Outlines of the Geology of Lake Superior, by Commander H. W. Bayfield, *Royal Navy, Member of the Astronomical Society of London, and Honorary Member of the Literary and Historical Society of Quebec.*

1. LAKE SUPERIOR—Preliminary remarks.—2. Its geographical situation and magnitude.—3. Variation of the compass.—4. Depth and nature of its bottom.—5. Proofs that its waters have been higher.—6. No tides.—Local causes of the partial risings of its waters.—7. Whether its waters are still diminishing or not, uncertain.—8. Elevation of its surface above the sea.—9. Geological situation.—Extent of great chain of older rocks. Its basin and height of the sources of its rivers and of its hills.—10. Division of its rocks into orders.—11. Sienitic granite, its situation and extent.—12. Greenstone, common jasper, slates, and transition limestone.—13. Trap or overlying rocks, amygdaloid, porphyry, trap greenstone. Sketch illustrative of its occasional basaltic nature. Trap sienite, how distinguished from sienitic granite.—14. Old red sandstone, its extent, rests on granite.—How stratified.—Explanatory sketches and remarks.—15. Reasons for naming the sandstone the old red, &c.—16. Traces of greywacke and remarks respecting the Greenstone.—17. Red rock of Neepigon bay.—18. Ile Royal, native copper.—19. Michipicoten island.—20. Caribou island. 21.—Islands of the twelve Apostles.—22. The great promontory or peninsula of Keewawonan.—Situation of a vein of copper ore.—23. Remarks respecting the connexion and relative ages of the rock formations.—Boulders of shell limestone.—24. Alluvial deposits of the lake and its rivers, downs, alluvial deposits of the St. Louis, Raministiqui-a, &c.—25. Synopsis of minerals.—26. Magnetic nature of the trap rocks.—27. Concluding remarks.

1. Lake Superior has been lately visited with a view to geological enquiry by the following gentlemen, with all of whom we have been personally acquainted: Mr. Schoolcraft, American Indian Agent at the Falls of St. Mary, Doctor Bigsby, and Doctor Richardson. The first of these gentlemen has written an account of his tour through the lakes to the head waters of the Mississippi, which contains brief, but faithful, notices of the south shore of Lake Superior. Doctor Bigsby is well known in this country, for the zeal and ability which he has displayed in the investigation of its geological phenomena. Doctor Richardson passed along the north coast of Lakes Huron and Superior in canoes, and arrived with Captain Franklin and his party at Fort William, where we then were, in May 1825. From this latter gentleman something worthy of his pen may be expected, relative to the geology of those parts of the lakes which he had an opportunity of observing; and although the land arctic expedition having a greater object in view, travelled with all possible rapidity, yet his great experience, and the advantage of having afterwards traced the great primitive formations further westward than either of the other gentlemen, will enable him to form a more enlarged idea of the extent and trending of the several formations, as well as their connexion with other rocks.

Each of these gentlemen has travelled with the avowed view of collecting geological facts, and with the intention of communicating those facts to the public. We, on the contrary, were fully occupied, by the engrossing details of a service, (the survey of the lakes,) which allowed of no respite; which required the most incessant exertion both of mind and body; and in which the practical application of several sciences, involving many long and difficult calculations, left us scarcely the necessary time for rest and refreshment. Under these circumstances we could only view the subject of

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Geology as amateurs, and our observations with regard to the great rock formations among which we lived, were viewed with interest, it is true, but also with a degree of regret, that our duties prevented us from devoting to their examination, that degree of research which we believe to be due to the importance of the subject.

From these considerations it at first appeared to us, as it possibly may to others, scarcely short of presumption to attempt to write any thing, concerning the Geology of Lake Superior, and it seems therefore necessary, that we should give our reasons, for attempting that which may otherwise appear a work of supererogation.

In the first place, we believe we are the only person, having any knowledge of geology, however slight ours may be, who has completely circumnavigated Lake Superior, and visited all its bays and islands. This gives us the advantage of considering the geology of the whole lake in one view, and tracing the various formations, from shore to shore.

Of the gentlemen whom I have mentioned, Mr. Schoolcraft has only visited the south coast, and even there he did not circumnavigate the interesting and magnificent promontory of Keewawonan.—Doctor Bigsby has only seen the north coast from St. Mary to the Grand Portage, and Dr. Richardson from St. Mary to Fort William. We have not mentioned the American gentlemen of Major Long's expedition who returned from Fort William to St. Mary, because their geological notices of the coast, from the rapidity with which they travelled, were extremely scanty.

None of these gentlemen has visited either the immense bays, or the distant islands, and even were this not the case, it may easily be imagined, that, in so great an extent of country, geological phenomena may be met with by one which may have escaped the other, particularly when the investigations of all have been more or less cursory.

We trust we have now said enough to explain the motives which induce us to hope that this attempt may be useful; and only wish, that our knowledge of the science of Geology were commensurate with the advantages which we have mentioned, or that those advantages had been enjoyed by either of those gentlemen, who, in that case would have rendered it unnecessary for us to attempt a task to which we feel ourselves but indifferently adequate.

It is not our intention to give a full and minute account of the various rock formations, or of the minerals which they contain. Our endeavours will be confined to giving a concise and general view of them, making such observations as may occur to us, and which may naturally arise out of the subject under consideration. We shall endeavour to avoid all hypothesis, convinced that the science of Geology is not yet sufficiently advanced to admit of the reception of any one theory to the exclusion of the rest.

The objects of Geology are to examine the crust of the globe: to seek among the ruins of strata for the only records of those awful events which have swept whole orders of organized beings from existence. These are only to be obtained by the accumulation of facts. By endeavouring to add to the mass of information now collecting in all parts of the world, we may fairly hope to be useful; and it is this which has stimulated us to this undertaking.

We shall also enumerate such minerals as were met with, and their localities.

2. Lake Superior is the largest and most elevated of those magnificent inland Seas, the Canadian Lakes. It is situated between the meridians of 92°. 14′ and 84° 34′ west longitude from Greenwich, and the parallels of 49° 1′ and 46° 25′ north latitude. Following the sinuosities of its coasts, it is about 1500 geographical miles in circumference. Its length on a curved line through its centre is about 360, and its extreme breadth 140 geographical miles. Its shape will

will be best seen by reference to a map, and will explain the reason for measuring its length in the manner which we have just mentioned.

3. The variation of the magnetic needle varies from 2° 42′ to 12° 8′ east. The dip, as ascertained by Captain Franklin, at Fort William is 77° 58′; the variation near that place is 9° 5′ east. The needle is very much disturbed in many places by the magnetic nature of the oxides of iron which enter into the composition of many of the rocks. The variation encreases gradually from the eastern extremity of the Lake westward, but is greatest near the Grand Portage and Ile Royale.

4. The water of Lake Superior is as pure and clear as any in the world, and is always extremely cold, from its great depth, which varies from 80 to 150 fathoms, but as we could sound in such depths only in very calm weather, not being furnished with the proper sounding machines, and did not sound in the centre, we have reason to think that its greatest depth will not be overrated at 200 fathoms.

The nature of the bottom of this lake was frequently ascertained by us, as portions of it were always found adhering to our anchors and sounding leads. It consisted, for the most part, of a very adhesive clay, containing small shells, of the species at present existing in the lake. When exposed to the air, this clay immediately became indurated in so great a degree as to require a smart blow to break it.—It effervesced slightly with diluted nitric acid, but whether from a mixture of carbonate of lime, or from the presence of finely comminuted shells we could not determine. This clay is of different colours in different parts of the lake. Between Ile Royale and the north shore it is blue in the vicinity of the south coast red, from the red oxide of iron in the sand stone of that coast: whilst near Michipicoten it is white and hardens into a substance resembling pipe clay.

We have mentioned these circumstances because they seem

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to us to throw considerable light upon what is now going on in these great bodies of fresh water. We see that extensive horizontal depositions are still forming which contain the shells of species at present residing in the lake: and that these depositions only require to be exposed to the action of the air, to become horizontal rock formations.

