

changes, for very soon after entering the conglomerate, the veinstone changes from its quartzose character, and is made up, either wholly, of calcareous matter, mostly rhomb spar, or of this mineral, with occasional ramifications of quartz. The whole usually including, and sometimes investing fragments of the conglomerate or the pebbles of that rock, separated.

As the vein is continued still farther in the direction of end into the red sandstone, these changes are still noticed, and eventually the vein is found to be composed either entirely or mostly of calcareous spar, and eventually so completely is its metalliferous character lost, that it would not, if examined singly, be suspected to be any portion of a metalliferous vein.

The metalliferous character of these veins is most largely developed almost directly at or near the line of junction of the trap and sedimentary rocks, and they rarely continue, without considerable change, for a greater distance than one-fourth to one-third of a mile, on either side of the line, though a few veins were noticed in which, in the southerly or trap extension, the character of the vein continued for a distance of over a mile, nearly unchanged, while in its passage through the conglomerate, for half that distance, its character was also perfectly preserved.

The mineral character of the veins is somewhat varied in those having different degrees of thickness, though it is difficult, if not impossible, to lay down any rule which would characterize this change. The different veins vary very greatly in width, ranging from a mere line to 14 or 15 feet, the greatest observed width of any single vein.

In the descriptions of the veins given above, I only intend to include those which are most perfectly developed; for, in addition to these, there are also many which are imperfectly formed and short, and in which many of the above characters are in part or entirely wanting. These latter are usually of little practical importance, and thus far have been comparatively little examined.

Of the metallic minerals occurring in those portions of the *true* veins which traverse the trap rocks, together with that portion of the conglomerate immediately resting upon or against the trap, by far the most important consists of the several ores of copper, with which iron occurs disseminated in the forms before described, and occasionally, though more rarely, native silver has been detected, associated in the same vein. After as minute an examination of the subject, as the circumstances will permit, I am led to the conclusion, that the only ores of the metallic minerals, occurring in those portions of the veins, which traverse the rocks last alluded to, which can reasonably be hoped to be turned to practical account, are those of copper.

In these portions of the veins, the metal referred to, occurs very frequently in the form of native copper, with which are associated the red oxid, azure carbonate, green carbonate, and more rarely what may be denominated copper black, and still more rarely, pyritous copper. *None* of these have been noticed in a crystalline form.

It must not be imagined that these several minerals make up the whole or even any very considerable portion of the entire length and breadth of the veins, in which they occur, for they are distributed in bunches, strings, and comparatively narrow sub-veins, in a manner

precisely analogous to that in which these ores are usually distributed, in similar rocks, in other portions of the globe. The quartz veinstone, before described, has always so much of the green tinge communicated by the carbonate of copper, that it cannot fail to be detected; but the presence of disseminated native copper in this veinstone, would, at first, hardly be suspected, and it is not until a fresh fracture has been made, and the mineral closely examined, that the numerous dark points and minute threads are discovered to be copper in a native state. Large portions of this quartz veinstone, (when the included metal can scarcely be detected by the naked eye,) when examined with a glass, are found to contain very delicate threads of native copper, that traverse the quartz in every possible direction, and so completely is this latter mineral bound together, that it is fractured with difficulty, and its toughness is very greatly increased.

The specific gravity of this veinstone is very considerably above that of ordinary quartz, and usually, the difference is so considerable, even in those masses where the copper can scarcely be detected by the naked eye, as to be apparent to even the most careless observer. But in addition to this finely disseminated condition of the native copper in the veinstone, it is also disseminated in a similar manner through the rocky matter embraced by the veinstone and in the amygdaloid and conglomerate portions of the rocks, it sometimes extends, for a distance of from two to three feet into the rocky matter on either side of the veins, sometimes completely, or in part, filling the cells of the amygdaloid rock.

The conditions above described refer to the main portions of the veins only, while there are other portions

in which the copper appears to be concentrated in larger masses, constituting bunches and strings, and in which places the sides or walls of the veins are sometimes wholly made up of thin plates of native copper. In these portions of the metalliferous veins where the metal appears, as it were, to be concentrated, it also occurs, much in the form before described, except that the masses of metal vary from the merest speck to that of several pounds weight. In opening one of these veins, at a concentrated point, the observer, unless he had previously examined other portions of the vein, would be led to erroneous conclusions as to its richness, a source of error which cannot be too strongly guarded against; for while the vein, for a short distance, may be found to be exceedingly rich in mineral, the mineral in another portion of the vein may either wholly or in part disappear, a condition which is similar to that observed in those veins of copper that have been extensively worked and found to be the most productive, on the continent of Europe and the island of Great Britain.

The excess of native copper, (compared with the other ores,) which occurs, in these portions of the veins, is a peculiar feature, for it may be said, in truth, that other ores are of rare occurrence. In those portions of the veins traversing the trap, and where other ores do occur, it is usually under such circumstances as to favor the presumption that their origin is chiefly from that which was previously in the native form; for the carbonate and oxides, almost invariably appear either investing the native copper, or intimately associated with it, though they sometimes appear in distinct sub-veins. Pyritous copper is so rare, in connection with the trappean portions of the veins, as scarcely to deserve notice.

I have already stated that native silver, occasionally, though very rarely, occurs in the trappean portions of these veins, intimately associated with the copper, but it is in so minute quantities as to render it probable that it will not prove of any practical importance. Other mixed compounds of this metal occur so rarely as scarcely to deserve notice.

Leaving the trap rock, the character of these veins, as they traverse the conglomerate, undergoes important changes; for not only does the veinstone become gradually changed, from quartz to calcareous spar, but the amount of native copper diminishes, and its place is either supplied wholly or in part by ores of zinc and calcareous spar, or wholly by this latter mineral. There are, however, occasional exceptions to this *general* rule, for occasionally the place of the native copper in the veins, in their passage through the conglomerate, is supplied by a variety of complex compounds of the same metal, which compounds are of exceeding interest; but this change would appear always to be intimately connected with, or to bear some relation to, the dykes of trap which traverse the conglomerate rock. Several instances of this kind were noticed upon the northerly side of Keewenaw Point, either directly upon or near to the coast, as also at several other places in the interior, westerly from Keewenaw Point. A vein, which may without doubt be referred to as one of this character, (though in consequence of intervening bays and lakes between it and the ranges to the south, its connection with the main range has not been seen,) will serve to illustrate the character referred to.

This vein, which reaches the immediate coast of the

lake, upon the easterly cape of the bay known to the voyagers as the Grande Marrais of Keewenaw Point,* terminates, so far as examinations can be made, in the coarse conglomerate rock. The coast of the lake, for many miles on either side, is made up of abrupt cliffs of a similar rock, as usual, being made up of coarse rolled pebbles of trap, chiefly cemented with calcareous matter, which is usually associated, more or less, with the red oxyd of iron. Immediately south of the coast, a heavy dyke of trap traverses the conglomerate, which dyke corresponds in position with the line of bearing and dip of the conglomerate rock.

The vein, which, at its termination upon the immediate coast of the lake, has an extreme width of about 10 feet, may be traced, in the bed of the lake, in a direction north 5° east, for a distance of several rods, after which, in consequence of the depth of water, it is completely lost. This vein, at the point where it appears upon the coast, may be said to be in a concentrated state, or in a condition analogous to that before described, where the native copper occurs in the condition of bunches and strings, though the condition in which the metallic minerals occur is essentially different from that in the trap; for, instead of native copper, we have several mixed forms of the green and blue carbonates of copper and copper black, more or less intimately associated with calcareous spar, and in the adjoining rock, and in small ramifying veins, occasional small specks and masses of native copper, weighing from 1 to three ounces, occur, but these are by no means abundant. No quartz occurs

* Copper Harbor.

as a veinstone, and none of the ores have been noticed in a crystalline form.

