantities of vitreous copper, variegated copper, copper pyrites, iron pyrites, blende, galena, and silver; and of those lodes among them which came under my inspection,

one having all these metalliferous products present, with the addition of cobalt and arsenic detected by my Chemical Assistant, Mr. Hunt, was strongly marked by the vitreous copper, which at the spot where the lode was tried, appeared to exist in a workable quantity. The veins coincident with the stratification cut by these, are in general rather thin. They often run by the side of the dykes, and seem for the most part to consist of a breccia of the wall rocks, held together by carbonate of lime and quartz, while steatite was frequently present. Green and purple fluor spar was found in some of them, and Prehnite, associated with Thomsonite, occurred in others. The only metalliferous minerals accompanying them were iron and copper pyrites, but it is doubtful whether the quantity of the latter was in any case sufficient to give great promise of profit in working them. One vein coincident with the strike of the formation, was met with on the northwest side of Thunder Bay, which appeared to be an exception to the rest. It was of great breadth, perhaps not under sixty feet, and in its general character it resembled the transverse veins; its earthy minerals being calcaspar, amethystine quartz, and heavy spar, while at the same time it carried small quantities of iron and copper pyrites, galena and blende.

Mineral veins analogous to those of the upper formations were found penetrating the older rocks, but the examination of these has scarcely been sufficient to authorize any remarks respecting them. The vein-stones connected with them appeared to consist chiefly of quartz and calcareous spar, with Laumonite occasionally, and the metalliferous minerals, when any were found, were variegated copper, copper pyrites, galena and blende; but the lodes did not seem to be of such frequent occurrence, as in the higher rocks, nor were those which came under my observation of so important a character.

GEOGRAPHICAL DISTRIBUTION OF ROCKS.

Commencing in the vicinity of Fort William, the granite, gneiss and chloritic slates, keeping to the north of the Kamanitiquia River, from the neighbourhood of the northern bend, which occurs in the upward course of its valley, and maintaining a northeasterly strike, come upon the shores of Thunder Bay about ten miles

below the mouth of the stream. The slates are visible only for a short distance, but the granite, out-flanking them both ways, is seen touching the water at intervals for a distance of seven miles. Before reaching the extremity of the bay, the granite again gradually leaves the coast, and, crossing the isthmus which separates Thunder from Black Bay, regains the water about nine miles from the bight of the latter, in a spur, of which the point is in Granite Islet, while the main range keeps several miles inland, and turning up in a more northerly direction, reaches Neepigon River some distance above the second rapid. The granite then attains the northern end of the small lake lower down, and its associated gneiss, bounding the whole length of this on the east side, again approaches the great lake, near the mouth of the Jack River which falls into a deeply indented cove in Neepigon Bay; farther on the rock emerges from beneath overlying red sandstone and trap, and comes upon the water of the bay itself, in a cove furnished with a river, rather west of a point due north from the Chenal Ecarté, the strait between St. Ignace and Simpson's Islands. From this, cutting across a projecting point of sand constituting the delta of a considerable brook, it forms a bold rocky coast overlaid by occasional patches of trap, along the north side of the Grand Detroit, leading out of Neepigon Bay to the eastward, by the Petits Ecrits, where it is intersected by east and west trap-dykes, to the deep cove receiving the Rivière au Brochet.

In this vicinity the chloritic and conglomerate slates come in, and occupy the coast by L'Anse à la Bouteille for about fifteen miles, to a point two miles westward of the mouth of the Old Pic River, striking in a direction that would carry them out to the islands to the southwest, which may probably derive their name of the Slate Islands from being composed of the rock. The slates again occupy the coast for about seven miles on each side of the New Pic River, while the interval from the neighbourhood of the Old Pic to that of Peninsula Harbour, including the Pic Islands, is composed of trap. It appears probable that the bands of slate by which the trap is thus flanked on either hand, may be the sides of a trough converging to a point inland, and would, therefore, be exteriorly followed by the granite and gneiss. In accordance with this, the two formations just mentioned, coming out from behind the southern band of slate, form a bold and rugged coast,

extending thirty-five miles, to a point about six miles southward of Otter Head. A gneissoid quality of rock prevails at both extremes of the line, particularly the southern, where Otter Head and its vicinity present a remarkably regular set of strata, in which the constituents of syenite are arranged in thin sheets, and in a highly crystalline condition, offering a beautiful material for flagstones, which might be obtained in almost any quantity or of any size required. Between the Rivière du Petit Oiseau and the Rivière aux Hirondelles, a distance of eight miles, about equally removed from both ends of the line, the gneissoid character of the rock appears to be wanting, and it would not be inconsistent with this fact, to suppose that the formations fold over an anticlinal axis situated somewhere in the vicinity, and running at about right angles to the trend of this part of the coast, which would be about twenty degrees to the north of east. It is not improbable that there may be minor undulations in the distance.

From the point to which the granite and gneiss have been thus traced, to the mouth of the Michipicoten River, the coast after a gradual turn, assumes a nearly east and west direction, the distance being about fifty miles. In this the slate and the granite rocks divide the coast. Slates occupy the first seven miles; epidotic granite, without much evidence of a gneissoid quality, succeeds, and continues for seventeen miles; slates occupy the next thirteen; granite the succeeding seven, to within a mile of the River Doré; the remainder of the distance displays the slates, and it appears not improbable that this, with the two previous patches, which in the first and last instances seem to be let down by transverse dislocations, may constitute the fragments of the northern rim of another trough, coming to a point some distance inland, in the vicinity of the river, and presenting its south side, cut through by the coast, where the gneiss once more makes its appearance, near the Rivière à la Vieille, between Cape Brulé and Cape Choyye. What undulations there may be in these older rocks farther on, has not been ascertained. It is not improbable there may be several. They do not, however, appear to be of such an important character as to bring in any great body of the chloritic slates on the coast, though they may serve to extend the spread of the granite and gneiss, to the strike of which, taken in detail, the eastern margin of the lake seems usually to

be transverse. With the exception of a few square miles of the upper trap at Gargantua, these two rocks appear to hold the coast all the way to the vicinity of the Pointe aux Mines, a distance not far short of fifty miles, at the extremity of which they separate from the shore, maintaining a nearly straight south-easterly line across to the eastern part of Bat-cheg-wa-ua-ung Bay, leaving the trap of Mamainse between them and the Lake. Thence they reach the northern part of Goulais Bay, and finally attain the promontory of Gros Cap, where they constitute a moderately bold range of hills, running eastwardly towards Lake Huron.

Upon the three inferior rocks, whose range has been noticed, the two superior trappean formations repose unconformably. The lower one, or bluish slates with their associated volcanic layers, compose the whole of the country, islands and mainland, between Pigeon River and Fort William; and the valley of the Kamanitiquia River in the eastern part of its course, may be considered the boundary of its outcrop in this district. Eastward, on the main front of the lake, it constitutes Pie Island, and the promontory of Thunder Cape, reaching to a point about six miles to the eastward of its extremity, where a transverse dislocation lets down the succeeding formation at least 1,300 feet, bringing it suddenly in to occupy the coast in the strike of the other. The lower formation, however, constitutes the whole of the bed of Thunder Bay, on the north side of which the conglomerate layer at its base, is seen to rest in a nearly horizontal position, upon the highly tilted chloritic slates beneath, where in one spot, it evenly covers over without any disturbance, a step in the slates produced by an ancient transverse fault. On the same side at the eastern extremity of the bay, the chert beds belonging to the series, occupy two miles of the coast. But the whole volume of the formation in this part, appears gradually thinning down; for while between Thunder Cape (in which alone a vertical thickness of 1,300 feet is displayed) and the final outcrop of the base on the northwestern side of the bay, there is a breadth of more than twelve miles, one of no more than probably three miles would span the distance in the bight of the bay between the granite and the southeastern cliffs, displaying the lower white sandstones of the succeeding formation; while the dip does not

increase in a ratio sufficient to preserve the western amount. In corroboration of this, where the spur of granite comes upon Black Bay, in the vicinity of Granite Islet, the bluish argillaceous slates are altogether wanting, and the succeeding sandstones are seen to come in contact with the inferior rocks. Nor were the slates again observed to the eastward, though the sandstones and granite were more than once detected in contact, with the exception of one locality where they were noticed by Mr. Murray forming part of some of the islands in the Grand Detroit exit from Neepigon Bay, to the north of the large centre island of the Battle Group, composed of those eastward of Simpson's Island. The thickness of the deposit was there not very important, and it probably does not reach much farther in that direction.

Commencing at the Thunder Cape downthrow which has been mentioned, the white sandstones at the base of the succeeding formation, constitute an escarpment on the southeast side of Thunder Bay, and are displayed in vertical cliffs rising to 200 feet above the water, which occupy about seven miles on the same side towards the northeastern extremity. The limestones and indurated marls start from a point about a mile and a half eastward of the downthrow, on the south side of the tongue of land separating Thunder from Black Bay; and running parallel with the sandstones, dipping southeasterly at an angle of about three degrees, they probably occupy the upper side of the latter bay, where there is however but little exposure of rock, a fringe of marshy land shielding much of the coast. Beds of red sandstone of a conglomerate character, associated with layers of variegated red shale, are seen reposing on the granite of Granite Islet. The conglomerate is composed of granitic ruins, and fills up the inequalities and worn fissures of the rock supporting it, displaying a southern dip at an angle of about ten degrees. The variegated shale is of a calcareous quality, and it is not improbable that a considerable part of Black Bay may be worn out of the indurated marls. The higher and more volcanic part of the formation, commences at Point Porphyry, and in Edward Island and others northward, grits and conglomerates are found interstratified with trap layers. The same interstratification is met with in the rocks bordering the southeast side of Black Bay, while those fronting the lake on the southeast side of the peninsula, are composed almost

entirely of various qualities of conformable overlying trap. This arrangement of the stratification occupying a belt of seven to ten miles in breadth, which on the lake front is carved out into a multitude of deep coves, and includes a great collection of small rocky islands, runs in a northeasterly direction across Neepigon Straits from the main land to St. Ignace Island; gradually changing its direction about the middle of this to due east, it continues on through Simpson's Island, and farther to the eastern extremity of the Battle Group. A high precipitous escarpment of red sandstone, with white bands and conglomerate layers, all interstratified with occasional beds of variegated red shale, and having a pretty constant dip of eight to nine degrees, keeps its place on the north side of each suceeeding island standing in the line, which curves a little to the south of eastward toward the eastern extremity. A section across from the granite through the large centre island of the Battle Group, would shew in place both of the upper formations in succession, apparently diminished in their proportions; and in the cliffs on the north side of the last of the Group, the limestones are displayed associated with white sandstones, with a conglomerate layer beneath, resting on trap of a porphyritic character, and overlaid by volcanic products of a more porous quality, the succession of the sedimentary part in ascending order being as follows:—