If the hypothesis that the lakes were once salt, (which we think is founded on very probable deductions drawn from the nature of their fish,) be really founded on fact, we may easily imagine a marine formation below that which is at present depositing.

5. There are appearances in different parts of Lake Superior, (as well as in the other lakes,) which lead us to infer that its waters have formerly occupied a much higher level than at present. For in valleys at a considerable distance from the present shores, ridges of rolled stones and shells were met with in parallel curves, rising one above the other like the steps, or rather seats, of an amphitheatre, and exactly similar to that which may be observed of the present beaches in most bays.

These ancient beaches attain the elevation of 40 or 50 feet above the present level. There are also appearances of this nature on the immediate shores of the lake. We shall mention, for instance, one near Cabot's Head, on Lake Huron, where we counted no less than seven ridges of shingle, from the present level upwards. The highest ridge was overgrown with a thick grove of spruce trees. The second downwards had bushes or smaller trees of the same kind. The third only small shrubs and flowers. The fourth lichens and mosses. The rest were bare of vegetation; and it is possible that the spray of the surf may reach the third ridge. These appearances plainly indicate an increase of age in proportion to the elevation of each of the ridges. As we have seen the lakes under all circumstances, during a period of many years, we are entitled to affirm, that no partial rise of water, whether from

from gales of wind, or any other cause, could form the three or four most elevated of these ridges, nor could the ice produce this effect. It has evidently been done long since, as is proved by the trees and shrubs which we have mentioned.

6. There is no regularly periodical rising or falling of the lakes, as has been asserted, whether it be, from the influence of the moon, or any other. They rise and fall regularly, from accidental causes, such as that of a very severe winter without the usual thaws. The springs are then locked up all winter, and the whole accumulated snow remains, until the spring of the year, when the weather becoming suddenly warm dissolves it all at once. Hence it will generally be found, that after a very severe winter, the waters of the lakes will be much higher than at other times.

Heavy gales of wind also rise the waters, in the upper parts of the lakes from which they blow, and also cause currents in various directions. The rise of water however, in any part of the Lakes Superior and Huron, from this or any other cause, never exceeds a few feet. When Doctor Bigsby asserts that autumnal gales will raise the water 20 or 30 feet, at Michipicoten, Gargantua, or Otters Head,* we perceive, that he has been deceived, by the hyperbolical mode of speaking of the fur traders. The same thing was told to us at the first of these places, but upon cross questioning the narrator of this story, we found that he only meant the spray of the surf. But we have been encamped on the shores of this Lake, at all seasons, and have seen some as heavy gales as ever blew there, which rose the water only a few feet.

7. Whether a gradual diminution of the waters of this lake be at present going on is a point upon which no one is at present qualified to give an opinion. For no observations have been made or recorded to ascertain this interesting

* Journal of Science, Literature, and Arts, No. XXXV, page 3, Dr. Bigsby on the Geology and Geography of Lake Superior.

ing fact. Any diminution which may be, must be almost imperceptibly gradual, and it would require constant, accurate, and regularly recorded observations during a great number of years, to render the fact indisputable. The streams which discharge into Lake Superior amount to several hundred in number, and the quantity of water supplied by them, is many times greater than that discharged at the Falls of St. Mary, the only outlet. There is however no reason to imagine, from this circumstance, that the quantity of water increases, for it is absolutely necessary that there should be a supply very far exceeding the discharge, to replace the immense expenditure arising from the evaporation from so extensive a surface.

8. The surface of Lake Superior is about 623 feet above the tide water of the Atlantic Ocean. Of this height, 565 feet, the elevation of Lake Erie, has been ascertained by the United States' Engineers, when leveling for the Great Western Canal of New York. 22 ½ feet have been also measured as the amount of the Fall of St. Mary's Rapids. Of the rest, which is merely estimation, 30 feet have been allowed as the difference of level between Lakes Erie and Huron, and we think that 10 feet are not too much for the whole descent of the River St. Mary's, exclusive of the Falls.

Having now mentioned these preliminary matters, which although not strictly geological, are in some measure connected with that subject, and are besides intrinsically interesting, we proceed to take a rapid and general view of the various rock formations.

9. Lake Superior is situated by the southern side of that great chain of Hills composed principally of rocks of the inferior or submedial orders,* which to the eastward, forms

* It will be perceived that we adopt the arrangement of the Revd. W. D. Conybeare in his Introduction to the Geology of England and Wales.

forms the northern coast of Lake Huron, passes close to the northward of Lake Simcoe, is met with in ascending all the streams tributary to the Rice Lakes, and doubtless crosses the Ottawa River, at some point above Lake Chat. It is met with in ascending all the rivers which enter the St. Lawrence from the north, approaches close to that river at Cape Tourmente below Quebec, whence it continues in a north-easterly direction to the coast of Labrador. A spur from this great chain, there is little doubt, crosses the St. Lawrence at the Thousand Islands. To the north-west, sienitic granite supporting slate always highly inclined, sometimes vertical, and having an east north east direction, has been traced as far as Lake Winnipec. The extent westward and south westward is not so well known. It is however certain, that it forms the table land full of the small lakes in which the Mississippi, St. Lawrence, and the rivers which run into Hudson's Bay have their sources: and it is a singular fact, that these are so nearly on a level, that canoes, in very wet seasons, have passed from one to the other. Either this ridge, or another in connexion with it, curves round the sources of the St. Lawrence,* whence it proceeds eastward, (in a curve to the southward,) to Point Iroquois, which, together with Gros Cap, form the entrance of Lake Superior. These opposite headlands, about 4 miles apart, form the gorge of its geological basin: and here it is that the barrier appears to have given way, and allowed a free passage for its waters to the Atlantic.

These southern highlands separate the rivers which run into Lake Superior, from those which are tributary to the Mississippi and Lake Michigan. The Basin of Lake Superior, we consider to be bounded by the summit level or height of land

* It will be perceived that we speak of the sources of the river St. Louis, as being also those of the St. Lawrence. We consider the St. Lawrence as running through the lakes to the sea, and the St. Louis, St. Mary's, St. Clair, Detroit, and Niagara as merely local names for various parts of the same river.

land on which its rivers have their sources. This is much more extensive than the space at present occupied by its waters.

The summit level is in some parts close to the lake, whilst, in others, it is distant 50 or 70 miles. All that is known, (and it is known imperfectly,) on this subject, may be seen by a reference to the latest maps. The height of the sources of such rivers as have been visited by Mr. Schoolcraft and Doctor Bigsby, has been estimated at from 505 to 614 feet above Lake Superior. The summits of the Hills are much higher, both on the north and south side of the lake; We measured some of them geometrically, and we are certain that the highest are at least 1500 feet above the lake; and consequently upwards of 2100 feet above the sea—an elevation insignificant when compared with other mountain chains, but very striking when compared with the general level of the Canadas.

It must be remembered, that it is not our intention to give a minute account of the rock formations of Lake Superior, for that has been already ably done, by that zealous and indefatigable geologist Doctor Bigsby:

We shall endeavour to give a concise and general view of the several formations, shewing the extent they occupy, and the connexion of one side of the lake with the other by means of the islands, &c. We shall then notice those other parts of the subject which have been left undone by Doctor Bigsby, or which may have escaped his notice.

10. For the sake of perspicuity alone, we shall divide the rocks of this lake into three orders.

First. The inferior order.

In this order we comprise various granites, which almost always contain more or less hornblende, and sometimes hornblende and felspar alone.

In this last state we have seen it of large crystals of both minerals

minerals, and at others in grains very minute, and passing into greenstone.

Neither gneiss nor mica slate was met with; although the granite, by an abundance of mica or a lamellar structure, may for a short space, sometimes assume the appearance of either.

Second. The submedial order.

In this order we noticed greenstone, common jasper, a variety of slates as greenstone, flinty chlorite and talcose slates, and, in one place alone, transition limestone. In one instance we think we observed traces of greywacke.