It has already been stated, that these true veins, in traversing the conglomerate, frequently almost lose their character, and it becomes difficult to define their absolute width, or in other words, it would appear as if, at the time of the formation of the veins, the conglomerate had not been perfectly cemented, the result of which would be, that the mineral matter, which, under other circumstances, would constitute a perfect vein, would frequently appear in only an imperfect one, or the mineral which would under other circumstances, make up the vein itself, may have been injected laterally through the interstices of the rolled masses constituting the conglomerate, in which case the mineral would, in fact, take the place of the ordinary cement, thus simply investing the pebbles of the conglomerate. Now, although at the point under consideration, a wide and remarkable distinct vein is developed, the rock, for many feet on either side, has the interstices between the pebbles filled wholly, or in part, with various mixed and irregular forms of the ores, accompanied by calcareous matter, as before stated, and with occasional specks and small masses of native copper.

These veins traversing the conglomerate take on a similar character, to a greater or less extent, rather frequently, but the place of the copper is more usually supplied by the siliceous oxyd, and more rarely by the carbonate of zinc, which compounds, sometimes may be seen forming a perfect or partial cement to the rock, for considerable distances on either side of the vein. These ores of zinc, like those of copper, are uniformly

amorphous, and almost invariably more or less associated with some form of carbonate of lime, with which they may, under some circumstances, unless closely examined, be confounded.

Although these copper and zinc ores occasionally appear in considerable quantities, in those portions of the veins traversing the conglomerate, they usually embrace or simply incrust portions of the rocky matter; or rather the rocky matter and those ores appear to be coarsely and mechanically mixed. These veins furnish beautiful cabinet specimens of the blue and green carbonates of copper, and more rarely of pyritous copper, together with the other varieties mentioned.

Having already devoted a larger space to the consideration of these veins than had been intended, I will simply add, that in pursuing their course northerly, across the mixed rock and the red sandrock, their mineral character is nearly or quite lost, the veins as before stated, being made up either entirely of calcareous spar, or of that material containing very meagre ores of zinc.

The district of country to which these veins have been referred, thus far, only comprises the ranges of hills south of Lake Superior, but veins of a very similar character, and of similar contents, also occur upon Isle Royale. The order and changes in the character of the veins upon Isle Royale is necessarily reversed, or in other words, the southerly point of the vein corresponds to that of the north point in the district south of Lake Superior. The mineral veins of Isle Royale have not been examined with sufficient care to enable me to determine with much certainty, their average width or value. Those examined were mostly narrow, the widest

not exceeding eighteen inches; but in these the mineral contents are essentially the same as in those upon the south side of the lake.

Native copper, in very thin plates, was occasionally noticed, occupying irregularly the joints of the compact greenstone of Isle Royale, but invariably in comparatively small quantities. It should, however, be noticed of Isle Royale, that the veins, so far as examined, are less perfectly developed in their passage across the conglomerate, and that they very rarely contain any traces of zinc.

Upon the north shore of the lake, no attention was given to the subject of mineral veins, but, from the character of the geology of that district, it may be inferred, that they will also be found in portions of it, and that, where they do occur, they will be uniformly either directly upon or not far from the coast of the lake.

In addition to the *regular* veins already described, irregular veins frequently occur, traversing the whole, or portions of the outliers of trap, or those knobs which appear to have been elevated singly; and, although these veins may, without doubt, be referred to the same epoch as the regular veins before described, they nevertheless frequently differ considerably in mineral contents.

The limits of the present report will not permit a separate description of these several distinct trap knobs. I will, therefore, confine my remarks to that already referred to, as occurring upon the south coast of Lake Superior, immediately northwest from Riviere Du Mort, and which forms the promontory known as Presque Isle.

In nearly all those portions of this knob, where the trap, conglomerate and sandstone, are exposed in such

a manner as to permit examination, each of the rocks are seen to be traversed by innumerable irregular ramifying veins, which in the sandstones are made up of quartzose and calcareous matter; but many of which, near the junction of the igneous and sedimentary rocks, are metalliferous, and this metalliferous character is more fully developed as the veins are extended into the trap rocks.

The metalliferous portion of these veins, rarely exceed three to four inches in width, and they ramify in such a manner that the mineral uniformly occupies situations similar to bunches or strings, at the junction of the ramifications. The minerals contained in the metalliferous portions of the veins, are sulphuret and carbonate of lead, earthy green carbonate of copper, pyritous iron, and more rarely, pyritous copper. Occasionally there is a quartzose, or mixed quartzose and calcareous veinstone; but more usually the several metallic minerals are blended in a base of rocky matter. The sulphuret of lead is distributed either in the form of small cubic crystals, while the other metallic minerals are usually distributed either in irregular masses, or investing portions of the rocky matter. These associations are referred to, as showing the character which these irregular veins assume, rather than from any supposed value which they may possess for practical purposes.

In addition to the minerals referred to, the trap of Presque Isle occasionally contains asbestos, common serpentine and imperfect agates; the two former minerals usually occupying the narrow joints of the rock.

Before referring to the economical considerations connected with the veins which have been described, I

will briefly refer to another situation in which the ores of copper have been observed in intimate connection with the trap range of rocks.

The southerly side, or greenstone portion of the trap range, appears to have been elevated in such a manner as to have caused but little disturbance to the sandrock lying between that and the range of simply altered rocks lying still farther to the south; but near to the junction of the sandrock and greenstone, there is usually a red slate resting against the trap, and which may be said to fill up, in a measure, the irregularities in the ranges of hills. This slate, which is sometimes seen of 100 to 200 feet in thickness, though usually it appears as a mere band, is traversed by irregular and imperfect veins, of what may be denominated a ferruginous steatite, containing placentiform masses of greasy and milkish quartz, that sometimes contain more or less of the ores of copper. The earthy carbonates of copper are also sometimes so intimately connected with these veins of steatitic matter, as at first to be scarcely recognized. More rarely, distinct, very thin veins of green carbonate of copper occur, well characterized, in this red slate, though these veins are never of any great length. The red shale extends, more or less perfectly, along the whole length of the trap range, skirting that range of hills upon the south, but I have not yet been enabled to devote sufficient time to its examination to enable me to determine whether any portions of these veins can be regarded as of practical importance. The examinations which have been made, would lead me to look unfavorably upon these veins, and I regard them as having an origin completely distinct from that of the veins which traverse the northerly escarpment of the trap rock.

Having thus considered all the general circumstances under which the several ores of copper, zinc, lead, iron, manganese and silver have been noticed, in connection with the trap rock and the sedimentary rocks, immediately resting upon it, it becomes important to consider how far inferences may be drawn from these examinations, as to their occurrence in such quantities as to be of practical importance. I have already stated that so far as regards the ores of lead, iron, manganese and silver, I am led to conclude that at none of the points examined do they occur in veins, or otherwise, sufficiently developed to warrant favorable conclusions as to their existence in sufficient quantities to be made available, and from all that is now known of the country, I am led to infer that neither of these, unless it be iron, will be so found.*

The examinations which have thus far been made of those portions of the veins containing ores of zinc, have not been extended sufficiently to enable me to determine with much satisfaction, their extent as a whole. At several points in the veins these ores are sufficiently abundant to admit of being profitably worked, but I would be unwilling, from an examination of a few points, to attempt to determine the character of the whole.