	Feet.
Conglomerate and red sandstones,	30
Red and white shales and sandstones,	70
Reddish or flesh-coloured limestons in beds of two to twelve inches,	30
White sandstones,	70
	200

The isthmus which separates Black Bay from Neepigon Bay appears to be entirely composed of sand and clay. But it seems not improbable from the direction which the spur of granite already twice mentioned assumes, in running out to Granite Islet in the first named bay, that an undulation in the stratification occasioned by it in the superior rocks may cross beneath the sand and clay, and carry its course between St. Ignace Island and those two islands to the north, of which the western one is called the Grange. No northern dip was anywhere observed, but this may be concealed by the loose

material of the isthmus, and the waters of the bay; and should such an undulation exist, it is probable the strata of the two islands would be a repetition of those of St. Ignace. An escarpment of south-dipping red sandstone exists on the north side of them, and it strikes for the sandstone and overlying trap on the main land both due east and due west; while two miles farther north, sedimentary strata still dipping south at an angle of about five degrees, underlie the perpendicular cliffs of columnar trap at the mouth of the Neepigon River. These strata are of a very calcareous quality, and probably belong to the limestones of the formation. The white sandstones which are at its base in Thunder Bay, were not here observed to crop out. A considerable space however, probably upwards of a mile, between the basset edge of the calcareous strata and the granite, was occupied by a deposit of sand about sixty or seventy feet thick in some places; but to the eastward, the sandstones of the Grange Island were seen to repose on the granite without the intervention even of the calcareous beds. Where these beds and the sandstones associated with them were seen at the outlet of the Neepigon, the overlying trap did not appear to be in a perfectly conformable attitude. It seemed to be more horizontal than the sedimentary portion of the cliff. The slope of the beds as stated, was about five degrees, and as they approached the base of the trap, they appeared to become obliterated, some of them proceeding farther than others into the volcanic mass, but in such a manner that it was difficult to say where any bed finally stopped.

It seems not at all improbable that Isle Royal belongs to this volcanic formation. My visit was confined to the upper half of it. In this, the bight of Siscouette Bay, which occurs in about mid length of the island on the south side, is at the base of a range of trap hills whose course runs nearly N. E. and S. W. The area in front of them, between Siscouette Bay and the south-western extremity of the island, is composed of red sandstones with conglomerate layers, which with a breadth of nearly three miles, rest upon the trap and dip about southeast at an angle of nearly ten degrees, while the remainder of the island in its whole length appears to consist of trap, much of which is of an amygdaloidal character. The average breadth of this trap is about six miles. The dip of the band appears to be greater than that

of St. Ignace, and it is probably stated within the mark at fifteen degrees, being to the southeastward. The general strike is well marked by the form of the island, and the number of deep inlets which are worn down in the softer beds at the lower extremity, the most southeasterly of which is not under ten miles long, shews the great parallelism of the different layers. The general position of the island and the dip and strike would bring the whole mass to the front of St. Ignace, as if it constituted an addition to the volume of the formation; but it appears to me a more probable conjecture that there is a trough between the two positions, the northern slope of which is concealed by the waters of the lake, and that Isle Royal constitutes only a repetition of the Neepigon peninsula and archipelago.

Proceeding eastward, the mass of trap which has already been mentioned as flanked on both sides by the chloritic slates in the northeastern corner of the lake in the vicinity of L'Anse à la Bouteille and the Pic River, may belong to the formation, but of this there is much doubt. In a straight line across from one side to the other on the coast, it occupies a space of about fourteen miles. No rocks of a sedimentary character were observed to be associated with it, but its stratification was very distinctly marked, with a dip southwesterly of about twelve degrees. Its quality differed in different places, but no portion of it was observed to be amygdaloidal, except one bed which exhibited a decided transverse columnar structure; the general character of others appeared to approach that of the more solid and crystalline trap overlying the amygdaloid towards the lake front of the Neepigon and St. Ignace band. On the upper side the mass is brought into position by an outburst through the slates, which is well displayed on the main shore, at a point nearly due north of the western extremity of Pic Island. The trap there abuts against the chloritic slates; on approaching them, its feldspar, constituting the predominant mineral, assumes a red colour, with occasional opalescence, and strongly contrasts with the brilliant black hornblende disseminated through it; it contains a few zircons. In the first hundred yards near the junction, the slates appear to be shivered and sliced into a very coarse breccia, of which the interstices are filled with trap of this quality; while in the second hundred yards they are cut up by a number of irregularly parallel, though somewhat ramified dykes

of the same, having a general northerly direction, which is that of the dingle marking the course of the junction of the two rocks. Removed from the junction, the trap is still coarse-grained, but the general colour of the feldspar is a dull-green, holding black hornblende, and magnetic oxyd of iron appears to be one of the constituents. The columnar bed has occasional large patches of a red colour, holding red feldspar, white quartz, and black hornblende; but the general colour of the matrix in which these are imbedded is chocolate-brown, resulting from the feldspar constituting the mass, in which small cells are filled with calcspar and red and white zeolites, while well defined slender acicular crystals of black hornblende are abundantly disseminated through it. The rock above and below is composed of brownish feldspar and black hornblende, but it is not so compact as the other. It is large-grained, and the general mass of the country constituting the Old Pic Point and Island appears to be composed of it; fluor spar occurs as a disseminated mineral in some beds. Judging from fragments on the shore, there are some beds composed of white feldspar, with occasional clusters of orange-red grains of elæolite, the whole studded with brilliant black crystals of hornblende, forming a very beautiful variety of rock. The general mass of these volcanic overflows weathers to a red, and from a distance may readily be mistaken for the granite which underlies the chloritic slates. The hills which it forms are not, however, quite so rugged as those resulting from the older rock.

Much to the south and a little to the east of this Michipicoten Island is another mass of trap belonging to the upper formation. The strata of which it is composed, have a general dip to the east of south, and the inclination appears seldom to fall short of thirty degrees. The lower strata towards the north side of the island, particularly as indicated at the upper end, appear to be composed chiefly of amygdaloidal trap, with occasional beds of trap conglomerates, red sandstones and shales; while towards the south these are overlaid by a considerable amount of compact earthy or sub-resinous red trap, assuming sometimes an obscure, and sometimes a decided porphyritic character, by the display of undecided imbedded crystals of red feldspar or well pronounced crystals of transparent quartz. Along nearly the whole of the south side of the island, the trap assumes a more resinous

aspect, and its colour becoming black it presents the characters of pitchstone and pitchstone-porphyry. Some of the beds associated with these are of an amygdaloidal quality, and exhibit large enclosed agates, while the pitchstones are cut by a multitude of agate veins, which run chiefly in the direction of the strike, but frequently also transverse to it. About three-fourths of a mile out in front of the harbour, which is half-way down on the south side, a few narrow islands occur, presenting beds amounting to between sixty and seventy feet, dipping southward at an angle of twenty degrees, whose character is peculiar. They are of a general red colour, spotted and patched with yellowish-white, and wherever a crack exists, the rock is thus blanched to a small distance on each side of it. The surfaces are uneven, and peculiarly marked with festooned and finely-wrinkled forms, composed of very thin close-fitting laminæ, with a ligneous aspect, possessing a greater or less aggregate thickness, sometimes exceeding one or two inches. The rock scarcely resembles a trap, nor does it bear the character of an indurated shale, but it may perhaps be an indurated mixture of volcanic mud and ashes, in which the wrinkled forms result from a partial flow. The total volume of the formation developed in Michipicoten Island, at the most moderate dip observed, would not fall short of 12,000 feet.

On the east side of the lake, white and red sandstones are seen at several points, and so also are beds of amygdaloidal trap with coarse interstratified conglomerates. The sandstones, except where in the vicinity of disturbances from dislocations, appear to be much less tilted than the trap and coarse conglomerates. Both have a dip westward, but the facts ascertained are not yet sufficient to determine in what precise relation the two rocks stand in regard to one another. About two miles north of Cape Choyye, a coarse-grained bed, supporting some thickness of sandstone, coloured red with white bands, dipping a little to the south of west at an angle of about ten degrees, abuts against a precipitous cliff of the older formations, as if let down by a N. E. and S. W. fault. To the south of this about nine miles, the Peninsula of Cape Gargantua, and some of the small islands immediately near, display amygdaloidal trap, disposed in beds dipping to the south of west at an angle of about forty degrees, and resting unconformably on the gneiss. Farther on,

Leach, Lizard and Montreal Islands, as stated by Bayfield, are composed of sandstone; but not having visited them, it is not in my power to state what the attitude of the rock may be; but it seems probable that the flatness of the geographical surface may be occasioned by the absence of any great slope in the constituent strata. To the south of Montreal Island, sandstones and amygdaloidal trap occupy the lower side of the cove above Pointe aux Mines; the sandstones, where first seen, are nearly in contact with the granite, against which they appear to abut as if brought in by a dislocation. Their dip, at an angle varying from ten to twenty degrees, from a direction N. 45° W. gradually changes to N. 15° W. The trap coming apparently from below, after an interval of about one hundred yards, in which it is difficult to ascertain its true attitude, from its being worn down level with the surface of the water, exhibits a decided dip S. 80° W., at an angle of between thirty and forty degrees, maintained for such a distance across the measures in ascending order, as to yield a thickness of about 3,000 feet. This trap is interrupted at Pointe aux Mines by a southeasterly dislocation, which brings up the granite, of which the extremity of the point is composed. From this point, the line of demarcation between the granite and the overlying unconformable rocks, as has already been indicated, runs across in a southeasterly direction to Bat-cheg-wa-ua-ung Bay, leaving the promontory of Mamainse between it and the lake. This promontory is composed of amygdaloidal trap and coarse interstratified conglomerates, whose pebbles and boulders consist chiefly of the ruins of the subjacent granite, syenite and slate. The general dip of the strata which occupy the area is maintained with considerable constancy in a direction rather south of west, at an angle of twenty to twenty-five degrees, and the breadth across the measures is sufficient to give a thickness exceeding 10,000 feet, of which fifteen per cent consist of conglomerate layers, one of them being 400 feet of the amount. On the south side of the promontory, approaching L'Anse aux Crêpes, irregularities prevail, and sandstones in a disturbed condition approach the trap, but keep on the lake side of it.

Between this point and Sault Ste. Marie, stratified amygdaloidal trap was observed in three places. The first was in the most eastern part of Bat-cheg-wa-ua-ung Bay, where it reposes on the

granite, with a dip S. 80° W. < 42°. The second was in a cove about two to three miles to the east of the southern boundary of the same bay. The worn condition of the rock rendered the dip obscure, but it appeared to be N. 60° W. < 22°, and it seemed not improbable the rock may be a part of a mass rising into a hilly surface, and resting on the granite between Bat-cheg-wa-ua-ung and Goulais Bays. The third position was at the extremity of Gros Cap, where there is but a small quantity of the rock, and where trap of a porphyritic quality appears to be associated with it. The dip is W. < 45°.