Third. Trap or overlying rocks.

These are very abundant. The most so is amygdaloid; various kinds of porphyry are next in quantity; then trap greenstone and sienite, (the former often basaltic,) and pitchstone.

Fourth. The medial order.

The only rock of this order is the old red sandstone.

We shall now proceed to give a general idea of the relative quantities of these rocks, and of their situation.

11. Of the inferior order, sienitic granite, almost always containing hornblende, (for which reason we adopt the term sienitic granite,) forms the highest hills; and it also either forms the shore, or is immediately in rear of it, from one extremity of the north coast to the other, that is, from Gros Cap to the St. Louis. It also forms the central parts of several of the large islands, such as Michipicoten Island, St. Ignatius Island, &c.

It is also met with on the south coast, where it forms the nucleus of Point Keewawonan, and many hills from in rear of Granite Point to the Huron Islands, which last are also of this rock. The Porcupine or Wisconsan Mountains about 1500 feet above the lake, are also of granite.

12. Submedial order. Greenstone. This is very abundant. It occurs in immense beds, forming perpendicular and

and columnar precipices, frequently 1000, and, at Thunder Cape 1350 feet above the lake. It forms almost the whole of the Pie Island the south side of which is a precipice from 500 to 800 feet high. This precipice displays a beautiful geological section of the island. In some parts stratification is visible half way up the cliffs; but, in general, only near the water. The strata near the water were alone accessible, they were of clay slate dipping to the NE. or nearly so, at an angle of about 10° with the horizon. These strata supported immense masses of greenstone of a pilastered or columnar structure, displaying no signs of stratification.

Greenstone is found associated with the granite from one end of the north coast to the other.

We venture it as our opinion, that this greenstone, which passes into sienite, and thence into sienitic granite, should be classed as we have done, separately from the trap greenstones and sienites, which are associated with the amygdaloids and porphyry, and which in general occupy, excepting in veins, a comparatively lower elevation. The greenstone which we have placed in the submedial order, merely for distinction, and without pretending that such classification is undoubtedly correct, or to decide that which is still matter of dispute with geologists, is found in immense beds, forming chains of precipitous hills, many miles in extent, sometimes alternating with, and sometimes overlying the granite, frequently at an elevation exceeding 1000 feet above the lake. Doctor Bigsby is of opinion that this rock is stratified: and so we think, but so very indistinctly and irregularly, that we will not venture any other opinion, than that its general direction is from northeast to east. Common jasper, coated with reddish iron ochre, flinty greenstone, chloritic, micaceous, and talcose slates, occur in considerable

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quantity in the Slate Islands, so named by us from that circumstance.

These slates are stratified, highly inclined, sometimes vertical, much disturbed and shattered, direction nearly east and west. Transition limestone has been found by Doctor Bigsby only on Thunder Cape, alternating with sandstone.

13. Trap or overlying rocks. These occupy the same extent as those before mentioned, that is, from one extremity of the lake to the other.

The amygdaloid, we have no doubt, rests on the sienitic granite, although, from the nature of the country, we never saw their junction. It passes into greenstone, simply by being divested of its nodules, on the one hand, and into porphyry, on the other. At least the porphyry often contains, besides its crystals of quartz and felspar, imbedded nodules of calcedony, agate, calcspar, &c. We traced the amygdaloid from near the eastern extremity of the lake at Point Mamainse to Gargantua, thence westward to the south side of Michipicoten Island. It is next found on the Slate Islands; and is very abundant, (forming whole islands,) along the south side of Neepigon and Black Bays, whence it continues to Ile Royale, and thence across to Point Keewawonan, where its debris is plentiful. We did not see it there in place, but we have been told that it was seen by Mr. Thompson astronomer of the boundary line commission. It is however certainly not the principal formation of that promontory as Doctor Bigsby has stated, and who has most likely been misled by report, or by seeing specimens from the masses on the beaches.

From Ile Royale amygdaloid appears at intervals along the north coast south westward all the way to the river St. Louis.

Associated with the amygdaloid are various clay porphyties

ries of various colours and degrees of hardness. Some of the hardest are very beautiful, and susceptible of a very fine polish, particularly one from Agate Cove. This is amygdaloidal porphyry and is an instance of these rocks passing into each other. It is bright red, with small crystals of glassy quartz, and here and there large nodules of calcedonic agate, quartz and calcspar.

Porphyry commences first at Gros Cap, the entrance of the lake. It is not plentiful along the east coast northwards to Michipicoten; but we traced it to Michipicoten Island, off the south side of which it forms a chain of small islets, associated with amygdaloid and other trap rocks.

Like the other rocks of its class, it is seldom seen along the coast, between the point last mentioned and the slate islands; but is very plentiful along the southern side of the archipelago of islands off the mouths of Neepigon and Black Bays. It occurs also on the south side of Ile Royale; and occasionally all along the coast to the westward, to the river St. Louis. We never could discover signs of stratification in any of the porphyries.

Trap greenstone is also found along the whole extent assigned to the two last mentioned rocks. It is frequently porphyritic, containing small rhombic crystals of brownish red felspar. It is also occasionnally basaltic both in veins and in masses.

The columns appear not to be easily separated. They are occasionally of five unequal sides, but by far the greater number have only four.

The pitchstone was found in small quantities, and in thin layers in the interstices of the columns.

The following rough sketch of a small Island in the mouth of Neepegon bay,* taken on the spot, will be explanatory.

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* See fig. 1.

There are other islands of the same kind, and near the same part of the lake.

Of the trap rocks, sienite alone remains to be noticed. This is merely a greenstone with a superabundance of felspar. Its highly ferruginous nature, and its intimate connexion with the amygdaloids and porphyries into which it passes, together with the absence of chlorite, distinguish it in our opinion from the sienitic granite; even although the last be destitute of both quartz and mica. Its felspar is never so red as that of the sienitic granite; but is often stained of a dark green colour by the hornblende, and iron rust brown, by the oxide of that metal which it almost always contains. It also strongly affects the compass needle, which the sienitic granite never does. Lastly, it is always found in intimate association with the other trap rocks which we have enumerated. There were certainly appearances of stratification in the amygdaloid, but they were so very indistinct, and we could spare so little time to the examination, that we cannot venture to assert this circumstance as fact.

14. Medial order. The old red sandstone. This extensive deposition forms the falls or rapids of St. Mary. It is again seen at the waters' edge at Gros Cap: thence northward at Bachewine Bay, Ile Parisien, Sandy, Montreal, Lizard and Gravelly Islands, all of which are horizontally stratified, or nearly so. It may be traced, although in small quantities, almost to Michipicoten. Caribou island is formed of it. Between Michipicoten and the east point of Neepigon Bay it was seen only as debris, but along the north side of the islands of that bay, and on its northern and western shores, it appears in high cliffs, and attains an elevation of about 400 feet above the lake. Continuing westward, it is found along the islands of Black Bay. In the centre of that bay it forms several entire islands. We continue to trace

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it to Thunder Cape. It is also met with on the opposite side of Thunder Bay, and in small quantities to the Grand Portage, and even to the St. Louis.

On the south-west side of Ile Royale it is found plentifully, being there frequently a conglomerate precisely similar to that of the opposite point of Keewawonan, on the south coast.

It forms cliffs alternately with sandy beaches on the south coast from Point Iroquois to the St. Louis. The magnificent cliffs of Les Portailles and of Grand Island, are of this rock, where it attains an elevation equal to that in Neepigon Bay on the north coast. At Les Portailles and Grand Island there are perpendicular cliffs, from 300 to 400 feet above the lake, broken into the most beautiful and picturesque arches,* (some of which a boat can pass under,) porticos, columns, and caverns of immense dimensions. These are formed by the heavy surges of this great lake, which rival those of the Atlantic.