In considering the practical value of the copper ores of the upper peninsula of Michigan, where we are as yet compelled to judge from our examination, of what may be said to be the simply superficial portions of the veins, we can arrive at no safe conclusions, except by comparisons of the district with those districts similarly sit-

*These remarks are intended to apply directly to the trap region. Beds of bog iron ore occur, east from Chocolate river, which probably may at some future day be profitably worked.

quated, which have been extensively worked in other portions of the globe. Comparisons of this character, to be really useful, must necessarily be sufficiently minute to enable us to understand the relations which the ores in the districts compared, bear to each other, in all respects, which circumstances render it necessary that a degree of minute information should be at hand, that is not at all times to be obtained. As the information on hand, with respect to the copper and tin veins of Cornwall; England, is more minute than that of any mineral district known, I propose, in order to avoid confusion, to confine my comparison to this district, simply, premising that however closely the two districts may resemble each other in character, it does not follow, as an axiom, that because the district with which we compare our own has been largely and profitably productive, that of Michigan must necessarily be so too; for it will be seen, as the subject is pursued, that there are not only several points in which it is impossible with our present knowledge of that of Michigan, to institute comparisons, but there are also some points on which there is a considerable degree of discrepancy.

The comparison instituted, in the main, is intended to refer rather to the character and contents of the mineral veins of the two districts than to the geology, although some general reference becomes necessary to the geology of the districts, to render the comparison perfect. The topography of the Cornish district bears a close resemblance to that of Michigan, both districts being marked by their irregular and broken outline, and by the occurrence of more or less frequent, nearly insulated knobs, rising to a considerable height above the elevation of the general ranges.

Although the older rock of Cornwall, or that from which the metalliferous veins of the district may be said to have their origin, is more distinctly granitic than that of the metalliferous region upon Lake Superior, the elements of which the rocks are composed, may be regarded as essentially bearing a very close resemblance; a resemblance which it is conceived, would have been still more perfect had the granitic rocks of Cornwall been subjected to the action of secondary causes similar to those of the region under consideration. The rocks resting upon or against the granitic rocks of Cornwall, consist of clay slates, hornblende rocks, &c., which bear little real analogy to the rocks resting directly upon the trap of Lake Superior, but it is conceived that the composition of these upper rocks has little bearing upon the origin of the metalliferous veins, and may be regarded as in a measure unimportant; and however much these rocks may differ, they are traversed alike by the metalliferous veins of the lower rocks in such a manner, that the close resemblance cannot be mistaken.

It is a matter of history that the ores of tin have been more or less, extensively raised in the mineral district of Cornwall, from the earliest settlement of the island of Great Britain, but the working of the veins of copper at an early day, does not appear to have been carried on to any very considerable extent. The great importance to which the produce of copper from the Cornish veins, (in a district which, compared with the mineral district of our own state, is of very small dimensions,) has arisen, will be shown from the accompanying table, which I have reduced from the official returns, included in the several years, and which table, it will be seen,

shows for a series of years, the average annual amount of copper produced from the ore, the average amount of which it sold, together with the amount per cent of copper contained in the ore, and the average value of the copper, per pound, at the smelting house. This table, which has been drawn with great care, from data that can scarcely lead to incorrect results, will not only serve to show the large aggregate amount of metal produced, but it also shows, from the low average per cent of metal contained in the ores, (if we had no further knowledge upon the subject,) that much capital must be required for, and a large amount of labor applied to the raising and smelting of these ores; a circumstance which should be carefully borne in mind, in all that relates to the mineral district of Michigan.

Table showing the average annual produce of the Copper mines of the County of Cornwall, England, from 1771, to 1822.

YEARS.	Average No. of tons of ore per year.	Av. No. of tons copper produced per year.	Av. amount per year for which sold.	Av. per cent of copper produced from the ore.	Av. value of the copper per lb.
1771 to 1775—5 years.	28,749	3,410	\$-16,283	12	c. m.
1776 to 1780—5 "	27,580	3,300	26,689	12	10 9
1781 to 1785 6 "	31,351	4,122	962,380	12	11 1
1786 to 1790 5 "	31,351	4,122	962,380	12	10 4
1796 to 1802 7 "	51,483	5,195	1,125,046	10	12 2
1803 to 1807 5 "	70,923	6,160	3,174,725	9	23
1808 to 1812 5 "	70,431	6,498	5,246,835	9	12 9
1813 to 1817 5 "	82,610	7,272	2,878,723	8 2	17 6
1818 to 1822 5 "	91,391	7,757	3,111,811	8 2	17 9

The general resemblance in the mineral contents of the copper veins of Cornwall and those of Michigan, is for the most part very great, though in some respects

there is a considerable discrepancy. It should, however, be remarked, that some difficulty exists in comparing the mineral veins of Cornwall, where several of them have been worked to the depths varying from 1,000 to 1,500 feet, with those of Michigan, where the examinations are nearly superficial.

In making these deep excavations, not only in the county of Cornwall, but also in the copper districts of Bohemia, Hungary, Silesia, Transylvania, Saxony, &c., (some of the veins in the latter districts having been explored to a depth very considerably greater than those of Cornwall,) an immense mass of facts has been accumulated, with respect to the general formation and mineral character of veins, or lodes of copper, which facts have led to the understanding of many of the contingencies connected with its associations, so universal, that, when applied to this mineral, they may be regarded as general laws, that may fairly be inferred to govern, with more or less certainty, all those lodes or veins which have similar geological relations. Though a general consideration of those relations of the veins of other countries, may, perhaps, be regarded as somewhat foreign to the present report, I deem it more advisable to refer to these general laws in such a manner as to leave the reader to judge, by comparison, the condition in which the ores of Michigan may be fairly inferred to occur, rather than to draw conclusions directly; and, in so doing, it will always become necessary to refer to some of the characters of mineral veins, or lodes, in general.

Veins are usually divided into two general orders, viz: "*cotemporaneous veins*," or those which were

formed at the same time as the containing rock, and *true veins*, whose formation is supposed to be subsequent to that of the rocks which are contiguous to them." A *true vein* may be defined to be "the mineral contents of a vertical or inclined fissure, nearly straight, and of indefinite length and depth."* The contents of a true vein, as a general rule, differ widely from the character of the rocks which it intersects, though this does not invariably hold good, and the vein also, as a general rule, has well defined walls.

The contents of contemporaneous veins, bear a much closer resemblance to the rocks which embrace them, and as a general rule, they are shorter, more crooked, and less perfectly defined than true veins.

The metalliferous veins being contained under the head of true veins, it is to these that the whole of my remarks will be directed.

Metallie veins are the repositories of most of the metals excepting iron, manganese and chrome, which occur more frequently and abundantly in beds than in veins. The thickness of the metallic veins varies from a few inches to many feet, and the same vein also varies in thickness in different parts of its course, sometimes contracting to a narrow string of ore, and then expanding again to a width of many feet. The deposits of metal in the veins are as irregular as the widths of them, and so much so as to render the profits of mining proverbially uncertain. Ore is generally found to occupy certain portions of the veins only, differing constantly in extent, whether the length or the depth on the course of the vein be considered, or the portion of its width which

*Darné, on the mineral veins of Cornwall.

is filled up by it. No veins occur which are regularly impregnated with metal to any great extent, and when ore is found, it is in what the miners aptly term bunches or shoots, or in interspersed grains and strings, which are more or less connected with, or embraced in, veinstone, that, according to the rock which the veins intersect will be fluor spar, calcareous spar, quartz, &c. The unproductive parts of veins, even in the most profitable mines, generally far exceed in extent the productive parts, but that mine is considered to be rich which has either frequent or extensive shoots of ore, and the great art of the miner consists in tracing and working the valuable accumulations of the metals, with as little waste of labor and expense on the poorer portions of the veins as possible. "In the mines of Cornwall, the ores of copper and tin commonly occur in detached masses, which are called bunches of ore; and the other parts of the vein, being unproductive, are called *deads*."

