North shore L. Superior: [specimens] 42136-42214. No. 340 1900

U. S. GEOLOGICAL SURVEY.

FIELD SECTION BOOK

9-891

Aug. 27th. 1905.

From head of Bachelwahnung Bay to Goulais Point

The rock at the south end of the bay, where the stream comes in, is
42136 hornblende-schist and massive horn-
42137 blendic rock cut by red granite. The east side of the point on the west side of this little bay is also schist and greenstone cut by granite, but the
42138 end of the point is graywacke-slate carrying granite fragments (42140). The granite fragments on the east side of the exposure are very sparse, but increase in abundance toward the west
42139 wnd. (42139) represents a small granite fragment in matrix,- some are 8 or 10 inches in diameter, but as so often in the slate conglomerate of Logan, the fragments are dispersed through the slate.

After a very little gap of
42140 about 50 steps, red granite (42140)
42141 comes in, and with this on the west
42142 side green, schistose red clay, cut
42143 by it. Resting irregularly on this complex, in direct contact with it and
42144 largely under the water, is again
42145 graywacke and conglomerate, the frag-
42146 ments of which are clearly derived in part from the adjacent complex. Could not be quite sure of dip of conglomerate and slate so as to take observations, but dip is certainly rather low.

In short, the relations here between the Huronian clastics and the granite-gneiss-schist complex, and the intrusive relations of the granite in the more ancient schist, are identical with those at Thessalon Point, described by Pumpelly and myself. However the relations are here less clear than at Thessalon, and could
4 easily be misinterpreted.
42147 Just around the point schistose
42148 rock (42147) cut by granite (42148)
42149 is again found.

The foregoing relations make it almost certain that the conjecture of last evening that the Bay of Bachchwahnung is structural, having a fragmentary border here and there of Huronian, almost cut away, an inner fragmentary border of Keweenawan, and finally a basis of Cambrian. In short, this bay is a minature Lake Superior Basin.

Here a shallow bay comes in, and the land from the south of the narrows of Bachchwahnung Island is in the Cambrian
42150 sandstone. This sandstone is cross-bedded, and the whole ledge at the point east of Rudder Head has a strike of N. 50° W., and a dip of 40° to the N. E. If one were not familiar with the gigantic scale upon which the Cambrian sandstone is cross-bedded, he might think same to Keweenawan sandstone. However I have no doubt that this is Cambrian. In crossing bay east of Rudder Head a rock sticks out of the water at one place, and this proved to be coarse gray granite.

Aug. 28th.

From Goulais Point to flat at mouth of Goulais river; thence toward Gros Cap.

Hoped to find the Huronian south of the mouth of Goulais river, as mapped; but immediately upon getting south of Goulais flat came to gray
42151 granite (42151) which was cut by red granite, and which contained numerous fragments of hornblendic schist. In going south various granites, gneisses and schists were encountered, some of which are represented by

At one place on the beach found a small boulder of conglomerate which contains numerous pebbles of granite of various kinds, and also a number of varieties of greenstone pebbles. Have no doubt the source came from Huronian.

The deltas and river deposits of Lawson continue toward the east end of the lake, but are much less marked than on the west end. In Bachchwahnung Bay and Goulais Bay examined the rocks with a glass for evidence of terraces, and while low terraces were plainly seen, high terraces if present are so obscure that they cannot be determined in this way. The absence of glacial drift for much of the north shore is almost complete, but the high level lake deposits are very marked.
2 At the new Ry. of Michipicoten these

are most beaufifully exhibited.

Aug. 29th.

From about 6 miles north of Gros Cap to Sault Ste. Marie.

42152 banded gneiss first seen in going north to Gros Cap.

42153 Coarse gneissic rock,- basic,- cut by granite in an extraordinarily complex fashion. Granite ramifies throu the schist so as to make same green, like limbs in granite, in places.

42154 greenstone, also cut by granite.

42155 cutting granite.

42156 " "

42157) amygdaloid at Gros Cap, south of

42158) strike N. W. - S. E., dip 60°-70° S.W

42159 dense diabase, with same.

42160 felsite making eastern most rock. This is in two masses along the shore separately.

42161 granite, coarse, and epidotic.