The sandstones in the same distance constitute the promontory between L'Anse aux Crêpes and Bat-cheg-wa-ua-ung Bay. They probably also underlie the large island of this bay; and with the exception of the interval occupied by the trap in the cove at the southern entrance of the bay, they compose the coast from a point three miles to the east of the cove, round to Goulais Bay, underlying the whole of Goulais Promontory and Maple Island. A narrow strip of the rock is found also leaning against the gneiss on the south side of Goulais Bay, extending seven miles along the coast towards Gros Cap, and dipping gently to the northwestward, not quite in the direction of Isle de Parisien, which is also composed of the rock, with a dip of two or three degrees in the direction of White-fish Point..

In every instance the geographical surface of the sandstones on the east side of the lake is low and flat, and their geographical position in relation to the stratified trap would seem to indicate that they overlie the latter, perhaps unconformably. Their presence in Caribou Island, as stated on Bayfield's Map, seven leagues south of Michipicoten Island, and more than twice as many east of Montreal Island, makes it probable their spread may be considerable under the waters of the lake, while sandstones occupy a great extent on the south shore; the geologists of Michigan represent them to exist at intervals from the vicinity of Point Iroquois to Grand Island, in which latter spot it has been ascertained by Mr. Higgins of the Michigan State Survey, that they are capped by fossiliferous limestone.

The age of the volcanic formations of Lake Superior is a question that has not yet been finally settled, and the doubt concerning them seems to be whether they are older or newer than the Potsdam sand-

stone of New York. The difficulty arises from the absence of fossils, none of a satisfactory kind that I am aware of having been obtained from any beds whose relation to the volcanic rocks is undoubted, either on the north or south side of the lake. In an excursion to Neebish and St. Joseph Islands, made in company with Mr. Bela Hubbard of the Michigan State Survey, while waiting in the vicinity of Sault Ste. Marie for an opportunity of transport to Copper Harbour, we found formations corresponding with the Utica slates and Trenton limestones with their characteristic fossils, resting upon other formations occupying the position and answering the conditions of the calciferous and the Potsdam sandstones, the whole of them exhibiting a very moderate dip southward; and there does not appear any reason to doubt that the last mentioned rock reaches up to Sault Ste. Marie, and extends to the foot of the Gros Cap Mountain and Point Iroquois. The nearly flat sandstones met with between this promontory and Grand Island, with the fossiliferous rock overlying them in the latter locality, appear to correspond with the necessary conditions of the same formations, and the presence of similar sandstones in the various low islands and peninsulas on the Canadian side to the east and north, would seem to make it probable that the lower rock has a still farther extension in those directions; while the contrast between the moderate dip which these display, and the higher inclination of the volcanic strata at Gargantua, Mamainse and Gros Cap, combined with the fact that the sandstones always keep to the lake side of them, while granitic rocks constitute the main body of the land, appears to support the view taken of the sequence by the late Mr. Houghton, in his Report to the Legislature of Michigan in 1841, that the copper-bearing traps of Lake Superior are of a higher antiquity than the Potsdam sandstone.

The chloritic slates at the summit of the older rocks on which the volcanic formations rest unconformably, bear a strong resemblance to those met with in the upper part of Lake Temiscamang on the Ottawa, and it appears probable they will be found to be identical.

Drift.

On the margin of the lake in several parts and on the banks of some of the streams which were examined for short distances up from their mouths, considerable accumulations of drifted materials

were observed, consisting of clay, sand, gravel and boulders, derived from the ruin of the rocks which have been described and others which did not appear *in situ*. No evidence was obtained of the age of these deposits. The only organic remains met with in them belonged to some of the pebbles composing the gravel; and these fossiliferous pebbles appear to have been derived from rocks not lower in the New York series of formations than the Niagara limestones. Some of these accumulations of drift reached the height of 330 feet above the level of the lake, and when on the coast they were generally found to present a series of well defined terraces, marking various periods of recession in the water which once covered them. One of the most remarkable is to be found on the north shore, about three miles below the Petits Ecrits. It displays six terraces in addition to the summit, which presenting a level surface throughout the whole length, may be considered a seventh. Blocking up the extremity of a deep cove from the rock on one side to that on the other, the accumulation is a barrier to an extensive flat and marshy surface that spreads out in a valley behind, down to the level of which there is a rapid slope from the summit of the drift, at a distance of about 1000 yards from the margin of the lake. The heights of the ancient beaches were rudely measured by means of a pocket spirit level, and they were found to be as follows:—

	Above the Lake. *Feet.*	Above the Sea. *Feet.*
1st beach,.....	30	627
2nd beach,.....	40	637
3rd beach,.....	90	687
4th beach,.....	224	821
5th beach,.....	259	856
6th beach,.....	267	864
7th beach or summit,.....	331	928

The third and fourth beaches were the most decidedly marked, the steps rising behind them sloping up at an angle of nearly 30°; and the marsh in the rear was precisely on a level with the fourth beach, its distance from which was about 500 yards. On other parts of the lake, terraces exist which are marked by the wear of the rock as well as of the looser material.

ECONOMIC APPLICATION OF MATERIALS.

To the possible existence of a mineral region of some economic importance on the Canadian shores of Lake Superior, allusion was made in the Report I had the honour to address in 1844 to His Excellency the late Lord Metcalfe, at that time Governor General of the Province. The nature of the region was inferred from the geological character of the south side of the lake, as described by the late Mr. Douglas Houghton, Michigan State Geologist, in an Official Report upon the District, submitted to the Legislature of the State in 1841. The occurrence of copper on the lake coast has been long known. It has been alluded to by several travellers, and one or two unsuccessful attempts of little importance have been made at different periods to obtain it by mining. Captain Bayfield, in his Geological Description of the Country, communicated to the Literary and Historical Society of Quebec, and published in the first volume of their Transactions in 1829, notices the presence of the metal; but it was not until the appearance of Mr. Houghton's Report, in which the character of the mineral veins containing it, was given with more definite detail, that the public mind became directed to the district as a mineral region.

Since that period a rush has been made to the district by the enterprising citizens of the neighbouring Union, with a view to the working of its mineral treasures, and a considerable amount of capital has been embarked in some of their speculations. The whole subject of this mineral region, however, is still so new that the present efforts to turn it to account can only be regarded as an extended exploration, by which a great number of valuable facts will be ascertained, to illustrate the true nature and position of the productive ground; and although it is probable some of the adventures may at present prove successful, a vast number cannot fail to end in disappointment to those concerned in them. But the metalliferous lodes which characterize the rocks of the country are so numerous, and spread over so wide an area, as naturally to excite strong hopes of many valuable discoveries, while they afford a reasonable foundation to expect that a period will at some time arrive, which circumstances may hasten or retard, when mining will become established as a permanent branch of industry in the region, and the extraction

and reduction of its metalliferous ores will form a source of wealth to its future inhabitants.

The same ultimate results may be anticipated on the Canadian shores of the lake, which are characterized by rock formations, and mineral veins of a similar description. These mineral veins are very numerous, and are marked to a greater or less extent by metalliferous indications along several sections of the coast from Pigeon River to Sault Ste. Marie. It is, however, in general a mere narrow strip along the water line which has been inspected, and it is still doubtful how many of the veins which were observed to contain these indications, will yield a present profitable result.

The uncertainties of mining are so great that even after a careful surface investigation, it is often very difficult to estimate with precision the probable value of mineral results. Any opinion in regard to them must of course, be founded on the quantity of the mineral, the cost of mining it and bringing it to the surface, of dressing or shaping it for, and transporting it to a market, as compared with the price to be obtained for it after its arrival there. No very great difculty will perhaps be encountered in any case in ascertaining all the elements of the calculation, with the exception of the first, that is the quantity. With regard to such minerals as are deposited with regularity, the quantity can be ascertained with facility. In the instance of coal, for example, which is almost always deposited in extensive sheets of pretty uniform thickness, the rule is that about 1,000 tons can be procured from every one foot thick of every superficial acre of a bed. But it is not so in respect to mineral veins, the most common form in which metalliferous ores occur.

Mineral veins, as distinguished from mineral deposits, generally occupy what are supposed to be cracks in the rocks of a country, and these cracks are conceived to be the result of upheaving forces which have broken the continuity of the rock. The crack is usually accompanied by a slip or dislocation of a greater or less amount, by which parts in the plane of the crack that do not fit, are brought opposite to one another, giving space for the subsequent secretion of the mineral matter. It is evident that a fissure of this description in which salient parts on opposite sides would touch, and re-entering parts recede from one another, would produce a very irregular mould, and the mineral vein just fitting it, would have a quantity that no *a priori* reasoning could determine with precision.

Mineral veins may be divided into two kinds, distinguished by the supposed mode in which the cracks may have been filled up. The mineral matter may have been injected from beneath into the mould in a condition fluid from heat, in which case it would be a *dyke*, and the quality would probably have a considerable amount of uniformity ; or it may have been secreted by means of deposit from infiltrated fluids holding the mineral substance in solution, or through the influence of electricity, carrying it from the interior of the rock of the country, or wheresoever it may have been within the influence of the electric current, to the receptacle of the vein, or by a combination of both these causes. In this case the almost endless modification of the acting forces may have produced a nearly infinite variation in the arrangement of the mineral substances, in regard both to their quality and distribution ; and the irregularities thus occasioned would greatly enhance the difficulty of estimating the quantity of the productive part of a mineral vein.

Metalliferous mineral veins, or metalliferous *lodes* as they are termed by miners, are of the complicated description last mentioned. They are sometimes perpendicular, but usually at high angles of inclination, and in general they are filled up partly with metallic and partly with earthy minerals, the proportions these bear to one another being very various in different cases, and often very different in separate parts of the same lode. It often happens that in some part of the lode there will be a very great deficiency of the productive material, both horizontally and vertically, giving intervals of what is termed dead ground.

In a great mineral district such as the Counties of Cornwall and Devonshire in Britain—where 30,000 inhabitants are engaged in working upwards of 160 mines, and the value of the metals annually raised exceeds £1,500,000, more than half the value of all the metallic products of Great Britain and Ireland, with the exception of iron, which amounted to the sum of £8,000,000 according to Sir H. T. De la Beche's Report in 1838, and no doubt now surpasses it—there is a vast amount of floating knowledge in regard to almost all the metalliferous lodes even in their inmost parts, and so many analogies for the solution of neighbouring cases are established by the facts ascertained in such an extensive range of excavations—which in some single large mines, taking adit levels, horizontal galleries and vertical shafts, equal sixty-three miles—that a fair guess can often

be made of the productive contents of a vein from careful surface inspection. Yet even in Cornwall the hopes of the miner are very frequently disappointed, and adventurers in a new mine are seldom very sure of their operations, until a trial level has been driven longitudinally in the lode, and more than one trial shaft sunk vertically, to ascertain facts upon which to found a calculation of what the produce of the whole mine may be.