The depth to which metallic veins descend is unknown, for we believe no instance has occurred of a *considerable vein being worked out in depth*, though it may sink too deep to render the operation of the miner profitable, or it may branch off in a number of strings which are too much intermixed with the rock to be worked to advantage.* Some veins appear to grow wider, while others contract as they descend.

The superficial part of a vein generally contains the ore in a decomposing state, and it frequently happens that the ores in the upper and lower parts of the vein are different; thus, "in Cornwall, blende or sulphuret

*Koenig.

of zinc often occupies the *uppermost* part of the vein, to which succeeds tinstone, and at a greater depth, copper pyrites.* When a metallic vein, in its descent, passes through different kinds of rock, it is frequently observed that the products of the vein vary in each bed, and when it passes through regularly stratified beds of the same rock, there are particular strata in which the vein is always found most productive. This change in the productiveness of mineral veins is more particularly noticed at or near the transition from unstratified to stratified rocks; thus, granite-syenite and those rocks which have a graniti-form structure, are frequently noticed to contain metals at or near their junction with stratified formations. On the other hand, the veins which traverse stratified rocks are, as a general law, more metalliferous near such junctions, than in other portions.*

Where a rock is crossed and penetrated by a great number of small veins in every direction, the whole mass is sometimes worked as an ore, and is called by the Germans a "stockwerke." Where the ore is disseminated in particles through the rock, such rocks are also worked for the ore, when it exists in sufficient quantity.

As a general rule, those metals which are oxidable at ordinary temperatures, or which readily combine with sulphur, *rarely occur in a metallic state*, but are usually found in combination either with sulphur, oxygen or acids. The chief ore of copper raised from the mines of Cornwall, is the yellow sulphuret, though the blue

*Lyeil. Necker.

and green carbonates and arseniate are more or less distributed; native copper and the oxids are also, though more rarely found.

By a comparison of what has been said upon the character and mineral contents of metallic veins in general, I trust a just view of the real condition in which the ores of copper are invariably found, will have been conveyed, and that, by the aid of this, we will be enabled to examine, without undue expectations, those mineral veins which occur within the limits of our own state. In the main the resemblance between the character and contents of the copper veins of Cornwall and Michigan, so far as can be determined, is close; the veinstones, (with the exception of fluor, which I have never observed in the latter,) are essentially the same; but in instituting this comparison, it should be borne in mind that the metallic veins of Cornwall have been in progress of exploration for centuries, and that shafts and galleries have been carried to great depths, while those of Michigan, simply superficial examinations have as yet been made, and these in a wilderness country, under circumstances of the utmost embarrassment, and attended with the utmost excessive labor, privation and suffering.

In respect to the character of the ores which occur in the two districts, there are important differences, for while pyritous copper is the most important workable ore, not only in the Cornish mines, but also in those of other portions of our globe, it is comparatively of rare occurrence in the mineral district of Upper Michigan; for, as I have already mentioned, the mineral of the trappean portions of the veins in the latter district, is

essentially made up of strings, specks and bunches of native copper, with which more or less of the oxides and carbonates are associated; while those portions of the veins traversing the conglomerate are characterized by the occurrence of the oxides and carbonates, with occasional metallic and pyritous copper, or the places of all these are supplied by ores of zinc, associated with more or less calcareous matter. In the thin mineral veins of Presque Isle, pyritous copper is more abundant, where it is associated with sulphuret of lead, as before mentioned.

The occurrence of this native copper in the veins, and the manner in which it is associated with the veinstones, in all respects corresponds with the ordinary association of the other forms of ores, in those veins that have been extensively worked in other portions of the globe; but I confess that the preponderance of native to the other forms of copper, was regarded as an unfavorable indication, at least until this had been found to be more or less universal with respect to all the veins. It should, however, be remarked, that in those portions of the veins where the quartz of the vein and the accompanying rock are very compact, the native form is much more common than in those portions where the veinstone and accompanying rock are more or less cellular and soft.

The worked copper veins of Cornwall, are stated by a Mr. Carne, to average from three to four feet in width, and to have a length as yet undetermined. But few have been traced for a greater distance than from one to one and a half miles, and but one has been traced for a distance of three miles.

The veins which I have examined in the mineral district of Michigan, exceed the average of those last mentioned, but the imperfect examinations which have been made, render it difficult to determine this with certainty. I have traced no one vein for a further distance than one mile; and usually for distances considerably less. It was not, however, supposed that these veins terminated at the points where they were left, but the further examinations were abandoned at these points, in consequence of physical difficulties connected with the present condition of the country.

The native copper is frequently free from all foreign matter, and is as completely malleable as the most perfect refined copper, but it more usually contains disseminated particles of earthy minerals, chiefly quartz. I have not been able to detect the alloy of any other metal, in a single instance.

The fatigues and exposures of the past season, have so far impaired my health, that, as yet, I have been unable to analyze as carefully, as could have been wished, the several ores furnished by the mineral veins of the upper peninsula, but sufficient has been done to show satisfactorily that the copper ores are not only of superior quality, but also their associations are such as to render them easily reduced. Of those which have been examined, embracing nearly the whole, (and not including the native copper,) the per cent of pure metal, ranges from 9.5 to 51.72, and the average may be stated at 21.10. Associated with some of these ores, I have detected a metal, the character of which remains, as yet, undetermined.

Were the analysis of the several ores of copper

sufficiently perfected, I should deem it unnecessary to lay them before you at this time, for with what is now known of the district, it is conceived, the result would lead to erroneous rather than correct conclusions. The analysis of separate masses of ore, no matter how much care may be taken to select the poor as well as the richer ones, for the examinations, will be usually far from giving the average per cent of what would be the product when reduced to practice. I have, in order to arrive at safe conclusions, not only analyzed, but also assayed many of them, but when we come to consider what constitutes the true value of a vein of copper ore, we will perceive why it is unsafe to judge of the whole by the analysis of small portions.

By reference to the previous statistical table of the product of the copper mines, of Cornwall, it will be seen, that the average produce of the ores since 1871, has never exceeded 12 per cent of the metal, and that, from 1818 to 1822, it was only 8.2. This shows the aggregate, and it was well known that while many of the productive veins are considerably below this, the largest average per cent of any single vein, in that district, it is believed, has never been over 20 per cent. and it should be borne in mind that this average is taken after the ores have been carefully freed from all the rocky and other impurities, which can be separated by breaking and picking.

The value of a vein may be said to depend upon the abundance of the ore, and the ease with which it can be raised and smelted, rather than upon its purity or richness. Upon this point, with respect to our own mineral region, public opinion would perhaps be more in error

than upon any other, and most certainly we could hardly look for a mineral district where the character of the ores were more liable to disseminate and keep alive such errors. The occurrence of masses of native metal, either transported or in place, are liable to excite, with those who have not reflected upon the subject, expectations which can never be realized, for while, in truth, the former show nothing but their own bare existence, the latter may be, as is frequently the case, simply imbedded masses, perfectly separated from all other minerals, or they may be associated in a vein where every comparison would lead to unfavorable conclusions, as to the existence of copper, in any considerable quantities, I have frequently noticed very considerable masses of native copper, occupying the joints of compact greenstone, under such circumstances as I conceive, might readily excite in many minds, high expectations, but a little reflection would satisfy the most careless observer of the uselessness of exploring these joints, under the expectation or hope of finding them a valuable repository of the metal. Again, not only native, but also the other ores of copper occur in veins, either so narrow as to render it useless to pursue them, or so associated as to render it probable that exploration would not be attended with success.