The rocks (42152-42156) represent as beautiful a set of Archean rocks as I have anywhere seen. Have no doubt of their age, as pre-Huronian. Ancient schists and banded gneisses of the most complex character; banded and crumpled, cut by granite, as usual with such complexes. The coarse ancient greenstone (42153 especially) is cut by granite in the most extraordinary fashion; so that many of the

masses of greenstone look almost like spheroids. Indeed, it is possible that this rock has had a sort of spheroidal structure and has been injected by granite along the curved surfaces of weakness.

Of the Keweenawan character of the bedded lavas making up the area of Gros Cap proper just across from Iroquois, there can be no doubt. Same is very close to granite in places; indeed, is almost plastered over its surface, although no absolute contact was seen.

The surprising thing to me was the steepness of the dip of the Keweenawan, about 60°, although I do not know that I could give any good reason for this surprise.

Spet. 3rd.

Rode by train from Sault to Walker's Lake, and then walked along Ry. track to Dubanate? The higher members of Logan's Huronian were seen as we passed along.

Got off train where Ry. crosses outlet of Walker's or Dubanate? Lake. West of stream the rock is the white quartzite of Logan. Immediately east of the stream the rock is Logan's
42162 red jasper conglomerate (42162). This material extends almost to mile-post 153, about 2 miles from Dubanate station.

The quartzite and conglomerate both have flat dips; but vary in their strike, so the strike observations have little meaning. The red jasper conglomerate is beautifully bedded; some layers containing more and larger fragments of red banded jasper, black chert, and white chert, than others. The amount however is very great, and I have absolutely no doubt that a search for the source of this material will be successful, just as it was at the east end of the Vermilion range with reference to the Ogishke conglomerate. The place is doubtless to the north of Echo Lake, and east and west from here.

The red jasper conglomerate is veined with white quartz, is much broken, and at various places con-

tains veins of ferruginous ma-
42163 terial. (42163) For the most part these are narrow; some are a foot or less in width. The widest noted is about 10 feet in width. In all cases these veins looked to me like fracture or fault zones along which iron impregnation has taken place, followed by later movement. In no cases did they look to me like beds. Certainly these ferruginous zones are wholly unlike the productive iron formations of the south shore, and certainly they are not the source of the jasper pebbles of the red jasper conglomerate; for they occur in the red jasper conglomerate, cutting the bedding, and moreover are wholly unlike the jasper fragments.

At the 153 mile-post red quartzite appears, and this extends to Baraboo? A short distance west of Ore? the
42164 quartzite is very ferruginous. (42164)
42165 The normal quartzite at D&A. is very like the Baraboo quartzite. In fact the gentle folding and faulting of the two series, the presence of jasper in both, the ferruginous character of both, furnish very close lithological and structural analogy.

Sept. 4th.

Drove in a general direction north of the Canadian Sault. In so doing, passed as beautiful a set of terraces as I have anywhere seen. These are at moderately high levels, the highest probably being from 300 to 500 feet. (Did not have my aneroid

Thence on road from which Garden river road branches pass from point to point of Archean. Now cut through by considerable streams or branches of Garden river, or else river next to west. Tops of same almost perfectly horizontal. Great wave-built terraces at time lake was at high level, although material doubtless supplied in large part by stream. In short, these terraces between points as beautiful as those seen anywhere, or described by Logan.

The old rock is light and dark banded Archean gneiss. In places the banding is nearly horizontal for some distance, although not far off is steeply inclined.

Sept. 5th.

At Marquette re-examined the ferruginous rocks of Pine street parallel to Michigan street visited so frequently before. Supposed same must be veins heretofore; but in the light of my Vermilion work of last year and my north shore work this year, they appear to me to be wonderfully like the iron-bearing rocks of those areas. Certainly the different bands appear to be interlaminated with banded tuff. Certainly they vary rapidly in thickness; certainly they have the same facies, including the pyritiferous and black apparently carbonaceous varieties seen in Little Gros Cap. It is hardly possible to believe that the two are not the same; yet while at Little Gros Cap supposed these the same as the much greater masses at the Helen mine, and the latter I did not doubt were the same as the Vermilion. In the Vermilion district also, besides the great masses, exactly similar small interbedded masses appear in the greenstone schists. In the latter district it is usually difficult to discriminate between the original greenstones and the later intrusives; but at the Marquette locality it is perfectly easy to discriminate between the banded tuffs which seem to be contemporaneous with

the iron-bearing rocks, and the later intrusive dikes of which clearly cut both the tuffs and the ferruginous material. The jasper is the so-called black jasper and the actinolite-magnetite-schist so common in the Vermilion where the iron formation is in thin bands.