The uncertainties in a new mineral region, unless it be one of a very uncommon character, being of course still greater than they are in an old, until the productiveness of a lode has been established by such test-works as have been mentioned, which will require time and a considerable outlay of capital, any opinion hazarded in regard to results must be regarded as very liable to error. But by a careful surface examination, a rude, imperfect, preliminary guess may perhaps be made at the contents of a vein by following its outcrop and taking from as many parts as possible in the run, fair average samples of the whole breadth at such depths as appear to be unaffected by the influence of weather, and assuming these to be an index of the interior quality both vertically and horizontally.

It is probably for the copper contained in the metalliferous lodes of the region in question that they will ultimately be worked, and the proportion of this metal, in those lodes of which it was in my power to obtain what appeared to me to be an approach to average crop samples, varied, according to the analyses of Mr. Hunt, the Chemist attached to the Survey, from two to seven per cent, while the thickness of the lodes ranged from ten inches to about four or five feet, yielding from three quarters of a hundred weight to three quarters of a ton of fine copper in a fathom forward by a fathom vertical of the lodes. Several of them contained traces of silver, although the quantity appeared scarcely sufficient in any instance to warrant its separation from the copper; but as the silver is found in the native state and irregularly diffused, analyses of different specimens may give very different results. If these copper lodes were situated in the midst of a practised mining population, and at a moderate distance from favourably located establishments for the reduction of their products, it is probable some of them might at once be worked to advantage; but the expenses attendant upon a region so remote from settlement, where the wages of labour must remain high for a considerable period of time, would require lodes of a more than

commonly fruitful character; and if the spot at which the ores are to be ultimately reduced and refined is remote, one of the most serious charges to be encountered is the cost of transport, in proportion to which it will become essential to concentrate the ores as they come from the mine, by dressing, or even partially smelting, if it can be more economically effected.

Since the restrictions on the introduction of the produce of foreign mines into Britain has been partially relaxed, copper ores have been sent to the British market from various parts of the world. In the Appendix will be found a table shewing the annual quantity of copper ores, British and foreign, smelted in Britain for the last eight years, from the 30th June, 1838, to the 30th June, 1846, classified according to the general sources whence the ores were derived, with the average produce, and the average price of the ore from each general source. By this it will be seen that the produce rises with the distance.

The average of Cornwall, after the ores have been dressed by washing, does not in any one year reach eight per cent, from which it will be readily understood that the portion selected for dressing must have been much lower before the operation, and that the whole quantity of material cut in the mine, must have been lower still. By reference to another table shewing the copper ore publicly sold from each mine in Cornwall for one year to the 31st December, 1845, it will be seen that the produce of some individual mines occasionally does not exceed 4 per cent even after dressing. The ores of Ireland, which have to bear a rather higher charge for transport, are raised to a rather higher percentage than those from Cornwall, the average being over eight per cent; while those of Wales, which are of less importance, and of which the quantity appears to be diminishing, vary from year to year in the percentage, according to accidental circumstances. The mines seem to be less regularly worked, and some of them are at much greater distances from the smelting establishments than others.

After Cornwall, the next great source of copper ore is Cuba, from a few mines in which island, with one or two unimportant additions from other parts on the eastern side of the American Continent, a quantity is supplied equal to more than one half that raised from all the seventy to eighty mines yielding copper in Cornwall, (some of which appear to be very poor concerns,) and four times

as great as the total produce of the copper mines of Ireland. The ores of Cuba are naturally richer than those of Britain, but the charge of transport being considerable, no doubt their percentage is in consequence raised by hand-picking or some other mode of dressing. In 1839 the average produce was nearly twenty-two per cent, but it has since gradually declined to a little over sixteen per cent. What the reason may be, I am not prepared to state, or to say whether the natural produce has deteriorated, or a diminution in the charges of transport has rendered it less necessary to concentrate the ore by dressing.

The ores from the Pacific side of the American Continent are very considerable in value. Until the last year, the value amounted to one-fourth of that of the ores of Cornwall. The average produce in 1839 was nearly twenty-five per cent, and in 1846 it reached nearly thirty-four per cent. To meet the charge of a high freight, a considerable quantity of the ore is concentrated by a partial smelting in South America. The quantity imported into Britain, and sold to British smelters, has during the last year materially diminished, and there are indications that these high-produced and partially reduced ores are finding their way to smelting establishments on the Continent in consequence of the duties still payable on foreign ores. The duties on copper ores imported into Britain are,—

On Foreign, not over 15 per cent, £3 10s. per ton of copper.
On Foreign, not over 20 per cent, £4 10s. per ton of copper.
On Foreign, over 20 per cent, £6 per ton of copper.
On Colonial, for all produces, £1 per ton of copper.

The charge on foreign ores is sufficient to compensate for a considerable difference in the value of the fuel, labour and skill required in their reduction.

The discovery which has lately been made of copper ores in South Australia appears to promise a considerable supply. The ores seem to be of an unusually rich quality; but some difficulty is experienced in furnishing full particulars of them, in consequence of the names merely of the mines being given in the Swansea ticketing-lists without anything to indicate localities, and from this circumstance some of the Australian ores may have been classed with those whose sources are uncertain. According to the Swansea ticketing-sales, the average produce of 912 tons of the ores received the first year, to the 31st December, 1845, was upwards of nine-

teen and a half per cent, and the average price £16 9s. 9d. per ton of twenty-one hundred weights. During the year ending the 31st December, 1846, a quantity of 2,718 tons was sold from six mines, yielding £47,379, the average produce being over twenty per cent and the average price £17 8s. 7d. The result from two of the mines was as follows:—

	Ore.	*Fine Copper.*		*Produce.*	*Price.*			*Total value.*
	Per 21 cwts.	*Tons*	*C.*	*Q.*	*Per cent.*	£	*s.*	*d.*	£
Burra-Burra.....	1,038	231	8	2	22¼	17	9	4	18,133
Kapunda.....	831	221	18	2	26 11/16	20	2	6	16,726

In Britain the copper ores disposed of publicly, are sold at what are termed *ticketings*, which are a species of auctions at which each bidder, being a smelter or the agent of a smelter, makes a written tender to the salesman for the parcels of ore put up from each mine in succession, all making them simultaneously, and no one knowing what the offers of his neighbours may be, until they are read out by the salesman. Each highest offer thus made, obtains each parcel for which it is bid; and if there are more offers than one at the same highest price, the parcel is equally divided among those making them. The ores of one mine, if the quantity is large, are usually for the convenience of the smelters, divided into lots not much exceeding 100 tons. The simultaneous bids for them having been read out and the parcels allotted, tenders of a similar description are made for the ores of the next mine on the list, and so on until all are sold.

The Cornish ores are disposed of by weekly advertised ticketings held at one or other of a few principal towns in the neighbourhood of the mines, and the ores are to be taken as they lie on the ore-floors of the mines, to be weighed, delivered and paid for within one month. The prices which the ores bring at the ticketing-sales determine the value by which the miners who have worked them, on what is called *tribute*, (which is on shares,) are to be paid, and by which the *Lord's dues* (or proportional sum to be paid as rent) are ascertained. Irish, Welsh, Foreign and Colonial ores are usually imported into Swansea, which is the most central town near the chief body of smelters, and there sold by ticketing, to be taken as they lie on the ore-floors of two or three ore merchants, who receive them on consignment and effect the sales on commission.

As each smelter will trust to his own examination only, to determine what copper the ores may contain, he employs his own assayer for the purpose, and keeps his own counsel in regard to the result. But he must of course obtain fair samples of the ores. In order that all may be dealt with equally, and to save trouble, there is but one sampling of each parcel of ore, at which each smelter as well as the owner has an agent present, and one large average sample being taken, it is subdivided into several smaller samples, of which one is given to each party concerned. If the ore is from abroad, a Custom-house officer obtains a sample, to determine the duty. When ores are imported in a rough or coarse state, it is necessary, for the purpose of fair sampling, that they should be broken down to a size in which no piece will exceed about half a cubic inch. A moderately fine size has the effect of assisting the smelting of the ore. The assay is effected in the dry way, which seldom gives so high a percentage as is obtained in the humid mode, and all metals but the copper are neglected. In no copper smelting establishment that I am acquainted with, is any attention given to the separation of these metals, or any attempt made to secure the volatile products, but every smelter expects to get out a rather larger quantity of copper than the assays give, the increase being from about two to three per cent on the copper, while from about a thirty-second to a sixteenth of one per cent is thrown away in the slags.

The charges made by the ore merchant at Swansea for the various operations connected with the sale of the ores, including sampling, weighing, yard rent, and his own brokerage, I am informed, amount to something over five shillings the ton when the ores do not require to be crushed, with two shillings more when they do, and these charges are to be added to freight, insurance and duty, in calculating the probable returns from shipments direct to that port. As the ore must necessarily be exposed to the vicissitudes of weather, it absorbs a considerable amount of moisture, and there results some wastage in the quantity in moving the ore. An allowance is made to the purchaser of twenty-four and a half pounds per ton for the latter, and of whatever it may be found to amount to by trial for the former. The two together may sometimes reach five per cent of the quantity.

The number of copper smelting establishments in Britain is very limited, but a vast amount of capital is embarked in them. It con-

sists in the stock of copper ore which it is necessary to hold to insure regular work; the ore and partially-reduced material in progress through the furnaces; the copper held in various towns to effect sales; the copper absorbed into the furnace bottoms, which is a very considerable quantity, varying from two to two and a half tons in an ore furnace, to about ten to fifteen tons in a refining furnace; and the various furnaces, implements, and buildings constituting the *plant* of the establishment. As will be seen by reference to the Appendix, there are seven houses that bid at the ticketings, whose smelting works are situated within twenty miles of Swansea, and four that purchase ore by private contract only, whose works are chiefly near Liverpool. The situation of the establishments is chosen in reference to the proximity of coal. It requires a greater bulk of coal than of copper ore to make a ton of copper, and hence it is cheaper to carry the ore to the coal than the coal to the ore. At the average produce of the Cornish and Irish mines, the proportion is about three of coal to two of copper ore, and the proportion increases with the increasing produce of the ore, although it decreases of course in relation to the ton of copper. As the furnaces are all of the reverberatory description, it is necessary that such a coal should be used as will yield a flame as well as a strong heat, and it must be sufficiently bituminous to bind together in the grate, and not fall through between the bars unburnt.