While I am fully satisfied that the mineral district of our state will prove a source of eventual and steadily increasing wealth to our people, I cannot fail to have before me the fear that it may prove the ruin of hundreds of adventurers, who will visit it with expectations never to be realized. The true resources have as yet been but little examined or developed, and even under

the most favorable circumstances, we cannot expect to see this done but by the most judicious and economical expenditure of capital, at those points where the prospects of success are most favorable. It has been said of the Cornish district, in respect to the supposed large aggregate profits, that "a fair estimate of the expenditure and the return from all the mines that have been working for the last twenty or thirty years, if the necessary documents could be obtained from those who are interested in withholding them, would dispel the delusion which prevails on this subject, as well as check that ruinous spirit of gambling adventure which has been productive of so much misery."* And if these remarks will apply to a comparatively small district, which has been explored and extensively worked for centuries, with how much more force must they apply to the mineral district of our own state. I would by no means desire to throw obstacles in the way of those who might wish to engage in the business of mining this ore, at such time as our government may see fit to permit it, but I would simply caution those persons who would engage in this business in the hope of accumulating wealth suddenly and without patient industry and capital, to look closely before the step is taken, which will most certainly end in disappointment and ruin.

The extreme length of what I have denominated the mineral district, (within the limits of Michigan,) may be estimated at a fraction over 135 miles, and it has a width varying from one to six miles; but it must not be imagined that mineral veins occur equally through all

*Hawkins on the tin of Cornwall.

portions of it, for sometimes, for many miles together, none have been noticed, and the situation of the country is such as to render it probable they never will be. The range and course of the mineral district has been so far defined as to render it unnecessary to say more upon this subject to enable such persons as may wish to examine, to pass directly along its complete length.

I have thus far omitted to allude particularly to the large mass of native copper, which has been so long known to exist in the bed of Ontonagon river, lest, perhaps, this isolated mass might be confounded with the product of the veins of the mineral district. That this mass has once occupied a place in some of these veins is quite certain, but it is now perfectly separated from its original connection, and appears simply as a loose transported boulder.

The attention of the earliest travellers was called to this mass of metallic copper by the natives of the country, and it has been repeatedly described by those who have visited it. The mass now lays in the bed of the westerly fork of the Ontonagon river, at a distance which may be estimated at twenty-six miles, by the stream, from its mouth. The rugged character of the country is such, that it is but rarely visited; in proof of which I may state, that upon my visit to it, during the last year, I found broken chissels, where I had left them on a previous visit, nine years before, and even a mass of the copper, which at that time had been partially detached, but which, for the want of sufficient implements I was compelled to abandon, was found, after that interval, in precisely the same situation in which it had been left.

The copper in this boulder, is associated with rocky matter, which, in all respects, resembles that associated with that metal in some portions of the veins before described, the rocky matter being bound together by innumerable strings of metal; but a very considerable portion of the whole is copper, in a state of purity. The weight of copper is estimated at from three to four tons.*

While the mass of native copper upon Ontonagon river cannot fail to excite much interest, from its great size and purity, it must be borne in mind, that it is a perfectly isolated mass, having no connection whatever with any other, nor does the character of the country lead to the inference that veins of the metal occur in the immediate vicinity, though, as before stated, the mineral district crosses the country at a distance of but a few miles.

The occurrence of cornelian, chalcedony, agate and amethystine quartz, in the amygdaloidal portion of the trap, has already been noticed, and these minerals are considerably abundant. They frequently possess very great beauty and perfection, and when ground and polished, they may be used for all the purposes to which those minerals are usually applied.

By the act admitting Michigan as a state into the confederacy, and in which her boundaries are defined, it does not appear to have been the intention to include within her limits any portion of territory lying upon the north shore of Lake Superior, but in consequence of the

*This mass of copper was removed by Julius Eldred, and after considerable masses had been cut from it, was weighed in New York November 1833, and found to weigh 3768 pounds, net weight.

peculiar shape of the coast at that point where the *national* boundary line "last touches Lake Superior," at the mouth of Pigeon river, a direct line to the mouth of Montreal river, if followed literally, would throw within the state of Michigan, several small rocky islands, together with a few miles of the south cape of Pigeon bay, situate upon the north coast. This boundary leaves in Wisconsin the whole of the Apostles' group of islands, near to the south coast, while it includes within Michigan, Isle Royale, situate near to the north coast of the Lake.

Isle Royale is a little less than an Island of rock, rising abruptly from the lowest depth of the Lake, in irregular hills to a height varying from 100 to 450 feet above the level of the Lake. The island has the length of a fraction over 45 miles from northeast to southwest, and a breadth varying from $3\frac{1}{2}$ to 8 miles. The most northerly point of the island is very nearly in latitude $48^{\circ} 12' 30''$ north, the parallel of longitude 89° west from Greenwich, crosses the island a little east from its centre. Its nearest approach to the main land is near its northwesterly end, where it is separated from a point of the north coast, a few miles east from Pigeon river, by a distance of a fraction less than 13 miles. Isle Royale is separated from Keewenaw point, of the south coast, by a distance of 44 miles, and the elevated hills of this point may be distinctly seen from Isle Royale, when the atmosphere is clear.

Nearly the whole of the northwesterly side of Isle Royale is a continuous, elevated, rocky cliff, which will scarcely admit of a landing; but the southeasterly side, together with the easterly and westerly ends, are deeply

indented with bays, which form secure harbors. The northeasterly end is made up of a series of elevated, rocky spits, with intervening bays. These spits of rock continue for a length varying from 10 to 12 miles, with a width scarcely exceeding half a mile, and altogether, they may not inaptly be compared to the hand with the fingers half spread. The bays have a sufficient depth of water to admit vessels of the largest class to enter nearly one-third the whole length of the island.

Much of Isle Royale is absolutely destitute of soil, and the island has a most desolate appearance; but notwithstanding this, it is of immense value for its fisheries, which are yet scarcely appreciated.

Though not within the limits of our state, I will briefly refer to the general character of a portion of the country west from Pigeon river, on the north coast. That district of country upon the immediate coast, extending from our national boundary, at Pigeon river, to Fond du Lac, is more decidedly and abruptly mountainous than any portion of the south coast of the lake. The hills rise in broad and somewhat knobby steppes or plateaus, to heights varying from 400 to 1,200 feet above the lake, and the summits of these hills are usually not farther inland than from ten to twenty miles. The rocks of the hills are very frequently bare over considerable areas, and the valleys containing arable soil, are few and very narrow.

The route of the fur trade to the northwest, *via* Rainy Lakes, Lake of the Woods, and Lake Winnipeg, was formerly wholly carried on by passing over these hills, from a point a few miles west from the mouth of Pigeon river. The trail or portage path passes over a low

portion of the range, and finally falls upon Pigeon river, which is ascended to its source, from which, by a series of portages, the sources of the streams flowing north-westerly are reached. The hilly portion of the country, though of exceeding interest in a geological point of view, is the most desolate that can be conceived.

EXTRACT FROM DR. HOUGHTON'S REPORT OF 1842.

During the current year, the geological and topographical surveys have progressed steadily toward completion, though in consequence of the reduction of the number engaged in the work, which became necessary in consequence of the comparatively small amount of funds applicable to that object, the amount of work accomplished has been somewhat less than that of the preceding year. The labor so applied has been chiefly devoted to the westerly portion of the upper peninsula, including a part of that which may be designated as the mountainous district of our state, while a smaller proportion of the labor has been directed towards a closing up and completion of the surveys upon the lower, or southern peninsula.