Certain that at the locality west of Michipicoten the iron formation material is interbanded with tuff and greenstone. It is notable that in both cases the greenstone is not spheroidal; but at Gros Cap, while the iron not in spheroidal greenstone, it is very near to same.

If this Marquette rock is really the equivalent of the iron formation of the Vermilion, great results follow. Either this iron-bearing formation is earlier than the Marquette for the whole region, or else the earlier parts interlaminated with the tuffs, and it is earlier. If the latter is the case, it would seem probable that the great masses of iron formation are also earlier. This would give them iron-bearing formation and also small parts of the sediments in the Archean.

Sept. 6th.

From Marquette to Calumet.

Sept. 7th and 8th.

42181 From Calumet to Eagle Harbor, and at Eagle Harbor examined again"the greenstone." This rock is exposed in the cliffs along by the Cliff and West Phoenix mines in the typical luster mottled rock so characteristic of the north shore. Also in the cliffs it shows the columnar structure so characteristic on the north shore. I did not see its contacts with overlying or underlying rocks, but think it probable that same is intrusive.

At the Arnold mine work has been
42182 renewed on the "ash bed." Some of
42183
the amoygdaloid is very rich in copper

At Eagle Harbor the topography most beautifully expresses the relative hardness of the beds and the structure. The shore and the points of the harbor are comprised of a succession of flows of amygdaloid, the upper parts scoriaceous and the middle and lower parts more dense.

The upper layers dip down to the lake, the slope corresponding to the bedding just as at
The backs of the beds break off vertically with steep slopes.

The sandstones and conglomerates

make the harbor. The south side of the harbor is made of a more than average hard conglomerate which dips bayward exactly parallel to the bedding, the softer layers being stripped off. South of the harbor the ? range rises with a slope, again corresponding to the bedding, and the south side of this set of lavas, including the greenstone, break off in cliffs as seen at the Cliff, Phoenix, and other mines.

S. T. R.

Spec. 42171 to 42180 incl., collected, but ~~not~~ described in note-book. 362

74,908.

Sept. 9th.

Drove from Eagle Harbor to Delaware mine; thence to the middle of the south slope to Lac La Belle; thence back to the Delaware; thence along the south side of the greenstone to the
42184 Phoenix; thence to the Calumet.
42166 Luster mottled greenstone on ridge be-
42167 fore reaching the Delware mine.
42168 Reddish rock cutting through above.
42169 Amygdaloid)
42170 Conglomerate) Delaware.

The greenstone in places is coarse and resembles closely Irving's black gabbro of the north shore. In other places it is very coarsely luster mottled, and like the typical Beaver Bay rock. As I drove along the south side of the range the columnar structure so well seen west of Phoenix was beautifully shown.

In the cross section to Lac La Belle saw conglomerates in the flat between the ranges, and on the road various diabases and amygdaloids. Did not see the coarse greenstone, although Hubbard afterward told me that it does cross the road, but near Lac La Belle. The road does not cross the high parts of the ridge where the main mass of the coarse gabbro is contained to the east, but which rapidly narrows in going west.

Sept. 10th.

Answered mail at Calumet.

Sept. 11th.

In conference with Hubbard, Seaman, and Bayley at Houghton.

Talked with Hubbard about the intrusive character of the greenstone. He did not know any evidence to the contrary. Had thought the gabbro of the southeast part of the point intrusive, but had not regarded the luster mottled rock as intrusive. Said he had not seen the columnar structure in any of the unmistakable lavas. Said he had noted the columnar structure on a small scale in one other rock on the point, and this is a dike. The probability seems therefore very strong to me that the greenstone is intrusive. Also I think it likely that the "orthoclase-gabbro" has the same genesis at the S. E. part of the point as on the north shore. Certainly the character of the rock seem identical. They are associated with gabbro and later intrusive red rock, just as on the north shore.