According to the British system of smelting, which consists in reducing the ores to a reguline sulphuret, and then oxydizing all the products but the copper, and the less oxydizable metals if there are any, the ores and their products undergo seven different processes of calcination or fusion, in the course of which they are exposed to the action of fire for about one hundred hours. The number of furnaces required to perform these operations, the ores averaging eight to ten per cent, is about equal to one for every forty tons of copper annually made, requiring to work and repair them, the labour of about four men for a week for every one ton of copper. The Cornish yellow sulphurets of copper can be used by themselves. They require calcination in the first instance, by which a portion of the sulphur is evaporated and a part of the iron oxydized. The ore is thus rendered more fusible, oxyd of iron being a flux for silica, while it is at the same time a means of forwarding the reduction, by desulphurating the copper. It would be considered hazardous to use carbon-

ates or oxyds of copper by themselves. The carbonates would quickly lose their carbonic acid, and being left as oxyds would, with the oxyds already present, become dissolved in the slags. But in a mixture of one-third carbonates and oxyds, with two-thirds yellow sulphurets, the sulphurets can be used with advantage without calcination. The sulphurets are advanced in the reduction by the oxyds, and these are saved from the slags by the sulphurets, with which they form a reguline sulphuret, having no tendency to mix with the slags, and only occasionally getting into them in accidental small globules by unskilful manipulation. An advantage is found in using a considerable mixture of the Cornish and Irish yellow sulphurets, with the rich imported yellow sulphurets containing sixteen to twenty-five per cent. If the mixture holds too large a portion of the rich sulphurets, however, the regulus comes out with more sulphur in it than when less is used. The explanation probably is, that the poorer sulphurets holding more iron pyrites, which readily parts with its sulphur in the process of calcination, afford a larger portion of oxyd of iron, and that this re-acting upon the sulphur combined with the copper in the richer ores, produces a better regulus. Thus it is found that both the poor and the rich ores act with mutual advantage on one another in the process of smelting as carried on in Britain.

The great expense attendant upon the transport of copper ore to a distant smelting locality, naturally turns the attention of those whose minds are directed to the subject of mining it, to the aid to be derived in its reduction from such coal deposits as are most nearly situated to the region in which it exists. The geological structure of Canada appears to promise little in regard to this useful mineral, but in the States of the neighbouring Union there are two localities on the great chain of lakes to which the mineral region of Lake Superior belongs, one at Cleveland on Lake Erie, the other at Chicago on Lake Michigan, within forty and sixty miles of which respectively, coal belonging to the great Appalachian deposit in the one instance, and the great Illinois deposit in the other, might probably be made available. But in the heart of the southern peninsula of Michigan, which is still nearer the metalliferous region, a third great coal field is spread out; and in this instance the waters of Lake Huron appear to make a deep incision into the deposit in Saginaw Bay. The coal seams have not, I believe, been yet

touched upon the coast, but the band of limestone which immediately underlies the whole deposit, is known to come upon the bay, constituting some of its islands and points. In other parts of its extension in the interior of the country, coal seams have been met with at no great distance above the band, and the great probability therefore is that they will occur either on the shore of the lake or a very short distance removed from it.

Saginaw Bay, therefore, appears to be the position naturally destined for the reduction of such copper ores as may result from the mineral region of Lake Superior. These ores, combined with the sulphurets reported to have been discovered on Lake Huron, seem to be sufficiently varied to give a favourable smelting mixture. The coal is of the bituminous description, and beds of fire-clay will be found supporting the seams. Unless some great change should be effected in the system of smelting copper ores, such as is reported in some of the respectable journals of the British Metropolis as likely to result from the recent discovery of a mode by which the aid of electricity is to be rendered available in the process, there is little doubt the produce of the Michigan mines will ultimately centre in this locality, and it can only be the operation of fiscal laws that will prevent the Canadian ores from finally reaching the same destination.

I have the honour to be,

Your Excellency's most obedient humble servant,

W. E. LOGAN,

Provincial Geologist.

REPORT

OF

ALEXANDER MURRAY, ESQ., ASSISTANT PROVINCIAL GEOLOGIST,

ADDRESSED TO

W. E. LOGAN, ESQ., PROVINCIAL GEOLOGIST.

Woodstock, 20*th April*, 1847.

Sir,

I have the honor to submit to you the following description of two tributary rivers of Lake Superior—the Kamanitiquia and Michipicoten—which you were pleased to direct me to examine in the course of the past season, while the Geological Survey were employed in the exploration of the mineral region on the northern and eastern shores of the lake.

A measurement was made of the Kamanitiquia from the termination of Captain Bayfield's survey of the river as far as Dog Lake, a distance of forty miles, and a partial survey of Dog Lake itself. The distances were ascertained, as in the former seasons on the rivers of the Gaspé Peninsula, by means of the micrometer telescope, and the directions by prismatic compass, two canoes being employed in the work. Beyond the head of Dog Lake I was induced to discontinue the measurement and to ascend the main stream called Dog River, with one canoe only, taking a bearing at each turn with the prismatic compass, registering at the same time an estimated distance. The measurement was discontinued because the time required in the operation was greater than the occasion seemed to warrant. The delay incurred in the carriage of two canoes across the portages, some of which were very long, with a party limited to four hands, was very great, and two out of the four proved to be very indifferent canoe-men, quite incapable of managing in difficult rapids. Under these circumstances it was considered expedient to leave one of the canoes and a portion of our provisions at the Great Dog Portage, to put the whole crew into one canoe, and to proceed

with as much expedition as a partial examination would permit, to the highest attainable waters of the river. I was enabled to ascertain the latitude and variation of the compass at various points as we advanced, by astronomical observations, but I had no means of determining the longitude with accuracy.

On the Michipicoten River, no actual measurement was made, but an eye sketch of its features was taken on our descent, with the assistance of the prismatic compass, the distances being estimated by the time occupied in running from one point to another, after the average rate of the current and our progress through the water were ascertained.

KAMANITIQUIA RIVER.

The Kamanitiquia falls into Thunder Bay by three different channels, nearly directly west of the Welcome Islands, the northern or main channel passing by the Hudson Bay Company's Trading Post of Fort William, which is about half a mile up from the lake. The ascending course of this channel is a little westward of south; at the distance of about a mile and three quarters, one of the other channels flows from it, and the third half a mile farther. The general course above this, turns to a few degrees southward of west, maintained for a distance which in a straight line is only five and a half miles, although the stream meanders through nearly double that distance, its deep and muddy water, with an average breadth of about 100 yards, possessing a scarcely perceptible current all the way to the lake. Above this the river becomes rapid, and the bearing against the stream is about due west for nearly ten miles, after which it bends to northwest, maintained for about three miles, and at the end of the distance the Grand Falls occur. Above these falls, which in some maps are called the Falls of Kakabica, the direct course is almost due north for a distance of between eighteen and twenty miles in a straight line to Dog Lake, which is an extensive sheet of water, thickly studded with islands, occupying an area probably upwards of 200 square miles. Its shape is related to a semicircle, with the straight side or diameter running nearly north and south and facing the west. At the northern extremity a sluggish stream, known to the fur traders as Dog River, falls in. Following this, the average course would be about northwest for a distance, including its bends, of about thirty-five miles, the first

twenty passing through a great swamp or marsh, with a current so slow as to be almost imperceptible ; while short rapids, falling over lifts or steps of a few feet, alternating with long stretches of still water, occur in the remaining fifteen miles of the distance, until reaching the little tributary by which the Hudson Bay Company's canoes take their route to Red River. Here the river turns off nearly due north, widening out into a long narrow lake for about two to three miles, after which there follows in the same line a chain of twelve small lakes or ponds, connected by short rapid streams, comprised within the distance of ten or twelve miles. The uppermost pond appeared at its northern extremity to terminate in a great marsh, which was supposed to be the ultimate source of the river, and to extend far and wide along the height of land, probably joining with the great marsh of the Savannah Portage on the Red River route. From its source to its exit at Fort William, the stream, following its windings, appears to be something upwards of 120 miles long.

The last part of our ascent was performed on foot, the highest point we reached in our canoes being the lower end of the chain of small lakes, where by observations of the sun and moon, the latitude was ascertained to be 48° 56′ N., while the variation of the compass taken by an azimuth of the sun was 7° 26′ E. The variation at the foot of Dog Lake by an azimuth of the sun was 7° 1′ E.

The upper part of the river between the sources and Dog Lake, for the greater part of the distance passes through a vast swamp, which is bounded on each side by low granite ridges, usually more or less covered with a stunted growth of evergreens and white birch. The timber on both banks of the river where the land is dry is generally pitch-pine, balsam-fir, spruce and white birch; where it is moist, tamarack and cedar prevail; and where the country is altogether marshy, destitute of timber, it is overgrown with willow bushes and long rank grass. In many parts large tracts have been overrun by fire, which has denuded the whole surface of its vegetation, leaving a dreary waste covered only by scorched and blackened poles. The only exception to this character is the vicinity of the chain of small lakes, leaving out the uppermost. There the valley contracts, the granite ridges come sometimes boldly to the river's edge, and the country thus diversified affords in some places interesting landscape scenery.

The country surrounding Dog Lake is of a mountainous character, thickly covered with forests, chiefly of ever-greens, and among them were observed red and white pines. White and yellow birch trees are abundant, and some of them of large dimensions; it is chiefly from the neighbourhood of Dog Lake that the Hudson Bay Company are supplied at Fort William by the Indians with bark for the manufacture of their birch canoes. The bold primary rocks by which the lake is bounded, and the innumerable islands with which it is studded, afford much picturesque scenery. The water of the lake, of which the surface is probably about 500 feet above Lake Superior, or about 1,100 feet above the level of the sea, issues through a deep narrow gorge, and is precipitated over a succession of heavy falls, amounting altogether to probably upwards of 200 feet, and occasioning the Great Dog Portage, extending a mile and a half across a narrow neck of elevated land, at the foot of which our measurements on the river ceased.

Between the Great Dog Portage and the Grand Falls the river flows over a series of steps, each of them causing falls or strong rapids, with long stretches of still water in the intervals, and six of them occasioning portages, both to upward and downward voyageurs, which vary in distance from a few yards to more than a mile. The country is of a primary character all the way, and is for the most part thickly wooded with dwarfish timber, consisting chiefly of spruce, balsam-fir, white birch, and occasionally a few pine trees. The total fall in the distance is probably 200 feet.

At the Grand Falls the river is precipitated almost vertically a height of 100 feet, below which it rushes very rapidly through a deep gorge, cut through slate, to the foot of the portage, a distance of about half a mile. The difference of level from the smooth water at the summit of the falls to that at the foot of the portage was found to be 119 feet. From this point to that at which our measurements commenced, the river is for the most part rapid. It passes through a poor and unproductive country, growing chiefly the usual evergreen trees, with white birch and poplars; occasionally, however, on the high banks some moderately good pines were observed, but by no means in such quantity or general size as to be of any commercial importance. For the remainder of the distance to its mouth, the river meanders through an alluvial country without any change in the species of trees, which are, however, frequently of larger

dimensions than generally seen farther up. This tract lies at the base of the high table land, which at its northern extremity is called McKay's Mountain; but reaching the point where the river splits into its three exit-channels, the land becomes for the most part marshy, except at the spot on the north side, where the Hudson Bay Company's Post and the cultivated grounds belonging to it are situated. Much of the marshy ground affords excellent pasturage for cattle, and a large stock belonging to the Company was feeding on it at the time of our visit.