In connection with the duties assigned me relative to the boundary line between our own State and Wisconsin, I have been enabled to complete a very perfect Geological section of nearly 180 miles in length, crossing from the mouth of Montreal river of Lake Superior to the mouth of the Menominee river of Green Bay, a district highly interesting both in its geological and topographical features. This section crosses the up-

per peninsular somewhat farther west than any of the sections I have heretofore made.

In addition to this a large amount of work has been performed in the mountainous region stretching from Montreal river to Ontonagon river, and extending southerly from Lake Superior, a distance of some 40 miles, including, what may be termed, the *westerly* portion of the copper district, within our State. This district has been but partially examined the preceding year, the examination of that year having been more particularly directed to a district of country lying east from it.

Several geological sections have been completed across this intricate region, and notwithstanding the many obstacles imposed by the mountainous and wild character of the country, the surveys of this district have been completed with as much minuteness as an adherence to the original plan of the survey would permit. In addition to the several geological sections completed, all the rivers entering Lake Superior between and including the two streams mentioned, have been carefully examined to their very sources, and the Porcupine mountains have been traced out through almost their entire range.

These surveys of the westerly part of the upper peninsular have added much valuable information to that before collected, respecting the geology and topography of that interesting portion of our State, and have served to add confidence to our previously expressed opinion respecting its value for its minerals and for agricultural purposes. The *general* geological and mineralogical character of this country was so fully given in a previous report, that it is not conceived to be necessary, at this

time, to make further allusion to it, except to add that the copper ores associated with the altered, conglomerate, and sandstone rocks, in *this* portion of the range have been found to be more extensive than was originally supposed. In character, these ores closely resemble those heretofore described as existing in the Keewenaw Point range.

The *southerly* range of mountains traversing the upper peninsula, and which in a previous report has been referred to, as commencing at a point a little north-westerly from the mouth of Chocolate river of Lake Superior, has been found to be continued in a south-westerly direction, with a gradually diminished altitude across the Menominee river of Green Bay, into the territory of Wisconsin. This chain of mountains through a portion of its course has a direction nearly parallel to that of Green Bay, and frequently approaches to within 25 or 30 miles of the coast of that bay. It will be recollected that the northerly portion of this mountain range was described as being composed of sienitic and gneissoid granite, flanked on the south by mica, talcose and chloritic slates and quartz rock, the separate members of the group being frequently traversed by dykes of trap, and with occasional knobby hills of the latter rock. Presque Isle of Lake Superior, made up of trap and altered sandrock, in which rocks were found numerous small ramifying veins of the sulphurets of lead, copper and iron, was referred to as a portion of this mountain range.

This southerly chain of mountains, with its hills and dykes of trap, though the elevation, in a south-westerly direction is considerably lessened, preserves very nearly

similar geological characters to that portion before described, and the rocks, in the vicinity of the trap, were frequently found to contain similar minerals to those observed in the vicinity of Lake Superior. The direction of this range is such as to leave no doubt but the low knobs of syenitic granite in the vicinity of Puckaway Lake of Fox river, and the more elevated knobs of trap and altered rock lying a short distance to the north, in Wisconsin, belong to the same system of rocks, and since the hilly district of the Wisconsin river would fall within this range, it may be fairly inferred that the disturbance of the stratified sandstones and limestones of this region may have originated from the same causes which have produced the more elevated mountains on the south of Lake Superior.

This subject possesses a high degree of interest, from the fact that within the limits of this range would fall the lead district of Wisconsin and Iowa, and this inference is rendered the more probable from the remarkable similarity in the character of the contained minerals. Thus far I have been unable to trace any portion of the great limestone formation of the upper peninsula, to any near proximity to this range, where the same traverses that part of Michigan, and thus far in tracing the range westwardly no considerable deposits of lead have been found until the lower rocks are covered by heavy deposits of limestone; which would lead to the inference that these upper deposits have performed an important part in *arresting* and *fixing* the minerals referred to, and which minerals may fairly be inferred to have had their origin from the lower rocks, to which reference has been made. If the position thus

assumed be tenable, we can scarcely look for heavy deposits of lead within that portion of the southerly range of mountains traversing the upper peninsula of Michigan, for the reason that the upper formations are wanting, at least they are so through all that portion of the district that has been minutely examined.

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TOPOGRAPHY AND GEOLOGY
OF THE
SURVEY
OF A
DISTRICT OF TOWNSHIP LINES,
SOUTH OF LAKE SUPERIOR,
1845.

DETROIT, FEBRUARY 16, 1846.

SIR:

By contract with the Commissioner of the General Land Office, under date of June 25, 1844, the Late Dr. DOUGLAS HOUGHTON was required to make both a linear and geological survey of a section of country bordering on the south shore of Lake Superior. He was engaged in this work, which was nearly completed, at the time of his lamented death. As administrators of his estate, we have caused the field notes and papers connected with the survey, as far as completed, to be carefully examined, and the accompanying reports of Mr. Wm. A. Burt, and Mr. B. Hubbard, to be prepared. Mr. Burt, who was the principal assistant of Dr. Houghton in the field, reports in full us to the geology and topography of that portion of the country surveyed by him; and Mr. Hubbard, Assistant State Geologist of this State, and whom we employed for that purpose, has prepared a like full report upon the remainder of the surveyed territory. For the field notes of the survey and the specimens collected, we herewith submit these reports to you, with the field notes and other papers, &c. The linear survey, as far as the work has progressed, is complete. It could not have been expected that the information, contained in the reports, in relation to the geology of the country, would be as complete and accurate in detail, as it would have been, could they have been prepared by Dr. Houghton himself, who had, for many years, been zealously engaged in the investigation and study of the peculiar formations of this region. Enough, however, will appear, to enable the Government to appreciate, both the advantages, and the perfect feasibility, of the plan of connecting geological with the linear surveys of the government lands, as originally proposed and zealously advocated by Dr. Houghton.

Respectfully, yours,

(SIGNED.)

HENRY N. WALKER,
SAMUEL T. DOUGLASS.

To Hon. LEWIS LYON,

Surveyor General, &c.

This survey embraces Keewenaw Point, and a narrow tract of land bordering the south coast of Lake Superior, from the south boundary of township 48 north, ranges 25 and 26 west, near Chocolate river, to the mouth of Carp river on the northwest side of the Porcupine mountains in township 51 north, range 44 west. (See the accompanying map, to which reference will be frequently made, in the course of these remarks.) Upon this map are delineated the boundaries of the survey, together with the principal streams and small lakes. The straight lines are the boundaries of townships with their numbers and ranges, and the irregular and dotted lines represent the boundaries of the different rock formations, with their characteristic names, on the side which they occupy.

The topography of this district may be divided into two parts, the hilly or mountainous, and the undulating or rolling lands.

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Of the hilly or mountainous land, three tracts of considerable areas, are found widely separated by undulating or rolling land.

That part of the district between Huron Bay and the south boundary of township 48 north, ranges 25 and 26 west, and denominated primary range on the map, is made up principally of numerous rocky knobs and irregular hills, with intervening valleys of arable lands; most of these valleys have small streams meandering through them, with rapid or quick currents of pure water. Between some of these knobs and hills, however, cedar, tamarack, or spruce swamps are found, and less frequently small lakes.