It seems therefore probable to me that the succession from Keweenaw Point is:

Basic lavas.

Intrusive gabbro and luster

mottled rock.

Intrusive red rock.

Felsites, etc.

Conglomerates and sandstones, with lavas.

Basic intrusives, possibly including the greenstone; but the greenstone may antedate all the conglomerates.

Upper Keweenawan sediments.

Unconformity.

Cambrian.

General:

Deformation at top fault in brittle slate.

Lower monoclinal flexure in shales.

Lower fault again in brittle slate

Michipicoten, Ont., Nov. 9, 1900.

With Messrs. Willmott and Brotherton visited the Helen mine again. First went up on top of hill back some distance from the mine, where a test trench exposed a considerable
42185 breadth of cherty iron carbonate with a thick weathering crust. To the north of this belt is the banded ferruginous chert. To the south of it, after a little interval, appears a schistose greenstone. The iron carbonate, according to both Brotherton and Willmott, strikes directly into the ore body.

The south slope of the hill is largely composed of a schistose gray rock (42186) containing much iron carbonate, as shown by the weathered crust This gray rock was traced to the rock south of the ore body, and noted at previous visit as being peculiar and containing iron carbonate. This rock I took to be a mashed porphyry on my previous trip, and this it certainly seemed to be in places, although at other places the rock, notably about a mile east of the Helen, takes on the unmistakable appearance of a tuff. The more carbonaceous varieties must certainly resemble the pure carbonate, and the question arises whether this porphyry does not grade up into the banded carbonate.

Carbonatted?

Went into drift east of mine.

Here saw the rock which I thought should pitch under ore body. Some huge boulders ; but in drift at two different cross-cuts is a sandy banded variety of rock which certainly looks like a bed. This strikes somewhat west of north, and dips 50° to 60° E., i.e., away from the ore body. This and the topography somewhat contradict each other. However the lake narrows to the west, and is separated from another lake by a narrow ridge of rock. This makes it possible that the ore body pitches to the east under the bluff of iron carbonate. If so, an impervious basement; and the ore body must have been made by some rock under the lake concentrating the drainage in this direction. It is notable that the drift east starts in on low grade ore, but continuing east and swinging south it finally cuts a pyritiferous rock. If the iron carbonate were the hanging wall, a horizontal drift would be sure to pass into poorer and poorer material.

The lake basin 160 feet deep is undoubtedly a rock basin. This basin must therefore be formed by glacial erosion. The ice, as shown by the striations, moved to the southwest; hence was diagonally across the basin. The rock of the basin must have been sodt in order that this cutting could occur; and probably this basin was once filled with ore.

The next basin to the east may also have been an ore basin, but the lake has the iron formation material along its north side and cutting diagonally across it; but still giving ample room for a basin of ore dipping to the north.

The iron formation rock along this basin is a peculiar gray banded chert containing some carbonate probably, and comparatively little iron. It is the "hungry chert" of the worst sort. Upon nearing its base at the west end of the exposure and on the north side of the belt, the rock becomes more ferruginous, and may become still more so before the greenstone is reached.

The greenstone north of the ore formation is on lower ground than the iron formation material along the belt, except at the mine section. The same is true of the gray schistose rock on the south side of the lake basins; and at the Helen mine the porphyry is higher.

A comparison of the iron formation with that of Vermilion would show four differences. At the Helen,

42185 (1) Much more iron carbonate.
42186 (2) The chert is gray and lean.
42187 (3) The ferruginous phases, ferruginous slate instead of jasper.
(4) Pyrite much more abundant.

All these things point, it seems to me, to the probable conclusion that we are here at a deep level in the ore formation. In fact, the glacial denudation has cut deeper. If this be true, how deep can the Helen body be expected to extend.

As yet the mapping at the Helen is too imperfect to enable one to determine the pitch, or the once probable presence of ores in other lakes which have been removed by erosion.

Sunday, Nov. 10th.