From Granite Point to the east point of the great bay of Keewawonan, it is found resting immediately on granite. It forms horizontally stratified cliffs along the whole of the south east side of the great promontory of Keewawonan. The north side of that promontory for many miles to the westward of its northeast extremity, is of the same formation, either stratified like the southeast side, or more generally as coarse conglomerate, similar to that of Ile Royale and Neepigon Bay. Precipitous points of this rock, with sandy bays, the beaches of which are formed from the disintegration of its particles, continue to the islands of the Twelve Apostles, which are also of sandstone.

From these islands to the St. Louis, the same formation continues, and it is found in cliffs, occasionally, on the north coast

* See Schoolcraft's tour for description of the arched rock.

coast opposite, for at least 20 miles to the north eastward of the entrance of that river. We ascended the St. Louis, about 15 miles in a direct line from its entrance. The first rapids are about 1½ or 2 miles further and are over this rock.

Having now traced the extent of the sandstone from one extremity of the lake to the other, noticed its existence on both shores, and traced it across the lake by many of the islands, so as to leave no doubt of its being a general formation, throughout the whole of the basin of Lake Superior, we next proceed to mention some other particulars concerning it. In the first place, it rests immediately on the granite.* It is in general horizontally stratified, or nearly so, even at its immediate contact with that rock ; as in the following sketches† taken on the south coast where there are many peninsulas of granite, joined to the main by isthmuses of sandstone, which are fast yielding to the incessant washing of the lake, so that, at no very distant period, these peninsulas will become islets, like many others near them, and which have become so in the same manner.

There are many other instances of the conjunction of these rocks similar to those above, which serve to prove that the sandstone was deposited after the granite occupied its present position, and that it has not been disturbed since : but our duty is to relate that which may bear on either side of a question : consequently we must say that we think that there are other appearances which directly contradict this inference, such as those represented in the following sketch,‡ and observations.

The sketch was taken on the west side of a bay the next north westward of that in which is Soosoowagaming river.

*Doctor Bigsby saw conglomerate resting upon and alternating with amygdaloid at or near the Point Mamainse north coast Lake Superior.

† See figure 2 and 3.

‡ See figure 4.

On the northwest side of Point Keewawonan the high central part of which we have no doubt is granite, the sandstone is inclined at various angles dipping to the north and northwest. Its inclination was always greatest, when the granite hills were nearest to the coast, amounting in some cases to 70 degrees. On approaching the Porcupine or Wisconsan Mountains,* the same phenomena occurred, and in that part of the coast where those hills are only distant about a mile from the lake the dip to the northward was 70 degrees.

At Montreal River, and at other places on the south coast, the sandstone was also highly inclined, but apparently from subsidence or displacement. Having now mentioned instances in which it appears that the granite has hove up the sandstone after it was deposited, as well as those of a contrary nature, we shall leave it to those who have more leisure and more ability to draw the proper deductions therefrom. Our business, to the best of our ability, is the faithful relation of facts.

The sandstone sometimes appears in undulating strata, as in the following sketch representing the entrance of Horse Shoe Cove, in an island in the mouth of Black Bay on the north coast.‡

Upon examination of the junction of the granite and sandstone in several places on the south coast, we perceived a mutual decomposition for 5 or 6 inches, and the sandstone, for the first foot above the granite was full of scales of its white mica.

There appears to be little doubt that this formation is of immense extent to the west and southwest. It probably reaches to the foot of the Rocky Mountains.§ It is also not improbable, that it is the formation upon which the limestones of lake Huron rest:—For sandstone appears at the Neepish Rapids, and in the bed of the river Minestan,†

*Wisconsan, in the Chippewa language signifies a Porcupine.

‡See Fig. 5.

§See Major Long's expedition and other American Writers.

†Here it supports diluvial calcareous sand clay containing shells similar to those of the lakes, with occasional boulders of granite, &c. on

on the south-east coast of that lake: also at the south point of Sagana bay.

At the Falls of Niagara and below them, it supports fetid limestone similar to some of the limestone of the Manitoulins, also at the Oswego and Genessee rivers on lake Ontario.

In opposition to this supposition, however, it must be remarked, that we have often seen the junction of the limestone of Lake Huron with the granite, gneiss, and quartz rock, and in every instance it laid immediately upon them, without any rock intervening.

We are of opinion that it requires much more elaborate investigation than has yet been bestowed to render it certain that the sandstone of Lake Superior, and that of the extensive tracts of country which we have mentioned are the same formation, for the sandstone of the northern parts of New-York, contain gypsum and rock salt, and would therefore according to the generally received opinions of geologists, belong to a younger order of rocks. On the other hand, great quantities of gypsum are found on the St. Martins Islands near Michilimakinac, in the immediate vicinity of which large slabs of sandstone occur, so little injured, that they must be very near their parent rock.

15. Having made all the observations which appear to us likely to throw any light upon this subject, we proceed to give our reasons for terming the sandstone of Lake Superior the old red. These are, its position immediately on the granite, its structure and component parts. The two last have been fully described by Doctor Bigsby, it will therefore only be necessary to observe, that it is principally composed of fine grains of quartz and small fragments of felspar, containing disintegrated particles of all the older rocks of the lake. When it is so coarse as to become a conglomerate, which very frequently is the case, it contains fragments of the trap or overlying rocks, as well as of the inferior order. It is in some districts

simply red and white ; in others it is variegated red, white, yellow, grey and dark reddish brown. It is sometimes argillaceous, and often ferruginous. There are often interposed between its strata thin layers of a black ferruginous sandstone not more than half an inch thick, which easily crumbles, and forms a black heavy sand very plentiful on the beaches. It also often contains thin plates of indurated red and green clay. It only sometimes slightly effervesces with acids : and when it is a conglomerate, it contains much carbonate of lime, both in veins, and in its cement. This is particularly the case on the north side of Point Keewawonan and on the island off its north east extremity.

It is in this sandstone, that the vein of malachite occurs on the east point of Copperas Harbour, about seven miles to the westward of the east end of Point Keewawonan*. We have met with traces of copper ore, in other instances in this sandstone.

We were ever on the look out for organic remains in this rock but never discovered any : nor has Doctor Bigsby. Lieut. Collins however who accompanied us thinks he saw a shell and Mr. Schoolcraft in his tour has recorded that he found another.

In the north western part of the great Neepigon bay, both on the main and islands, we remarked that the sandstone which was superimposed on granite supported immense beds of greenstone, more than a hundred feet thick. In short greenstone laid upon the sand stone in almost every island in this bay.

16. There is a high island near the main, in the east end of Neepigon bay, which has a perpendicular cliff of dark iron

*Doctor Bigsby has been misinformed. He says, that this vein of copper ore is amygdaloid. We have examined the locality, and have specimens which we took from the place, both of the ore and of the rock.

grey

grey coloured rock in strata 10 or 12 feet thick. This rock alternates with thin strata of slate until near the summit, when there succeeds several conformable strata of sandstone. The whole of these strata were parallel, dipping to the south east at an angle of about 20° degrees with the horizon. The whole cliff was about 450 feet above the lake. We have little doubt that this dark rock and the alternating slate belong to the greywacke formation, for we found a large mass of well defined greywacke on a neighbouring island. Lydian stone was found on the same island. It may not be unimportant to remark here, that the greenstone of this lake has, in general, a massive and columnar structure at the summits of the cliffs, and that lower down those cliffs it becomes more or less slaty, in which it sometimes merely shows signs of stratification, in others, as at the Pic Island, it is decidedly so. It then sometimes contains globular concretions not unlike those observed in the greywacke of the St. Lawrence. We certainly feel some hesitation in opposing our opinion to that of Doctor Bigsby who conceives these appearances to arise merely from a change of structure in the greenstone. Nevertheless we are decided in thinking, that, at least in the locality which we have best examined, the Pic island, the greenstone rests on a clay slate which we class in the submedial order.