The waters of the Kamanitiquia are every where turbid, perhaps owing to the swampy sources from which they spring, and during the summer season they are so warm as to be scarcely potable. Many parts, however, both of the stream and its lakes, abound with fish. Some of the upper portions literally teem with the common pike, and near the mouth sturgeon and white fish are frequently found. The game of the country consists chiefly of the caribou, the bear, marten, mink, musk-rat and common hare; the first three are scarce, the last two abound. Of birds we observed several species of duck, the ruffed and spotted grouse, and the passenger pigeon. Birds of prey were likewise frequently seen, among which were numerous eagles and falcons, and several species of owls.

Character and Distribution of the Rocks.

The geological formations of the section of the country drained by the Kamanitiquia may be divided into three groups :—

1. Granite, syenite, gneiss, micaceous and chloritic schist.
2. Blackish argillaceous slates, with associated trap.
3. Drift clays and sands.

1. *Granite, syenite, gneiss, micaceous and chloritic schist.*— The whole of the interior of the country above the Grand Falls, as far as our Survey extended, belongs to the granite, syenite, gneiss, and lower slates, and a line drawn from the Falls to the head of Thunder Bay would mark nearly the junction of the upper slates which rest upon them, and occupy the country between such a line and Lake Superior. The first development of the older rocks seen upon the river is at the second portage, about half a mile above the Falls. Where they make their appearance at the lower end of the portage, the character of the rock is a red or in some instances a

whitish massive syenite, which passes gradually into a gray gneissoid syenite, dipping at a high angle N. N. W. Resting conformably on the gneiss, there occurs a series of dark greenish blue or greenish black altered slates, the one rock passing almost imperceptibly into the other. The section occupied upwards of a quarter of a mile on the river banks, and at the upper end of it, as well as at the head of the portage, the dip was N. 47° E. Parallel joints were observed to cut the rocks, the directions of the two main sets being 132° and 160°. Numerous strong veins of white quartz intersected the slates sometimes occupying the joints, and the whole formation both in the strata and in the veins, was highly charged with iron pyrites.

At each rapid part of the river, above the turn of the Grand Falls, there is a greater or less development of the older rocks, most frequently presenting the slates or the gneiss. The best exposure of the slates is at the Three Discharges, about four miles above the Grand Falls, where the rocks are observed to pass from syenite to slate. The slates have a horizontal breadth at right angles to the stratification of upwards of thirty-seven chains, with a dip of 311°<68°, without any apparent irregularities. This would give a vertical thickness of about 2300 feet. Towards the bottom near the junction with the syenitic portion, the slates are of a dark bluish and occasionally of a brownish colour. They appear to be highly altered, and are intersected by numerous parallel joints, which divide the mass into rhomboidal forms of singular regularity. The middle and upper portions of the section are usually of a bright green colour resembling that of epidote, and frequently in part present the character of jasper; they are generally very hard and compact, but sometimes splintery. The divisional planes are frequently covered with mica, and in such cases the rock may be termed mica slate. The whole of the beds are largely charged with iron pyrites, and numerous veins of white quartz intersect them. Rounded masses are sometimes observed imbedded in the slates of various irregular shapes, very rudely spherical; and on the basset edges of the strata, along the banks of the river, numerous pot-holes are worn, some of which are not less than four yards in diameter. Above this section and in continuation of it, the same rocks are still exposed upon the banks, but in a more disturbed condition. Their colour is mostly of a bright green with occasional red streaks running through it, and iron pyrites is met with in almost every part of them.

Above the Three Discharges, and as far as Dog Lake, the rocks wherever they were seen, resembled those in character which have been above described, and were probably members of the same formation. About two miles above the Three Discharges, some very large boulders of an altered conglomerate were met with, containing bright red jasper pebbles and balls of iron pyrites, in a dark brown or blackish matrix, having much the aspect of trap; although nowhere seen in place, it appears probable this conglomerate is a member of the older slates. The boulders rested upon these slates, and their form and size did not indicate a far removal from the parent rock, while conglomerates are known to be associated with the slates in other parts of their distribution.

The high land around Dog Lake is chiefly granite or syenite, and the islands on the western side are the same, with mica slate resting on it occasionally. On the west coast several promontories jut out, with deep bays between them. Each point in succession appears to be in the axis of an anticlinal arch, bringing up the syenite in the middle, while mica schist dipping in opposite directions, rests upon it. The colour of the syenite is usually red and white, the component parts being red or white feldspar and white quartz, with only a small proportion of hornblende. The schists were for the most part black or brownish, and were in many places made up almost entirely of black or brownish mica. Both rocks were intersected by veins of white quartz, some of which were highly charged with iron pyrites, but no other metallic ore; and many of them were upwards of a foot in thickness.

2. *Black Argillaceous Slates.*—The base of this formation, as has already been stated, was observed on the Kamanitiquia near the Grand Falls. Its immediate junction with the rock on which it reposes was concealed from view, but appears to be indicated by the position of a small lake or pond, occurring just below the second portage, and the marshy ravines which run from it in the direction of the strike on each side. The slates visibly reach to within a short distance of the pond, probably brought into place against the syenite by a dislocation, and keep the river for a quarter of a mile to the Grand Falls, where the strata seem to slope to the southeast at a very small angle. It is probable the river flows on the formation all the way from this point to its mouth.

The general colour of the rock is black, weathering to a rusty brown; some of the beds being soft and shaly, are easily decomposed by atmospheric influences, while the mass is for the most part a hard argillaceous slate. The whole formation appears to be more or less calcareous, and among the lower members thin beds of impure limestone occur sometimes alternating with thin beds of chert, and sometimes holding irregularly disseminated chert nodules. Connected with the chert beds a black mineral resembling anthracite was frequently seen filling up small cracks, and small red jaspery veins often intersected the rock. Spheroidal concretions of singular uniformity, and sometimes of large size, are disseminated through all that part of the formation over which the river passes; and they are more conspicuously displayed among the more shaly portions of the rock. A little above the lowest rapids there is a great accumulation of these concretions, which have been known to the fur traders for many years under the title of the Devil's Pots. Some of them are six feet in diameter, with a thickness of two feet, and they are found of all sizes down to that of a pigeon's egg. They are usually more convex on the top than on the bottom, bearing a strong resemblance to the stones used in the game of *curling*. The lines of lamination are distinctly visible in these concretions, and in some instances, where not removed from the parent bed, the lines could be traced from the concretion to the partially enclosing rock. They were always highly charged with iron pyrites, and their weight was in consequence great.

The formation is strongly marked by a jointed structure of a very symmetrical character, dividing the finely laminated slates into rhomboidal forms of great regularity. At the Grand Falls the direction of the principal joints is S. E. and N. W., and E. N. E. and W. S. W. Where the structure was regular, the slates appeared to be applicable to roofing purposes.

The total absence of fossils makes it difficult to determine what the geological relation of this formation may be in respect to the sedimentary deposits which prevail in other parts of the Province.

Trap Dykes and Mineral Veins.—Trap Dykes were occasionally seen intersecting the argillaceous slates of the Kamanitiquia River, and running in the general direction of the stratification to the North of East and South of West. Mineral

veins also occurred. They sometimes ran alongside of the dykes, and the general bearing, where independent of them, was in the same direction. They varied in thickness from a few inches to three feet, and were usually composed of a breccia of the wall rocks cemented together by calcareous spar with a smaller quantity of quartz, which was sometimes of the amethystine variety, and heavy spar occasionally accompanied them. In some of the veins small quantities of dark-purple fluor spar occurred. The metalliferous minerals perceived in the veins were iron pyrites which strongly marked every one of them, together with blende and galena in a few, and occasional traces of copper pyrites.

3. *Drift.*—The principal display of drift was met with between McKay's Mountain and the Grand Falls, in which distance the banks of the river on both sides were frequently seen to consist of a light buff-coloured clay, covered over by stratified yellow ferruginous sand, both together attaining a thickness of full sixty feet above the level of the water. Banks of sand were found to occur likewise at Dog River, and although they rest upon a much higher surface than the deposit further down, it is not improbable that both are of the same age. The clays appear to be of a quality favorable for the manufacture of bricks. The sands contain a considerable proportion of peroxyd of iron, and from between the two deposits, there issue in various spots a number of small streams of which the water in most cases is more or less chalybeate, throwing down by exposure to the air, a dark brown deposit of oxyd of iron, which is traceable along their courses.

MICHIPICOTEN RIVER.

The Michipicoten River falls into Lake Superior on the east side, a little to the south of the 48th parallel of latitude, where the Hudson's Bay Company have established one of their trading posts at its mouth. The upward course of the valley in a straight line for about ten miles to the first interruption of the canoe navigation at the Great Falls is due East, and the distance may exceed fifteen miles following the sinuosities of the stream. Here there is a portage of about three miles in a northeasterly direction, and from the head of it the general course of the ascent is nearly due east for fifteen miles farther. From this to its sources, on the height of

land separating the St. Lawrence from the Hudson's Bay Waters, a succession of lakes exist joined by narrow rapid streams, the general course of which is about N. E. by N. in a straight line, the distance being about thirty miles. The principal of these sheets of water are known by the names of White Fish, Manatoowick, and Dog Lakes, the last being the uppermost.

The country at the head of Dog Lake appears to consist chiefly of extensive swamps, relieved by occasional intersections of low granite ridges, which run out in long promontories into the lake, and form numerous islands in it. Towards the south on each side of the lake, and in some of the islands, the land occasionally attains an elevation of two or three hundred feet. Between Dog and Manatoowick Lakes the distance is about two miles or a little over it, and the stream is rapid all the way, presenting falls at two places known by the names of the Great and Little Stony Portages, which interrupt the canoe navigation for a mile and a half at the one and for one hundred yards at the other. Manatoowick Lake is a fine sheet of water about eight miles in length and from one and a half to two miles in breadth, locked in on every side by high primary rocks, which frequently rise abruptly from its banks in bold precipitous cliffs. From the lower end a rapid runs into White Fish Lake, below which there are three small sheets of water connected by short rapids, at the lowest of which there is a portage of about half a mile. White Fish Lake is surrounded by hills of moderate elevation, which recede from the little lakes below, whose banks are for the most part low and marshy. Between the portage at the foot of the chain of lakes and the Great Falls, the river is rapid the greater part of the way, although there is but one place where it was found necessary to lighten the canoe in order to secure her safety in running the stream. The country on each side is low for a considerable way back, until within about two miles of the Falls, where it rises abruptly to a height of nearly three hundred feet. The Great Falls are nearly vertical, and their height is about eighty feet. Below them the stream runs with great velocity for the distance of about three miles, and for the remainder to its exit near the Hudson's Bay Company's Post with a more moderate current, though still occasionally rather swift.