The highest elevations on this range, probably attain an altitude of 800 or 900 feet above the water of Lake Superior, and present to the spectator a very rugged and broken appearance, and frequently along the southeasterly slope of these knobs and hills, which is generally the most precipitous, high cliffs or sloping ledges are seen; but along the south boundary of the survey, the hills are more regular in outline and have a westerly direction.

The land upon this part of the district not occupied by the primary range, is undulating and rolling except where furrowed with deep ravines or interrupted by the valleys of streams. These lands lie between the primary range and the Lake coast, and are in many places considerably elevated, forming bluffs on the Lake coast, from 20 to 80 feet in height.

SOIL AND TIMBER.

The soil on this part of the survey is generally a sandy loam, but in some places it is decidedly a sandy

soil, and sustains a heavy growth of timber, of sugar maple, hemlock, birch, pine, cedar, fir, lynn elm, ash, spruce, tamarack &c.

STREAMS AND HARBORS.

The largest streams (rivers they are called here,) on this part of the district, are not above the size of ordinary mill streams, for which purpose they would answer well, having generally falls or rapids within one or two miles of the Lake coast. Some of these streams at their mouths form convenient harbors for small boats, and may be ascended with them to the first falls or rapids, for which purpose the Huron, Pine, Yellow Dog and Riviere Du Mort or Nekomenon river, are the best.

The only harbors for vessels are at Presque Isle, T. 48 N., R. 25 W., and to the south of a point of land on the east side of Huron Bay, T. 54 N., R. 31 W. (See map.)

TRAP RANGE OF KEEWENAW POINT &c.

This second hilly range commences at the northeast end of Keweenaw Point, and has a course a little to the south of west, for about eighteen miles, where it gradually bends to the southward until its general course is southwest, to the south boundary of the survey.

This range is from two to six or seven miles wide, and about eighty miles in length upon this district, and from the east end of Keweenaw Point, to a little west of the east boundary of range 29, these hills occupy nearly its entire breadth. Here the southeast side of this range recedes from the Lake coast, and stretching inland southwesterly, passes along the northwest side of a small lake in township 55 north, ranges 32 and 33 west,

from thence generally in a southwest direction, to the corner of sections 31 and 32, on south boundary of T. 51 N., R. 37 W.

The northwest boundary of this range leaves the Lake coast in township 58 north, range 32 west, and stretching a little inland, crosses Portage Lake, in township 55 north, range 34 west, thence generally in a southwest direction, to near the corner of sections 33 and 34, on the south boundary of township 51 north, range 38, west. The highest elevations upon this hilly range, are supposed to be, from five to eight hundred feet above Lake Superior, and, as in the hills of the primary range already described, their southeasterly sides are generally the most precipitous; and it should be farther remarked, that these hills are not destitute of interest in an agricultural point of view. Considerable tracts of tillable land are found upon them, with a good soil, and well timbered with sugar maple, birch, lynn, ironwood, red oak, &c., and, on Keewenaw Point, better adapted to cultivation than most of the land upon its coast. To the east of this hilly range, (south of Portage Lake,) to Huron Bay, and west of it to the Porcupine mountains, with the exception of a few moderately elevated hills, the country is undulating or rolling; there are, however, many deep ravines, and valleys of streams on this part, also tracts of level land. These lands are generally susceptible of cultivation, and, so far as they have been proved at the Missions near the head of Keewenaw Bay, and at the Ontonagon and Iron rivers, have been found to yield abundantly, in produce suitable for culture in this climate.

Over this entire tract, except where occupied by

swamps or in some places on the Lake coast west of Keewenaw Point, the soil is generally a sandy loam, and the most loamy parts are in the valleys of the Sturgeon and Ontonagon rivers.

These lands are extensive and generally support a heavy growth of timber of sugar maple, birch, hemlock, pine, fir, cedar, lynn, ash, elm, spruce, &c. And it may be worthy of remark, that scattering pines of an excellent quality, may be found southeast of the hilly range of Keewenaw Point, and northeast of Portage Lake to the south boundary of township 57 north, range 30 west.

LAKE COAST AND HARBORS.

The Lake coast is generally bold and rocky, and though very irregular in its course, has few indentations of a character to form good harbors for vessels. The best and most convenient, are Copper, Agate and Eagle Harbors, situated on the north side of Keewenaw Point. (See map.) Also, a lee can generally be made south of a point on the east side of Keewenaw Bay, T. 51 N., R. 32 W., and a vessel drawing $5\frac{1}{2}$ feet of water may enter the Ontonagon river, T. 52 N., R. 40 W.

RIVERS.

Upon this part of the district, there are three rivers navigable for small crafts, for a considerable distance into the country; they are the Portage, Sturgeon and Ontonagon rivers.

Sturgeon river has its source to the south of the head of Keewenaw Bay, in the hilly country, and runs northerly, nearly parallel to the west coast of this bay, and enters Portage Lake on section 33, T. 51 N., R. 33 W.

and may be ascended with small boats into T. 52 N., R. 33 W. section 7; here its navigation is interrupted by drift wood which fills the channel for about 25 or 30 chains. This passed, which may be done by a good portage, the river may be ascended into T. 51 N., R. 34 W.; but on account of a strong current in this part of the stream, setting poles or the best oarsmen are necessary, to effect an ascent to this point.

Portage river is about four miles in length, and the outlet of Portage Lake. It is a stream of considerable depth and breadth, and after passing the bar at its mouth, may be ascended with vessels drawing eight feet of water into Portage Lake, and thence to the head of this Lake near the south boundary of T. 50 N., R. 34 W. about 20 miles from the entrance at the mouth of Portage river. From the head of Portage Lake light boats ascend a small stream about one mile, and from thence by a portage of another mile over nearly level land enter Lake Superior.

Doubtless, at some future day, these two miles will be canalized, for the passage of larger crafts through this channel into Lake Superior.

The Ontonagon river is the largest stream on the south side of Lake Superior. This stream is navigable for bateaux in an ordinary stage of water, to the rapids, near the south boundary of T. 51 N., R. 39 W.

Near the mouth of this river, on the right bank, is an eligible site for a town, and when this harbor is improved, as it deserves to be, will probably become a place of considerable importance. There are other small streams on this part of the survey, the most important of which are, Eagle, Elm, Misery, Sleeping,

Fire Steel and Iron rivers. These streams cannot be ascended far, even with canoes, on account of rapids or drift wood, but most of them form convenient harbors for small boats on the Lake coast.

PORCUPINE MOUNTAINS.

The third hilly range embraces the northerly portion of the Porcupine mountains, the easterly boundary of which commences on the coast of Lake Superior, three or four miles west of the mouth of Iron river, in T. 51 N., R. 42 W. thence runs nearly south to corner of sections 33 and 34, on south boundary of said township. Westward, these knobby mountains spread over the remaining part of the survey to the coast of Lake Superior, the highest elevations of which have an altitude probably of 950 feet, and the easterly hills have a more regular outline, than those of the westerly part, the latter in some places presenting cliffs and sloping ledges of great height.

These mountains, and the valleys between them, except near the Lake coast, or where occupied by rocks, have a good soil of sandy loam, which supports a heavy growth of timber of sugar maple, birch, lynn, hemlock fir, elm, &c.

The Lake coast bordering these mountains is generally rocky, and affords no good harbors for small boats, except at Carp river. This stream runs W. S. W. nearly parallel to the coast of the Lake, for about ten miles, and at the distance of about two miles from the coast, it then bends to the northwest, and after passing falls and rapids near its mouth, enters Lake Superior on section 33, township 51 north, range 44-west.

GEOLOGY.

Within the boundaries of this survey there are five principal groups of rocks, which occupy large areas.— They are, primary, trap, conglomerate, sandstone, and slates.