Spent the larger part of two days on trail, running about N. W., 30 miles long going from Michipicoten to the Frances claims. The first part of the distance, for at least six or eight miles, the rocks were mainly the old greenstones and greenstone-schists. At one place what was supposed to be a schist conglomerate was found. Next we came to a broad belt of granite and gneiss, mainly granite. Both red and gray granite found, but the red granite is dominant. At various places the granite was seen to be intrusive in the hornblende-gneiss. For some distance along the trail at one place the hornblende-gneiss showed parallel foliation, very flat-lying, inclination not more than 15° to 20°, but at some places even less. About 3 miles before we came to the Frances claims we again came on the greenstone and greenstone-schists.

At a little lake about one mile before reaching the Frances claims found the greenstone formation to be a fissile schist. In this schist were lenses of white cherty quartz which so frequently came in this formation before a big belt of ore formation.

Upon reaching camp we found a big hill at least 1000 or more feet long and at least a third as broad. Many exposures were seen, and large stripping operations had been carried on so that there are many large artificial exposures. The rock throughout is ferruginous chert. In many places this chert contains bands of hematite. These bands vary from a small fraction of an inch to several inches across. Those of the latter width are exceptional. No greenstone or other rock was seen. The chert is for most of the hill very much broken. In many places it is strongly brecciated. This is especially the case on the east part of the hill where the jasper makes a turn from a nearly E.-W. strike to a nearly N. & S. strike, as shown on plat. In the bell of this curve are good showings of ore in a shaft 9 x 10 ft., the part of which below the [illegible] is wholly in very good ore. To the east is a group of pits. To the east is a group of pits, a number of contiguous ones, of which all are in ore. This ore was found by test pits cutting through from 3 or 4 to 8 or 10 feet of drift. The area between the shaft and the group of test pits to the east has not yet been prospected. If the intervening territory shows ore, the surface showing would be that of a very fair prospect. Contiguous

to the ore and just back of it is the bend in the jasper, and within this curve the ore has been found.

The exposures on the south border of the hill are very good looking jasper, indeed, containing many bands of hematite. Between this material, which is on the south slope of the hill near its east end, and the jasper to the north is a depression in which there are no exposures, and which is well worth exploring. The thing lacking for a big body of ore is a bounding formation, a basement; but following up the ore body may show this; for the swamp to the south may be mainly underlain by the fissile schist like that near the lake seen before reaching camp.

All the objections to the Helen, i.e., the four which make it look like a [illegible] are here lacking,- (1) no carbonate, (2) no pyrite, (3) no lean gray chert, or at least very little of it. Also the country looks as if weathering work was well done.

Spent the 12th and 13th in going from the Frances claims to the Iron Lake claims, examining the same and returning to the Frances camp.

Along the north side of Iron Lake is a broad belt of banded ferruginous chert; then soft ore jasper. At the lake this rock contains layers of hematite from a fraction of an inch thick to possibly an inch or more. I saw none more than a fraction of an inch in thickness, but it was said that some were two or three inches across.

The band of jasper is of considerable width. Did not measure same, but suppose the belt to be 100 to 200 feet across. How much wider it is could not be determined as the jasper extends to the south shore of Iron Lake.

The jasper, especially in its northern half, is interlaminated with
42188 beds of slate (42188) from a few inches in thickness to several feet. This part of the formation upon the whole was not more heavy in iron, but

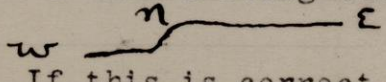
poorer if anything. This also was the opinion of the Foreman. To the north of the exposed interbedded slate and jasper is a longitudinal depression in the hill, and in this depression in one place is a small lake.

To the north of this depression
42189 is found banded iron carbonate (42189)
42190 and pyritiferous slate and gray slate,
which appears to grade down through
42191 fissile varieties into a dense rock which has the appearance of a felsite.

The dip of the slate and jasper dike is about 75° to the south.