17. Before quitting the consideration of the sandstone, we must mention a singular rock which has been only slightly noticed by Doctor Bigsby. It occurs in cliffs on the north side of the easternmost Neepigon islands, where it is massive, of a brick red colour, striped and veined with impure white. It is surmounted by a single stratum of a dark grey rock which we could not get at, and which may be limestone. Doctor Bigsby found this rock near Thunder Cape, of a red colour, also massive, and superimposed on alternate strata of red sandstone and limestone destitute of organic remains. This is the only instance of limestone in place hitherto discovered

on

on this lake. There is however a large tabular mass, or perhaps a bed of crystalline limestone, (discovered by us,) superimposed upon, or imbedded in the trap greenstone of the slate islands. The red rock above mentioned is also abundant in the western parts of Neepigon bay. It has been supposed that it is stratified, but this we think is a mistake arising from the stripes and veins which we have mentioned. Doctor Bigsby has ventured an opinion, founded principally upon the above supposition, that this is porphyry divested of its crystals, and also that it passes into sandstone.*

The first part of this supposition we think extremely probable; but the last, we think, would require strong and unanswerable reasons to support it, ere it could be received as an undoubted fact, contrary as it is to all former observations on the nature and connexion of those rocks. We have mentioned the colour of this rock. It is of different degrees of hardness in different places; sometimes as hard, or nearly so, as hornstone, when it has a flinty fracture passing into conchoidal. At others it is slightly granular. It also occurs of earthy fracture, and so soft that it can be cut by a knife, in which state it is used by the Indians to make their pipes. It then very much resembles potstone. Upon the whole we are of opinion that the base of this rock is compact felspar, and that it is nearly allied to the porphyries.

Having now noticed the whole of the rock formations of Lake Superior, we shall give a brief description of the large islands, which have, we believe, never been visited with this object, by any excepting ourselves.

18. Ile Royale is about 45 miles long, by 7 or 8 broad, lying in a north east and south west direction. Its centre is composed of ridges of trap sienite parallel to its length, and of greenstone, which last abounds principally on its south side.

*See Doctor Bigsby on the geology and geography of Lake Superior in the periodical work mentioned in a former note.

About

About half-way along its north west side, from the south west towards the north east, parallel chains of long and narrow islets of amygdaloid, containing the usual nodules, together with native copper, commence and continue to its north east extremity. At the distance of about two miles further in the same direction is Passage Island, also of amygdaloid, and containing native copper in veins and cavities associated with prehnite, quartz and calcspar.

In the small bays of these agmydaloidal islets, the debris of veins was found in great quantities. From the rock, which frequently adhered to these tabular masses, it seems that they are from a dark brown porphyritic trap. Native copper in small grains, plates and wires was very plentiful in these masses, and was associated with prehnite, quartz and calcspar. These portions of a vein could not have come from far, as their edges and angles were not in the least worn. It is probable, that they have been washed out of a neighbouring vein by the waves.

It is a very remarkable and interesting fact, that Doctor Richardson found specimens precisely similar to these, near the Polar Sea. He says, "we also found some large tabular "fragments, evidently portions of a vein, consisting of prehn- "ite associated with calcareous spar and native copper."*

This vein, (he also adds,) he supposes to be in feldspathose trap.

On the south east side of Ile Royale, there are similar chains of islets, extending 7 or 8 miles in length, and exactly parallel to the long narrow point of trap sienite which is a continuation of the central ridge of the island, and which, projecting a little beyond these chains of islets to the north eastward, forms the north east point of the island. Porphyry and greenstone are also common among these islets, and here and there the sandstone is visible. Further to the south west this latter rock

* Appendix to Franklin's first journey to the Polar Sea.

rock appears, in a long and low chain of small islets, across a bay : and the south west end of the island is of conglomerate belonging to the same formation, and exactly similar to the shores of Point Keewawonan opposite, where copper is also found. Copper has also been found among the Wisconsan mountains. Either these mountains or those of Point Keewawonan, there is little doubt, are the original site of the great mass of native copper described by Henry, and since by Schoolcraft on the banks of tne Ontonagon river.

19. The central parts of Michipicoten island have never been explored ; but there are appearances sufficient to justify us in affirming, that granite and greenstone are its principal rocks.

On its south side, like all the rest of the islands of the north coast, amygdaloid, porphyry, and trap greenstone abound ; but no sandstone, except in debris, was noticed.

20. Caribou Island, so little known hitherto, is about 6 miles in circumference and of horizontal sandstone, surmounted by sand and boulders of the rocks of the north coast. These last are in immense quantities off its south and south west points, and form a very dangerous shoal for about 3 miles out into the lake.

21. The islands of the Twelve Apostles, as well as the others, have never been examined, excepting by ourselves. They are twenty-three in number, and are all based on the sandstone, which is here highly ferruginous. Over the sandstone is a thick deposit of ferruginous sandy clay, of a dark red colour. It is remarkable that the north-east and south-east sides of all these islands have perpendicular cliffs of sandstone, seldom more than 60 feet high. These were fast decreasing from the action of the waves ; whilst on the south-west and north-west sides, the cliffs were of the red sandy clay. There were no beaches, excepting at the south points of these islands, where, in general, there were triangular points of sand,

sand, inclosing a small lake or rather pond. The sandstone was not so distinctly stratified as usual. It also appeared sometimes in a state of disintegration and passing into the red clay. The same appearances were observed in the neighbouring bay of Chequamegon, and in the vicinity of Montreal River. This red sandy clay certainly resembles very much the red marle of the new red sandstone formation; but yet we adhere to our former opinion that it is the old red, from its lying immediately upon the granite, being conformably stratified with slate which appears connected with the greywacke and supporting very old limestone.

22. The great promontory of Keewawonan has only been examined, and that slightly, by ourselves. Mr. Schoolcraft passed over the Isthmus of this Peninsula, and did not, therefore, circumnavigate it.

It has been erroneously stated to be a district of amygdaloid; but the gentleman who wrote thus did not visit it, and was therefore obliged to take the report of others. The central parts of this great peninsula are very high, consisting of steep and conical hills, which from the distance that we could see them at, from a vessel in the Lake, we consider to be at least 800, and probably 1000 feet above the lake. Being familiar with the appearance of granite hills, we have no doubt that these are of that rock. All along the south east side of the Peninsula, points of sandstone cliffs and sandy beaches between, continue until within about 7 miles of its north east extremity. Here a large bay runs into the foot of the hills, and the sandstone ceases, the shore being then of the older rocks. The weather did not permit us to land, but we think, that porphyry, greenstone, and amygdaloid will be found here, from the nature of the fragments which compose the beaches, as well as from the appearance of these rocks. The extreme end of Point Keewawonan is of trap greenstone, off which lies an island, which we have named Manitou Island, because it is much dreaded by the Indians, who believe that it is the

habitation of a Manitou or Spirit. This island is of conglomerate. The north-west side of Point Keewawonan is principally of conglomerate, which is in general the lowest stratum of the sandstone formation to which it belongs. Sandstone and conglomerate however, that is fine and coarse sandstone, not unfrequently alternate with each other. Points of trap greenstone are common, and almost all along this side of the point, there are parallel chains of small trap islets close to the shore, very like those of Ile Royale, which is distant about 41 miles to the northward.

Further to the south west, points of sandstone cliffs and sandy bays between, occur as on the south east side.

We never met with amygdaloid in place, on this promontory: we however think it very probable, that it may be found there, for of course we could not land every where. That rock is very plentiful among the debris of the beaches, containing almond shaped nodules, of calcspar encrusted with green earth, also agates, carnelians, and native copper. Small pieces of malachite associated with calcspar, were also met with occasionally; but never very distant from the locality of that mineral, which we are about to describe.

About seven miles westward from the north east extremity of point Keewawonan, on the east point of Copperas Harbour, there is a vein of copper ore (malachite) 5 or 6 feet wide, and in the old red sandstone, which it traverses in a north and south direction nearly. It is rich in ore, and can be perceived running along the bottom of the lake, under water, until the depth hides it from view. To a person in a boat or vessel close in shore, it appears like a large bluish green rock on the beach.

23. Doctor Bigsby has written so fully upon the trap and other veins which traverse the granite and greenstone, that we shall not dwell on the subject. We must however remark, that we have never noticed a vein of trap passing from granite into

into sandstone. That Gentleman thinks that these trap veins traverse all the rock formations of the lake promiscuously.