The trees constituting the forests of the country through which the river flows, are pitch-pine, spruce, balsam-fir, white birch and poplar, on the dry ground, cedar and tamarack on moist places. Nearly the whole of the timber is of stunted growth and of little value, especially around the lakes, where many spots are destitute of wood altogether. A considerable tract of country below the Great Falls appears capable of cultivation, but the soil is for the most part very light and sandy.

Character of the Rocks.—The whole of the rocks seen upon the Michipicoten consist of granite, syenite, gneiss and the older slates. The latter occupy all the country below the Great Falls, in which, however, there are but few exposures, the rocks being for the most part concealed by a thick deposit of sand and gravel, of which the banks of the river are composed; but where they do emerge, they are invariably found to consist either of a highly altered slate or a syenitic gneiss, beds of which appear to be interstratified with the slates. At the lower end of the portage at the Great Falls, the slates are of a pale green colour, weathering to a light brown; they are of a splintery structure, and the beds are nearly vertical, their dip where they join the granite being to the southwest. At the head of the Great Falls, the rock is a gray granite, and a granite of much the same description in which epidote is often a constituent mineral prevails all the way to the foot of Manatoowick Lake, with the exception of a few spots where gneiss occurs, one of which is at White Fish Lake. The whole of the country between the lower end of Manatoowick and the head of Dog Lake appears to be occupied by the slates, which, where they occur on the former, maintain a general dip to the N. E., while on the latter the inclination was usually found to be to the north. In the middle and lower parts of Dog Lake, the strata bear a general similarity to those of Manatoowick, where they are occasionally interstratified with layers of a syenitic quality. A trap dyke was observed on the east side of Dog Lake maintaining a course nearly due east and west through a red syenitic rock, which appeared to be in parts overlaid by beds of trap.

I have the honor to be, Sir,

Your most obedient servant,

ALEX. MURRAY,

Assistant Provincial Geologist.

APPENDIX.

1.

Table shewing the quantity of Copper Ores, British and Foreign smelted in Britain, the total quantity of Fine Copper, and Total Value, classified according to their General Sources, with the Average Produce and the Average sale Price of the Ores from each general source, for Eight Years, from 30th June, 1838, to the 30th June, 1846.

SOURCE.	Year.	Ore. Tons of 21 cwt.	Total value.	Fine Copper.	Average Produce.	Average price. Per ton of 21 cwt.
			£	Tons.	pr. ct.	£ s. d.
Cornwall, ...	1839	159,551	932,298	12,451	7.80	5 16 10
	1840	147,266	792,758	11,038	7.50	5 7 8
	1841	147,846	898,164	10,935	7.39	6 1 6
	1842	154,180	934,387	11,239	7.28	6 1 2
	1843	153,668	852,227	11,577	7.52	5 10 11
	1844	152,667	815,246	11,247	7.35	5 6 10
	1845	157,000	835,351	12,239	7.79	5 6 5
	1846	158,913	886,785	12,448	7.81	5 11 7
Ireland, ...	1839	22,290	143,448	1,831	8.21	6 8 8
	1840	23,412	135,293	1,799	7.68	5 15 4
	1841	16,538	137,442	1,560	9.43	8 6 2
	1842	14,030	115,571	1,294	9.22	8 4 8
	1843	16,523	115,792	1,470	8.89	7 0 2
	1844	19,385	127,898	1,684	8.68	6 11 11
	1845	18,597	113,560	1,544	8.30	6 2 1
	1846	17,264	110,159	1,438	8.33	6 7 7
Wales, ...	1839	4,643	32,909	416	8.97	7 1 9
	1840	2,023	10,223	138	6.84	5 1 0
	1841	1,836	8,133	100	5.42	4 8 7
	1842	897	3,632	44	4.89	4 1 0
	1843	1,051	4,971	66	6.29	4 14 7
	1844	1,199	8,946	118	9.83	7 9 3
	1845	429	2,438	34	7.79	5 13 8
	1846	965	5,385	70	7.28	5 11 7
Cuba and other parts East side of America.	1839	10,444	190,636	2,286	21.88	18 5 1
	1840	20,148	328,900	4,074	20.22	16 6 6
	1841	29,704	476,647	5,700	19.19	16 0 11
	1842	32,431	479,557	5,630	17.36	14 15 9
	1843	28,986	410,380	5,013	17.29	14 3 2
	1844	32,254	487,695	6,086	18.87	15 2 5
	1845	32,965	430,237	5,851	17.75	13 1 0
	1846	37,674	467,892	6,103	16.20	12 8 5

SOURCE.	Year.	Ore. Tons of 21 cwt.	Total value.	Fine Copper.	Average Produce.	Average price. Per ton of 21 cwt.
			£	Tons.	pr. ct.	£ s. d.
Chili and other places on the Pacific side of America.	1839	10,547	218,271	2,604	24.69	20 13 11
	1840	9,860	190,440	2,347	23.80	19 6 3
	1841	10,651	245,345	2,886	27.10	23 0 8
	1842	8,453	202,974	2,339	27.66	24 0 3
	1843	13,352	303,655	3,692	27.65	22 14 10
	1844	11,425	246,728	3,079	26.95	21 11 11
	1845	9,025	203,469	2,768	30.67	22 10 11
	1846	5,152	133,306	1,742	33.82	25 17 6
Australia, &c.,.....	1845	64	598	8	12.72	9 7 0
	1846	970	15,837	207	21.33	16 6 6
Sundry places, British and Foreign, the localities of which are doubtful.	1839	1,550	12,732	159	10.26	8 4 3
	1840	842	9,156	118	14.02	10 17 6
	1841	650	3,780	46	7.08	5 16 4
	1842	1,010	6,448	77	7.62	6 7 8
	1843	2,126	12,904	166	7.81	6 1 5
	1844	1,257	11,303	146	11.61	8 19 10
	1845	1,868	9,697	131	7.04	5 3 10
	1846	2,962	16,335	214	7.22	5 10 4
From all places,....	1839	209,025	1,530,294	19,747	9.45	7 6 5
	1840	203,551	1,466,770	19,514	9.59	7 4 2
	1841	207,255	1,769,511	21,227	10.24	8 10 9
	1842	211,001	1,742,569	20,623	9.77	8 5 2
	1843	215,706	1,699,929	21,984	10.19	7 17 7
	1844	218,187	1,697,816	22,360	10.25	7 15 8
	1845	219,948	1,595,350	22,575	10.26	7 5 1
	1846	223,900	1,635,699	22,222	9.92	7 6 1

2.

Table shewing the quantity of Fine Copper in various British and Foreign Copper Ores, purchased by private contract and smelted in addition to those mentioned in the preceding Table, during Eight Years, from 30th June, 1838, to 30th June, 1846, as far as known.

Year.	Fine Copper. Tons.
1839,.....	725
1840,.....	1,127
1841,.....	2,809
1842,.....	3,477
1843,.....	Uncertain.
1844,.....	5,973
1845,.....	2,312
1846,.....	3,265

3.

Table shewing the Copper Ores, sold at public ticketings in Cornwall, with the total Quantity, Value, Fine Copper, Average Produce and Average Price for each Mine, for one year, to 31*st December*, 1845.

MINES.	Ore. Tons of 21 cwt.	Average Produce.	Fine Copper.			Average Price. Per ton of 21 cwt.			Total Value.
		pr.ct.	T.	C.	Q.	£	s.	d.	£
Alice (Wheal) and Harmony	154	8.98	13	16	3	6	14	3	1,034
Andrew, (Wheal),	166	7.79	12	18	3	5	19	9	994
Anna, (Wheal),	215	5.46	11	15	0	3	16	6	823
Bedford, (Wheal),	1,297	9.65	125	4	0	6	14	10	8,744
Botallack,	1,274	11.11	140	13	1	7	11	7	9,657
Brewer, (Wheal),	1,142	6.88	78	12	1	5	0	11	5,766
Buller, (Wheal),	1,313	5.80	76	3	1	3	19	4	5,212
Busy, (Wheal),	420	3.91	16	8	3	2	7	1	989
Camborne Vean and Stray Park,	2,751	6.77	185	0	1	5	0	10	13,873
Carn Perran,	158	5.08	8	0	3	3	4	11	518
Carn Brea,	6,674	7.97	532	10	0	5	18	3	39,463
Clifford, (Wheal),	348	8.47	29	10	0	6	9	6	2,254
Comfort, (Wheal),	122	4 24	5	3	2	2	11	3	313
Condurrow,	166	6.47	10	15	0	4	14	8	786
Consolidated Mines,	8,798	7.79	685	14	2	5	16	3	51,147
Cook's Kitchen,	502	4.82	24	4	2	3	0	7	1,522
Copper House Slag,	218	4.12	9	2	1	1	10	5	332
Creeg Braws,	546	7.15	39	1	0	5	6	3	2,902
Darlington, (Wheal),	649	5.43	35	5	0	3	13	10	2,397
Dolcoath,	3,504	6.66	233	14	1	4	17	0	16,997
East Pool,	929	8.10	75	5	1	5	16	10	5,430
East Wheal Crofty,	6,173	7.81	483	4	1	5	17	7	36,303
Ellen, (Wheal),	714	8.10	57	17	3	6	2	6	4,373
Fowey Consols,	8,976	8.54	751	15	1	5	9	8	49,233
Friendship, (Wheal),	5,993	6.77	406	4	2	4	17	3	29,144
Godolphin,	852	11.96	101	19	2	9	1	1	7,715
Gorland, (Wheal),	366	6.31	23	2	1	4	10	3	1,652
Grambler and St. Aubyn,	1,494	7.50	112	2	1	5	9	9	8,202
Hallenbeagle,	2,879	5.29	152	10	0	3	12	9	10,479
Harriet, (Wheal),	689	5.96	41	1	3	4	5	4	2,942
Harvey's Ore and Dross,	211	4.14	8	15	0	1	9	10	315
Henry, (Wheal),	148	6.94	10	5	2	5	1	4	750
Holmbush,	1,887	11.02	208	2	2	7	18	6	14,957
Jewell, (Wheal),	1,476	7.46	109	5	2	5	6	11	7,893
Lanivet Consols,	1,125	8.13	91	11	0	5	8	1	6,082
Levant,	1,088	9.79	106	11	0	6	11	6	7,155
Lydia, (Wheal),	2,267	6.02	136	13	2	4	5	1	9,653
Maiden, (Wheal),	484	6.70	32	8	0	4	16	4	2,333
Maria, (Wheal),	11,288	13.15	1484	6	2	8	18	11	100,972
Mark Valley,	165	4.71	7	15	2	3	3	3	522