That group of rocks which may be denominated primary, and including the metamorphic rocks on the south, are found generally a little inland, (excepting in the vicinity of Presque Isle Harbor) from the coast of Lake Superior; and from the south boundary of township 48 north, ranges 25 and 26 west, into township 51 north, range 32 west, about three miles S. S. W. of the head of Huron Bay. (See map.)

These rocks make up a series of knobs and high conical hills, forming a broken range which has a course as near as could be determined W. S. W.

These elevations are of various heights, probably from 75 to 900 feet above Lake Superior, and, generally, the elevating force appears to have acted mostly upon their southeasterly sides, as this side generally presents cliffs and bold ledges, while their northwesterly sides slope away more gradually.

The metamorphic rocks alluded to, flank the primary rocks on the south, where the two becomes so much blended with each other as to make it difficult to define a line of junction between them. It may, however, be approximately drawn, commencing at the lower falls of Riviere Du Mort, or Nekomenon river, about one mile S. S. W. of Presque Isle Harbor, thence running W. N. W. to corner of sections 31 and 32, on south boundary of T. 49 N., R. 25 W. and curving a little westerly crosses the east boundary of T. 49 N., R. 27 W. near the corner of section 25 and 36.

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The principal rocks which compose the metamorphic group are quartz, compact and granular, imperfect talcose slates, which are in some instances slightly argillaceous, and slaty hornblende. These rocks are more or less stratified and imperfectly jointed, and dip generally N. N. E.—In two instances however they were seen to dip S. S. W. A few veins of quartz were seen traversing these rocks, but no one was observed to be metalliferous. I have however seen specimens of specular iron ore said to have been obtained in township 48 north, range 26 west.

Within the boundaries of the metamorphic rocks upon the survey, several knobs of syenitic granite, and also dykes of greenstone were seen.

PRIMARY ROCKS.

That portion of this range which may be denominated primary rock, and lying to the north of the metamorphic rocks already described, is generally composed of granular quartz, feldspar, and hornblende, constituting a compact syenite. In some places slight traces of mica are observable, giving rise to a syenitic granite.

These minerals predominate in different proportion in different places, and not unfrequently in different parts of the same ledge or hill.

In some places it is mostly a hornblende rock and in others the leading minerals are feldspar and hornblende, giving rise to a syenitic greenstone, and less frequently a well formed granite is found. In several instances a compact greenstone was found, intruded among these rocks in various forms. And when in veins or dykes these do not appear to have any particular magnetic bearing.

One of these veins may be found of about one foot in thickness, traversing a ledge of sycnite W. S. W., at 45 chains and 69 links in going west on south side of section 36, south boundary of T. 51 N., R. 28 W.

Throughout this entire group of rocks, quartz and feldspar veins are often found, and, in many instances, both are seen traversing the same rocks, and crossing each other at various angles. These veins are from a line to a foot or more in width, and were observed to be more frequent and of a larger size in townships 51 and 52 north, ranges 28 and 29 west, than in any other part of the primary range. Also a few veins containing calcareous spar were seen near the junction of the primary and sedimentary rocks.

In regard to the metalliferous character of any of the veins traversing the primary rocks, in this portion of the mineral region (so called) it may be sufficient to say that no vein indicating a workable quantity of metal of any kind was observed, but it should not be inferred from this that they do not exist here.

My observations were mostly confined to township lines, which do not *always* pass over the most favorable places for examination; and afforded no opportunity of tracing up veins, that have some metalliferous indications, until their characters were developed.

ARGILLACEOUS SLATES.

Flanking the primary rocks already described on the northwest, in T. 51 N., R. 30, 31 and 32, W. argillaceous slates were found. They seldom crop out, and, on account of their being generally covered with a considerable depth of earth, their precise limits could not

be defined. They are, however, supposed to occupy a space from one to two or more miles in breadth, before they are overlaid with the sandstone. These rocks have, generally, near their junction with the primary rock, a dip from 20 to 30 degrees to the N. or N. N. W. and their line of cleavage dips to the S. or S. E. making an angle with the line of deposition of about 65 degrees. These slates are generally of a dark brown color; but a curious variety was found in both branches of Huron river, on south boundary of T. 52 N., R. 30 W. section 36. Loose masses have been brought down these streams in abundance, some of which are varied with numerous stripes of red, light gray, light and dark brown &c.

RED AND VARIEGATED SANDSTONE.

Flanking the slates already described, and resting upon them, red and variegated sandstones were found.— These rocks extend north and west in nearly horizontal strata, passing Huron and Keewenaw Bays, and flank the base of the trap range of Keewenaw Point, on the southeast, throughout the survey. This sandstone also flanks the primary rock before described, on the north and northeast, to the coast of Lake Superior, except in the vicinity of Presque Isle. These rocks occupy a larger area on the survey than all the other rocks; they are generally laminated, and not unfrequently jointed, and vary considerably in the fineness of the materials of which they are composed, in different strata; and the whole are tolerably compact.

Though the strata of the sand rock may, in general, be considered horizontal, it has evidently been some-

what disturbed and contorted, and was observed in the vicinity of the northern slope of the primary and trap hills, to have a considerable dip from them.

This rock borders a large proportion of the Lake coast throughout this part of the survey, and may be seen, forming ledges from a few feet to 70 or 80 feet in height; and it should be mentioned, that novaculite, or at least a very fine grit for whetstones, may be found in a ledge on the east side of Keewenaw Bay, near its head, on section 35, T. 51 N. R. 33 W.

This ledge is laminated and jointed, and from it may be obtained whetstones of almost any degree of fineness. Also, to the S. S. W. of this ledge, on section 2, a good quality of reddish clay was seen, and at several other points on the bay coast, in this vicinity.

TRAP RANGE OF KEEWENAW POINT.

This range commences at the east end of Keewenaw Point, and has a course generally to the southwest, in a series of trap knobs and irregular hills, from three to seven or eight hundred feet in height above Lake Superior.

Their general topographical character and boundary have been already described. (See map.)

Generally, the middle and southeasterly side of this range is a compact greenstone, which gradually obtains an amygdaloidal structure, near the northwest slope; and along this slope, in many places, a decided amygdaloid is found, the cavities of which are frequently filled with quartz, calcareous matter and epidote.

These characters of the trap rock are well sustained throughout this range of the survey. It has also been

observed, that generally the slope of the trap rock has a much higher angle on the southeast, than on the northwest side of this range.

CONGLOMERATE ROCK.

This rock is of a great thickness, and flanks the trap range on the northwest side, from the east end of Keewenaw Point, westward, into township 57 north, range 33 west.

The conglomerate rock is made up of rounded pebbles and small boulders, principally derived from rocks of the trap family, and so firmly cemented together, that when broken, these rounded masses frequently divide through the middle. This rock does not appear to be very uniform in its dip; it may be estimated, however, to dip N. N. W., from 20 to 50 degrees.

Resting conformably upon the conglomerate rock, are a series of alternating strata of sandstone and conglomerate, embracing between their strata several trap dykes of considerable extent, which dip with these rocks to the N. N. W., at an angle of 30 to 40 degrees. The injection of these dykes has produced great changes in the rocks, by which they are embraced. The sandstone near the dyke is converted into an amygdaloid, and the character of the conglomerate much changed by igneous action. This is exemplified on the points of rocks, west of the entrance of Eagle Harbor, where they are severally seen.

These trap dykes may be seen at several other places, from Copper Harbor to a little west of the east boundary of T. 57 N., R. 33 west.

The conglomerate rocks above described, were not