There certainly appears an intimate connexion between the various orders of rocks which we have mentioned. We think the immense beds of greenstone which are superimposed upon the sandstone in Neepigon Bay, an instance of this. As for the latter rock resting upon and alternating with amygdaloid, it does so only in one or two instances, and to small extent, and may possibly arise from displacement.

We have already recorded our opinion as to the porphyry passing into sandstone ; and we are equally incredulous as to amygdaloid passing into granite. Facts so contrary to the results of former experience and observation, must be clearly and obviously established, before they can meet with general reception.

It has been written that the sandstone is contemporaneous with the amygdaloids and porphyries ; and younger, but not much more so, than the granite. The following considerations may possibly throw some light upon this subject. It is acknowledged that the nodules of the coarser kinds of this sandstone are often composed of the trap rocks* as well as of the inferior order. In short there is scarcely a rock in the lake, of which rounded masses may not be found in this formation. Hence it is obvious that those rocks, not only were formed first ; but that they have, subsequently to their formation, been shattered by some powerful agent. The fragments are all worn perfectly smooth, and most of them have been completely rounded by attrition. It seems therefore equally probable that they have been subjected to the long continued action of powerful streams of water, before they were deposited in their present horizontal strata.

How

* We have seen this conglomerate, in some places almost entirely composed of porphyries and other trap rocks ; not only its nodules but also its cement.

How then can it be reasonably asserted that the sandstone is older than those rocks from whose partial ruin it is derived ?

As in no instance, to our knowledge, has a mass of shell limestone been found in this sandstone, it appears tolerably certain that the great convulsion which formed the materials for this extensive deposition took place at a period previous to the formation of the Lake Huron limestones ; and this deduction is rendered still more probable from the boulders of shell limestone which are found, among others, on the beaches in various parts of the lake, but principally in the north-eastern parts of it. These, we have every reason to believe, have come from the north-east ; for we are in possession of specimens of this limestone, of the same age as that of the Manitoulins' from the vicinity of the height of land between the Michipicoten river and that which enters Hudson's bay at Moose factory. We have also seen large masses of foliated gypsum from the same part of the country.*

It is a fact not generally known, that Captain Parry, R. N. found limestone containing similar petrifactions as orthoceræ, fossil corals, &c. near the north eastern extremity of this continent.† The Boulders of shell limestone which we have mentioned, appear to have been brought to Lake Superior by the same great torrent or rush of water, from the north or north east, which has strewed all the southern shores of the lakes with rolled masses of the older rocks ; most of which can be traced to their parent rocks, on the northern coasts ; and which must have taken place subsequently to the deposition of the sandstone.

Having thus slightly mentioned that which probably has been, we shall next give a brief account of operations at present going on in the lake—operations arising from local causes

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*These were given me by J. Haldane, Esq. late chief Factor Hudson's Bay Company.

† See Capt. Parry's second voyage.

ses and altogether insignificant in their effects when compared with those terrific convulsions to which we have alluded. It will be perceived, that we make no mention of the few diluvial beds which are occasionally met with on Lake Superior. That subject has been noticed by Doctor Bigsby, and to him we refer our reader. That Gentleman has, however, made no mention of those alluvial operations, which have been for ages, and are still, at work. These we are aware, are not extensive ; yet this appears to us inferior in interest to no other branch of geological inquiry ; for here the cause is still in action. We have therefore certain data from which to draw our deductions, which can never be the case, in regard to phenomena of diluvian, much less of antediluvian origin. We however acknowledge that the circumstantial evidence attending many diluvial depositions, falls little short of positive proof.

24. At the bottom or southern side of that bay, of which Point Iroquois is the east point, sandstone, horizontally stratified, is succeeded by sand and gravel, which runs up to the northward 17 or 18 miles, forming the projecting low headland of White Fish Point. From this point, in a W. by S. direction 45 miles, the coast is composed exclusively of beaches of fine sand and gravel, to the west point of the Grand Sable,* where the horizontal sandstone again makes its appearance, protruding from under the sand. A line drawn from the first point in the bay to the westward of Point Iroquois, to the last—the west point of the Grand Sable—will cut off to the northward a triangular tract of country, which is composed of sandy barrens or downs.

It is probable that the southern parts of this tract may be diluvial, like the Grand Sable, but the northern part, for a considerable distance in rear of the present margin of the lake, is composed of parrallel ridges of sand hills, which have evidently

* For the description of this immense diluvial bank of sand and gravel, see Schoolcraft's tour.

evidently been formed by the prevailing N. W. winds. Gales of wind heave up the sand far above the usual water mark. At times of comparative tranquillity, the sand becomes soon dried by the sun, and is then easily acted upon by the winds, and carried in great quantities into the interior, as we have often observed. New beaches were in process of formation parallel to, and outside of the present: hence there is a constant accumulation of sand upon this part of the coast; the supply for which arises from the destruction of the sandstone cliffs to the westward, by the incessant action of the waves, which, it has been mentioned, form immense caverns, &c. and which, doubtless, by undermining, frequently bring down thousands of tons of this rock, which being of mechanical formation in thin strata, is easily disintegrated and reduced to sand. The progress of this sand to the eastward is assisted by the set of the waters of the lake towards their outlet, for we observed along this part of the coast, near the shore, a slight current in that direction. No doubt this current is stronger, (we observed it in August,) in the spring of the year, when the several hundreds of rivers to the westward, on this side of the lake, are filled to overflowing with the produce of the winter snows. It is remarkable that their entrances were all directed to the east. A long point of sand extending from their western points, ran to the east across their mouths, leaving an entrance several hundred fathoms down the coast. In the dry season, the smaller streams are completely closed, and the river is then barred with sand. After having been some time shut up, these rivers occasionally form a new outlet through a part of the sandy barrier which had been long formed; disclosing to view vast numbers of trees which had been long buried in the alluvial sand and mud. This last contains the shells of the lake, and not unfrequently the bones of fishes, birds, and small land animals, brought there by the eagles, fish hawks, bears, foxes, &c. which usually bring their prey to such unfrequented spots, for the purpose of devouring it at leisure.

The

The trees were in general in good preservation, and in only one instance, we observed a crack in one of them, filled with dark red oxide of iron and pyrites.

From what has been just related, it is evident that the lake is gradually changing its shape, by the destruction of the cliffs, and the consequent formation of the downs. The lighter argillaceous particles of this disintegrated sandstone, as well as those brought down by the rivers, are carried further out into the lake; for we observed that when the depth exceeded 7 fathoms, the bottom was generally of mud or soft clay.

The head, or S. W. end of Lake Superior, is formed by a ridge of sand hills, slightly curved to the westward, which extends across the lake about 9 miles from the sandstone on the south to the older rocks of the north coast. About 15 miles to the S.W. these rocks close; leaving only a passage for the river St. Louis, which there falls over sandstone, as we were informed by the gentlemen of the American Fur Company, who reside near the rapids. The sandy ridge which we have mentioned, may be considered as the base of a triangle, the apex of which is the rapid, and the sides, the ridges of sandstone, and of the older rocks on the north and south. Through this triangular space or valley, the St. Louis winds among alluvial islands of its own formation.

These islands do not continue to the ridge of sand hills forming the head of the lake, for, besides this outer ridge, there is another parallel to it, about a mile further to the S. W. cutting off a section of the triangle, and forming a small lake or large pond, with about 9 feet of water.

The southern part of this pond is filled with reeds and rushes, through which another considerable river flows from the southward, having a common outlet with the St. Louis. The outlet of the St. Louis through the inner, is not opposite to that through the outer ridge; but there are evident marks of a former outlet in the latter, which was nearly so.

The

The following rough eye sketch, from memory, will probably serve to make us understood, and explain the nature of the constantly increasing alluvial deposits of the St. Louis. *See Fig.*

This sketch is merely explanatory; it is not pretended that the number or shapes of the islands are correct.