MINES.	Ore. Tons of 21 cwt.	Average Produce.	Fine Copper.			Average Price. Per ton of 21 cwt.			Total Value.
		pr. ct.	T.	C.	Q.	£	s.	d.	£
North Downs,.....	306	7.84	24	0	1	5	13	1	1,731
North Pool,.....	217	4.97	10	16	1	3	12	7	788
North Roskear,.....	6,430	8.45	543	12	0	6	7	4	40,956
Par Consols,.....	5,655	8.21	464	10	1	5	9	2	30,881
Penstruthal,.....	534	8.42	45	1	2	6	5	3	3,345
Perran St. George,.....	1,665	6.32	105	4	3	4	7	11	7,323
Poldice,.....	2,485	6.16	153	3	0	4	7	7	10,889
Providence, (Wheal),.....	2,615	7.86	205	15	0	5	12	9	14,750
Providence Mines,.....	433	7.22	31	6	0	5	7	5	2,326
Prudence, (Wheal),.....	513	4·68	24	1	1	2	17	6	1,477
Rodney, (Wheal),.....	132	5.30	7	0	1	3	10	5	465
Seton, (Wheal),.....	2,035	7.37	148	14	0	5	11	6	11,352
Sisters, (Wheal),.....	577	6.44	37	4	1	4	9	11	2,595
South Wheal Basset,.....	3,390	7.88	267	5	2	5	17	9	19,962
South Caradon,.....	4,631	8.52	394	15	0	5	17	9	27,266
South Wheal Francis,.....	249	5.79	14	8	3	3	18	8	980
South Roskear,.....	1,464	7.78	113	18	2	5	19	4	8,738
St. Andrew, (Wheal),.....	370	4.06	14	18	2	2	4	7	826
Treleigh Consols,.....	1,637	7.51	123	0	3	5	13	3	9,270
Trenow Consols,.....	2,306	11.15	257	2	2	8	9	8	19,566
Trenwith, (Wheal),.....	203	10.43	21	3	2	7	11	2	1,535
Tresavean,.....	6,683	5.62	375	19	0	3	18	4	26,194
Tresavean Barrier,.....	874	9.50	83	2	0	6	18	1	6,055
Trethellan,.....	2,612	5.48	143	5	3	3	16	4	9,979
Tretoil, ...	658	7.81	51	9	2	5	6	4	3,500
Treviskey,.....	767	10.70	82	1	3	8	7	9	6,436
Trewavas,.....	977	7.48	73	3	0	5	11	7	5,452
Tincroft,.....	5,644	7.30	412	5	1	5	8	6	30,628
Ting Tang,.....	100	5.87	5	17	2	4	0	4	402
United Hills,.....	3,348	6.00	201	4	2	4	4	6	14,154
United Mines,.....	14,374	7.04	1012	3	2	5	4	3	74,908
Virgin, (Wheal),.....	655	6.36	41	13	3	4	10	6	2,964
Vyvyan, (Wheat),.....	378	5.88	22	4	3	3	17	4	1,463
West Caradon,.....	4,457	10.65	475	0	2	7	9	3	33,272
West Wheal Treasury,...	267	6.68	17	16	3	4	15	5	1,274
West Fowey Consols,.....	169	6.82	11	10	2	4	7	5	739
West Wheal Jewell,.....	1,883	6.03	113	13	1	4	5	5	8,045
Williams East Downs,....	242	6.69	16	4	0	4	15	11	1,161
Sundry small Mines,.....	706	6.93	48	18	3	4	16	1	3,392
	160,262	8.02	12864	5	2				918,867

4.

Table shewing the Copper Ores, sold at public ticketings in Swansea, with the Quantity, Value, Fine Copper, Average Produce and Average Price, from each Mine, Irish, Welsh, Foreign and Colonial, for one year, to the 31st December, 1845.

MINES.	Ore. Tons of 21 cwt.	Average Produce.	Fine Copper.			Average Price.			Total Value.
		pr.ct.	T.	C.	Q.	£	s.	d.	£
IRISH.									
Ardulty,	120	10.70	12	17	0	7	17	8	946
Ballymurtagh,	2,773	5.03	139	14	2	3	14	0	10,262
Beerhaven,	5,835	9.99	583	2	3	7	16	9	45,756
Connorree,	410	7.30	29	19	0	5	0	11	2,069
Cosheen,	125	22.60	28	5	0	18	4	0	2,275
Cronebane,	1,448	6.58	95	8	1	4	18	2	7,106
Kilduanne,	75	7.40	5	11	0	6	0	0	450
Knockmahon,	6,948	8.74	603	16	2	6	12	5	46,021
Lackamore,	119	11.09	13	4	0	8	13	3	1,031
Tigrony,	606	6.68	40	10	3	5	2	5	3,105
WELSH.									
Llandidno,	625	7.92	49	10	3	6	5	7	3,925
Parys Mine,	113	5.88	6	13	2	4	12	2	521
CUBA, &c.									
Cobre,	22,741	15.30	3,479	17	0	11	9	11	261,454
Cuba,	5,591	18.58	1,039	5	0	13	19	3	78,072
Pennsylvania,	395	14.10	55	13	3	11	1	4	4,372
San Jose (in Cobre),	2,931	16.93	496	5	1	12	11	0	36,787
Santiago,	7,930	19.12	1,516	13	3	14	10	6	115,201
CHILI, &c.									
Chili,	3,806	36.90	1,404	13	3	29	10	4	112,347
Copiapo,	666	23.48	156	8	1	18	14	0	12,455
Valparaiso,	283	20.81	58	18	1	15	12	0	4,415
AUSTRALIA.									
Australia and Kawkaw,	675	20.41	137	15	3	17	3	1	11,579
Montacute,	237	17.04	40	8	1	14	11	4	3,453
SUNDRY PLACES.									
Bacuranao,	449	7.61	34	4	0	5	9	6	2,459
Davies Ore,	168	3.83	6	8	3	2	10	5	424
Molland,	136	10.03	13	13	1	7	12	9	1,039
Victoria,	852	8.74	74	10	0	6	14	2	5,718
Vigra et Cloga,	600	4.59	27	11	2	3	5	0	1,952
Sundries,	597	6.19	37	0	0	4	9	4	2,668
	67,454	15.13	10187	19	2				777,862

5.

Table shewing the Number of Mines, Yielding Copper Ore, in Cornwall, and selling the same at public ticketings, classified according to the value produced, for eight years, from 30*th June,* 1838 *to* 30*th June,* 1846.

VALUE OVER	NUMBER OF MINES.							
£	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.
150,000	1	...	...	...	...	...	...	...
100,000	...	1	...	...	...	...	...	1
90,000	...	...	...	...	...	...	...	...
80,000	1	...	1	1	...	...	...	...
70,000	1	...	1	2	1	...	...	1
60,000	...	2	2	3	...	2	1	...
50,000	1	...	1	...	4	1	1	1
40,000	...	2	...	...	1	2	2	2
30,000	2	...	2	2	2	1	3	4
20,000	4	5	5	5	4	6	6	5
10,000	15	10	14	15	13	14	12	7
9,000	1	2	3	...	2	1	1	3
8,000	3	3	...	1	2	3	5	2
7,000	6	3	1	1	3	1	4	6
6,000	2	5	3	5	2	4	4	4
5,000	1	5	4	4	1	4	2	1
4,000	4	5	6	7	4	2	4	4
3,000	4	2	2	2	4	4	3	5
2,000	10	4	10	4	3	4	9	6
1,000	7	9	7	14	8	5	9	10
900	1	2	...	2	...	3	...	2
800	1	2	3	1	...	2	...	4
700	2	4	...	2	2	...	2	3
600	1	2	2	...	5	4	2	...
500	3	2	7	2	2	3	3	7
400	1	2	3	4	1	1	1	4
300	2	1	2	3	2	1	1	2
200	5	5	...	1	...	...	1	2
100	...	1	...	1	4	...	1	2
	79	79	79	82	70	68	77	88

6.

List of Copper Smelting Establishments in Britain, with the situation of the works.

1. Establishments that bid at the public ticketings, with the quantities of Ore smelted and Copper made by each.

	ORE.	COPPER.
	Tons.	Tons.
Williams, Foster & Co.,.....Swansea and Neath,.....	72,000	7,200
Vivian & Sons,.....Swansea and Port Talbot,	60,000	6,000
Governor & Company of Copper Miners in England,.....Swansea and Port Talbot,	40,000	4,000
Pascoe Grenfell & Sons,. .....Swansea,.....	32,500	3,250
Sims, Willyams, Nevill & Co.,.Llanelly,.....	32,500	3,250
Freeman & Copper Company,..Swansea,.....	20,000	2,000
Mines Royal Company,.....Neath,.....	10,000	1,000
	267,000	26,700

2. Establishments that purchase Ore by private contract only, with the quantity of Copper made by each.

	COPPER
	Tons.
Ravenhead Company, composed of— Sims, Willyams & Co. Jno. Bibby & Co., Managers,.....Liverpool,.....	1,240
British Copper Company, Newton, Keates & Co.....Liverpool,.....	1,134
Whiston Company, Sneyd & Co.....Liverpool,.....	250
Anglesea or Amlwch Company, Marquis of Anglesea,..... } Parys Mines, Anglesea,... { Lord Denorban,..... }	Quantity not known but small.

Table shewing the Number of Shares, Lord's Dues, Sett, Depth, Persons employed, Coals used, and Value of Copper Ore sold at ticketings, for one year, from 30*th June,* 1845 *to* 30*th June,* 1846, *in seven principal Mines in Cornwall.*

MINES.	No. of Shares.	Lord's Dues.	Extent of Sett.	Depth. From surface to adit.	Depth. From adit to bottom.	Total number of persons employed.	Coals consumed.	Value of Copper Ore, sold at ticketings, from 30th June, 1845 to 30th June, 1846.
				Fms.	Fms.		Tons.	£
Carn Brea,.....near Redruth,...	1,000	$\frac{1}{24}$	1,016 fathoms long,..500 fms. wide,..	25	145	1,040	330	43,220
Consols,.....in Gwennap,.....	100	$\frac{1}{24}$	$1\frac{1}{2}$ mile long,..... $\frac{1}{4}$ mile wide,.	45	274	1,460	1,000	52,999
South Basset,...near Redruth,...	128	$\frac{1}{15}$	600 fathoms long,.....	30	90	200	160	19,147
South Caradon,.near Liskeard,...	128	$\frac{1}{15}$	1 mile long,.....	20	100	250	100	26,907
Tincroft,.....near Redruth,...	6,000	$\frac{1}{24}$	500 fathoms long,.....	20	150	600	180	31,702
United Mines,..in Gwennap,.....	100	$\frac{1}{24}$	$1\frac{1}{4}$ mile long,..... $\frac{3}{4}$ mile wide,.	42	220	1,290	1,060	71,185
West Caradon,.near Liskeard,...	256	$\frac{1}{15}$	372 fathoms long,..424 fms. wide,..	22	114	487	85	36,350

DIGEST OF THE

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