At Mauvaise Rivière, near the islands of the Twelve Apostles, the Michipicoten River, and the Kamanistiqui-â, the alluvial depositions are extensive; and of course constantly encroaching on the lake. The last, (on the north bank of which is Fort William,) has formed two Deltas, through which it enters the lake by three mouths. In excavating a few feet through the sand, we always came to clay, similar to that deposited immediately without the bar of sand. In this clay, clam and other fresh water shells were abundant; and in the superstratum of sand, small angular fragments of the flinty slate which is found in place at the rapids of the river above. These last have been brought down and deposited by the stream.

The river has evidently elevated its bed; for on either side, its immediate banks are not only much higher than the land a little back; but this last is, in many parts, lower than the level of the river when the waters are high.

It appears that the lighter argillaceous matter is carried out by the stream, and deposited without the bar; and that the sand which is continually coming down also, is thrown out further and further, covering this clay by degrees as it is deposited—an operation which meets with little interruption, from without, as the place is well sheltered from the prevailing winds.

As the nature of these alluvial depositions has, we trust, been explained by the instances which we have related; and as this paper has extended to a much greater length than we at first anticipated, we shall pass over the other rivers, and proceed to give a synopsis of the minerals which we observe in the various orders of rocks. 25.

25. In classing the minerals which we noticed on Lake Superior, we shall follow the system of Professor Jameson, third edition, published in 1820. He has divided minerals into three classes: earthy, saline, and metalliferous. All the minerals hitherto observed on Lake Superior are referable to the first and third classes. As it is not our intention to describe these minerals, we shall confine ourselves to noticing their geological and geographical situation, with such occasional remarks as may be thought of interest.

CLASS FIRST.—EARTHY MINERALS.

GEOLOGICAL AND GEOGRAPHICAL SITUATION.

ORDER I. *Gem.—Genus 10th, Garnet.*

Common Garnet. Is found disseminated in very small crystals in sienitic granite, near east point of Neepigon Bay, L. S. Also, in mica slate and hornblende rock, north coast, Lake Huron. The latter occurs on the Ile aux Outardes 5 or 6 miles east of the French River.

Genus 13th, Quartz.—1st *Species Rhomboidal Quartz.*

Common Amethyst. Is found in veins in Thunder Bay, associated with black and brown crystals of quartz. Also in agate balls and cavities in amygdaloid wherever that rock is found.

Rock Crystal. Occurs in drusy cavities in amygdaloid of the North coast, &c.

Rose Quartz. In veins and druses in amygdaloid.

Milky Quartz. Do. do. do.

Fibrous Quartz. In nodules do.

Common Quartz. Occurs as a component part of the granite, sandstone, &c. in imbedded crystals, in porphyry, and in veins in the granite, greenstone, and amygdaloid.

Flinty Slate and Lydian Stone. The first is found in clay slate, Falls of Kakabika, Kaministiqui-a River. Also in fragments in the alluvium near Fort William. Lastly associated with other slates in the slate islands.

The second occurs in thin strata, alternating with slate, supposed to belong to the greywacké formation, Wedge Island Neepigon Bay, &c. Flint.

FLINT.—GREY, GREEN, WHITE, AND RED. { In agates, veins, layers, and masses in amygdaloid, and amygdaloidal porphyry, Islands of Neepigon Bay, &c.

CALCEDONY AND CARNELION, YELLOWISH, WHITE, AND RED. { In agates, in amygdaloid. It frequently forms the outer coat or layer of agate balls, having amethyst or quartz in the center. Calcedonic incrustations are frequent in drusy cavities.

JASPER.—Striped red and white, at Agate Cove. It also occurs in agate balls in amygdaloid; in rolled nodules in old red sandstone conglomerate; in boulders of the jasper pudding-stone which appear to have come from the Neepish rapids, river St. Mary; in the quartz rock of La Cloche, lake Huron. This beautiful puddingstone is very abundant, and contains, besides red, brown, and striped jasper, fragments of calcedony, carnelion, &c. in a white quartzose cement.

A coarse common jasper also occurs in the slate islands smeared with iron ochre, and in veins in trap rocks.

Second Species.—Indivisible Quartz.

PITCHSTONE.—Found in thin layers, and in very small quantity, in the interstices round the ends of the columns of basaltic Trap-Islet, in the mouth of Neepigon Bay.

ORDER II.—*Spar.—Genus 1st.—Prehnite.*

FIBROUS PREHNITE.—Abundant on the beaches of Ile Royale, associated with native copper, calcspar, &c. These minerals are found in the tabular fragments of a vein in trap porphyry. It also occurs, according to Doctor Bigsby, in druses in amygdaloid, with rock crystal and calcedony near the Point Mamainse.

Genus 3d.—Zeolite, 6th & 7th Species.

MESOTYPE AND STILBITE.—In nodules and vesicular cavities, usually associated with calcspar and quartz, in

in amygdaloid, wherever that rock is found. The finest specimens were taken from Gargantua, and the south side of Michipicoten Island.

ORDER II.—*Spar.*—*Genus 5th.*

Felspar.—Besides forming a component part of sienitic granite, and of the trap rocks, felspar is present in grains in the sandstone. It also occurs in veins in the former rock, and imbedded crystals, (red, white iron rust brown, & glassy,) in clay, porphyry, and greenstone. In trap sienite, the greenstone and oxide of iron colour the felspar muddy green, or dark reddish brown.

Compact felspar is, in all probability, the principal ingredient in the base of the porphyries.

Clay Family.

Clay Stone.—Near the entrance of Neepigon river. It is probably connected with the clay porphyries. It is dark red, or brick red, opaque, and just sufficiently soft to be cut with the knife. The Indians make their pipes of it; and, in their possession, we have seen grey varieties, the locality of which we could not ascertain.

Indurated Clay, or Lithomarge.

Green and Red.—Is found in thin layers, in the old red sandstone of Ile St. Ignace, mouth of Neepigon Bay.

Genus 8th.

Hornblende.—Besides forming a component part of sienitic granite, &c. was met with in large black crystals, in sienitic granite near Peninsula Harbour, North Coast, Lake Superior.

ORDER II.—*Spar.*—*Genus 8th.*

Epidote.—Occurs in minute crystals in druses and fissures in porphyry of Gros Cap, (Bigsby.) Also in

veins, and disseminated in sienitic granite, associated with purple fluor spar, in Peak Island Bay, and near the Black River. Doctor Bigsby also found epidote in a quartz vein in granite, associated with fluor spar, and, we believe, in many other instances.

ORDER III.—*Mica.*

Common Mica.—Occurs, black, white, and brown, as a component part of granite; also in veins. A few scales of mica are also visible, occasionally, in the old sandstone.

Chlorite.—Occurs disseminated in granite and greenstone. chlorite earth occurs also in veins in greenstone in the bay next westward of the Peak Island, where it is associated with calcspar.

This mineral was also found in veins in granite, associated with quartz, felspar, and mica. chlorite slate, associated with other slates on the south coast of the Slate Islands.

Green Earth.—It is very plentiful in amygdaloid, in nodules and vesicular cavities, generally associated with calcspar. It very frequently coats the agate balls. It is also disseminated through amygdaloid. It is also plentiful in, and colours the sandstone occasionally, when in the vicinity of the other rocks.

ORDER IV.

Malachite.—This mineral occurs in a vein about 5 or 6 feet wide, in the old red sandstone, on the east point of Copperas Harbour, about 7 miles westward of the eastern extremity of point Keewawonan.

The direction of the vein is nearly north and south, (we did not however take the bearing,) and it is rich in ore. Compact blucish green malachite

malachite was the most plentiful, but brown copper and earthy blue copper were also noticed. It was met with in fragments on the beaches of point Keewawonan, often associated with calcspar. Doctor Bigsby found malachite in boulders of sienite, on the north coast. These must in all probability be derived from the northern hills.

As Mr. Thompson gave Doctor Bigsby a specimen of malachite, in which the ore was interspersed in thick coatings and plates, through a dark hornblende trap, it seems probable that there is more than one locality of this mineral on point Keewawonan, probably not far apart.

ORDER VI.—*Baryte.*—*Straight Lamellar.*

SULPHATE OF BARYTES.—Was found in a vein in greenstone, Fluor island—off western entrance to Neepigon bay. It was associated with fluor and calcareous spars.

ORDER VII.—*Haloide.*—*Genus* 1*st Limestone.*

RHOMB SPAR.—Found in a small vein in the chlorite slate of the slate islands.

CALCSPAR.

REDDISH, GREENISH AND GREYISH WHITE.—Occurs in veins in sienitic granite and greenstone, associated with quartz, felspar, chlorite, &c. In masses in porphyry and vesicular cavities and veins in amygdaloid. In the last rock it often forms whole balls coated with green earth, less frequently with zeolite, sometimes with quartz. It occurs also in the cement of the conglomerate of the old red sandstone, and sometimes traversing it in veins.

SATIN SPAR.—In veins in amygdaloid (Bigsby.)

Genus

Genus 3d Fluor.

OCTAHEDRAL FLUOR FOLIATED & CRYSTALLIZED. } Green fluor spar occurs in a vein in greenstone associated with sulphate of barytes and calcspar. Green and blue fluor occurs with calcspar and red oxide of iron in another vein in the same greenstone, about 3 inches wide, the sides of which were thickly coated with the red oxide of iron. Another vein in company appeared filled almost alone with this ochreous iron ore. The veins are on the south side of fluor island—western entrance Neepigon bay.

Purple fluor associated with pyrites and calcspar, in islands close to Wedge island, east part of Neepigon bay—Also disseminated in sienitic granite Pic island bay.

At Hawk Islet, and near Gargantua in amygdaloid, associated at the latter place with much ferruginous matter, green earth, and calcspar, (Bigsby.) Near Black river it was associated with epidote, in a quartz vein, in granite. (Bigsby.)

Traces of fluor spar were observed in various other parts of the north coast, or in the old red sandstone.

CLASS THIRD.—METALLIFEROUS MINERALS.

NATIVE COPPER.—The most remarkable locality of native copper is the Ontonagon river, on the south coast, which river has its source among the Wisconsin mountains. There is an immense mass of it lying under a high bank, 30 or 40 miles up from the river's

river's mouth. (Schoolcraft.) We also found it on Ile Royale, in considerable quantities, disseminated through tabular masses on the beaches, (which have been noticed in describing Ile Royale,) in membranes, plates, and wires, associated with prhenite, quartz, and calcspar. It also occurred in Ile Royale, and its islets, in veins, and nests in amygdaloid. In one instance a wire of copper passed through the centre of a fortification agate. This agate was split in extracting it, but the copper wire held the parts together.

Small masses of native copper are found occasionally on the beaches of Point Keewawonan. (Schoolcraft.)

NOTE.—Copper pyrites, green carbonate of copper, and plumbago, were found in the amygdaloid of Point Mamaiuse. (Bigsby.)

Copper pyrites incrosting the sides of an empty vein in greenstone, near Michipicoten. (Bigsby.)

CLASS THIRD.—METALLIFEROUS MINERALS.

OCHRY RED.—IRON ORE.—Iron ore was the only metalliferous mineral found besides copper. It occurs in veins in greenstone floor island, where it coats the veins which contain fluor spar. In amygdaloid it often coats the agates and other nodules. In the sandstone it is very plentiful, being probably derived from the disintegrated trap rocks. In the conglomerate of the old sandstone it frequently coats the imbedded fragments.

BROWN IRON ORE,—(crystallized and otherwise.)—Was met with on the Islets of Gargantoa.

PLUMBAGO,

Plumbago.—In amygdaloid, Point Mamainse. (Bigsby.)

Clay Iron Stone.—In a vein $\frac{1}{2}$ an inch thick in amygdaloid, Point Mamainse. (Bigsby.)

Iron Pyrites.—Was found in various parts of the north coast. Disseminated in cubic crystals through greenstone slate—slate islands; in granite—Neepigon Bay. Lastly, in very considerable quantities, both massive and crystallized, in slate subordinate to the old red sandstone, on an islet between Wedge Island and the main land—eastern part of Neepigon Bay. At this place it was also found in veins traversing the black slate in the most beautiful manner in all directions, and having imbedded crystals of quartz, fluor, and calcspar.

26. Iron is a very abundant material in the trap rocks of Lake Superior, rendering them more or less magnetic. They always disturb the magnetic needle, and, in many places, so strongly as to change the variation two points. In one place, the eastern entrance of Black Bay, this local attraction was so great as to render the compasses useless, the North remaining in any direction or point of the horizon to which it might happen to be placed. Whenever the theodolite was set upon a granite or sandstone point, the needle remained undisturbed. On a trap point it was always the contrary. When we were running lines in the boats from a granite headland to one of trap rocks, we could frequently plainly observe the direction indicated by the compass on the boat's table to change, in some cases, a point or two as we approached the latter, and resume its former correct direction as we returned, or as we proceeded out into the lake, without the sphere of its influence.

27. We have now noticed all the genera of minerals which were met with on Lake Superior, and, in some instances, the species also. We have not divided them into subspecies, for that would have been equivalent to a description. It will be seen that they are very numerous; their localities are, however, new and therefore valuable.

Simplicity seems to be characteristic of this lake, particularly in regard to its geology. The formations are few in number, but on a scale of grandeur not frequently met with. Its geological features may be thus summed up· An irregularly oval basin is formed by the inferior order of rocks, having a broken belt or range of trap or overlying rocks on the inner declivity of its northern margin; and probably on its southern margin also, as these trap rocks were observed on the south coast, whenever the granite approached the lake. Lastly, an immense deposition of sandstone, formed from the ruin of parts of the foregoing rocks, extends from side to side, and end to end, of the lake; attaining the same elevation, and resting on granite on either side, containing the same component minerals and imbedded substances. The granites of the north and south coasts are also similar. Both contain hornblende in large quantity, and are traversed by veins of the same nature. These veins pass frequently from granite into greenstone, unaltered either in their nature or direction. This circumstance is one of the reasons which has induced us to class the last named rock in the submedial order, instead of considering it as a trap or overlying rock. Its passage into sienitic granite, and its generally more crystalline nature, as compared with the basalt-like trap greenstone and veins, are others. We think we are correct in this classification, but even if it should appear that we have made a distinction where none exists, it can do no harm. It cannot mislead, for the facts are stated, and consequently any one may draw from them his own conclusions. It is worthy of

remark that calcspar is abundant in all the orders of rocks. That copper, native or in ore, was also found in all, and fluor spar in all but the sandstone. The various slates of the submedial order, were only found on the slate islands, and on Wedge Island and islets near it, in Neepigon bay; unless the slate which we sometimes observed under the greenstone as at the Pie island, be added. Hence, almost all the formations which usually intervene between the granite and the old red sandstone are wanting, excepting greenstone, and perhaps the limestone discovered by Doctor Bigsby at Thunder Cape, which, as it alternates with the sandstone, is probably transition limestone.

The numerous horizontal depositions above the old red sandstone are entirely wanting; traces of mountain limestone having alone been observed.

With respect to the relative ages of the granite and trap or overlying rocks, it would be mere hypothesis to give an opinion, when it is remembered that the origin of these rocks, whether igneous or aqueous, is still matter of dispute with geologists.

But we are decided in our opinion that the sandstone is of posterior formation to all the rest, from the reasons which we have before given.

It appears to us, that at some period, previous to the deposition of the shell limestones, a great catastrophe, the nature of which it would be vain to surmise, has shattered the granitic and trap formations. That their fragments were then long subjected to the action of rapid streams of water. A period of quiet seems then to have occurred, in which the sandstone was horizontally deposited. Since its deposition, it appears to have been only partially disturbed in the vicinity of the granite, &c. either by the upheaving in places of that rock or by subsidences.

Finally,