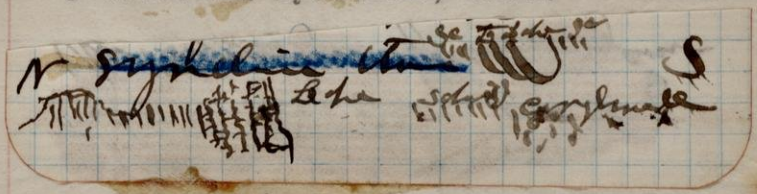
The presence of the iron formation on the north side of the valley makes me inclined to believe that the rock in the valley is largely iron formation; but the presence of the slate to the south of it, and the existence of the carbonatted variety of slates, lead me to suspect the same contains considerable belts of slate, and therefore is less favorable to ore concentration than if it were pure ore formation material.

For the most part the schist ridge appears here to run straight; but it, or rather back of the camp, it appears to make a swing thus:



If this is correct, this would be the most favorable place to begin the search for ore.

On the south side of the lake, which is less than 1/4 mile wide, are found carbonaceous slates, some of which are banded and look as if they might turn into iton formation. This still farther to the south changes
42192 to felsite-schist (42192) similar to that north of the iron formation. The dip is still to the south and the structure is therefore that of an overturned syncline, thus:



Willmott says south of the schist and felsite, conglomerate appears.

Returning now to the north side of the lake, north of the first felsite ridge is another depression in which is another longitudinal lake somewhat further west than the first, and on the south side of this is a pyritiferous schist which contains a layer or lens 8 or 10 feet across of pyrite and quartz. Where not weathered, it looks like solid pyrite. Where weathered are seen continuous skeletons of quartz in which are innumerable or rectangular areas in which pyrite doubtless was. Along the border of the mass is a few inches of limonite. Quartz lentiles,- dense, white, and

hard,- are also seen in the mass. These are resistant, and may be seen alike in the weathered and unweathered pieces. Do these represent pyritiferous slate beds, or at least beds in which an unusual amount of organic matter was present to reduce the sulphides? The abundance of sulphides in the region suggests that the most of the sulphur present in the original greenstone was greater than in the Vermilion district. Was this due to volcanic action?

Also examined the Minnesota workings about one mile east of the Iron Lake camp. Here the iron formation exposed is wider than at Iron Lake. Prof. Willmott says quite an occurrence of pyrite at its widest place, i.e., more than 1/4 mile wide. Mr. Murrary, in charge of camp, says same was at least 100 paces across, and where I saw it, it must have been wider.

At or near the camp the schist to the north appears to make a forward swing in going from east to west, similar to that at the Iron Lake camp, but more pronounced than at the latter place. Here the jasper, in accordance with this, is much broken and contorted. At one place the jasper was seen to make a distinct fold, plunging to the east away from the schist. At the top of the hill is a

great mass of diorite, and this perhaps is at least a partial cause of the folding. At a number of places in this area, Mr. Murray has found bunches of ore several feet across, and a number of bands two or three feet across which he hastraced some distance. But up the present time no ore deposits has been shown; but as Mr. Murray expressed it, It is a good place to prospect. At one spot, Mr. Murray has put down a shaft on the contact of the iron formation and the schist where the same is cutting across up the valley. He He found at the contact a little sheet of ore, but no big body. However, it is possible that a large body of ore may be found. I did not note at the Minnesota location any of the slate interbedded with the jasper.

While I did not see the jasper belt to the west of the Murray camp, Mr. Murray says that there is another cross valley in which the schist again makes a southward swing in going west.

Iron formation is said to extend, by Prof. Willmott and Mr. Edey, some 10 or 15 miles farther west across the Pucaswa.

In going out we crossed a sand plain in which prof. Willmott says detached outcrops of iron formation occur.

Nov. 14th.

Went from the camp at the Frances claims northeast to the claims N. W. of Paint Lake. In the low area between [illegible] Paint Creek for banded carbonaceous slate, conglom-
42193 erate, and graywacke (42193). I thought it probable that these rocks belong to the upper series, but could not certainly determine because of the snow. However did not see any of the unmistakeable greenstone characters.

At Paint Lake is a broad belt of slightly ferruginous quartz rock, banded, but nowhere taking on the characteristics of good ore formation material. The quartz material varies from fine cherty through medium
42194 grained varieties, to coarsely crystalline material. The more coarsely crystalline material was noted to the north side; i.e., nearer the granite, to be mentioned presently.

At various places the ferruginous quartz rock contains much pyrite, in places in nearly solid bunches. In short, the relations of the pyrite and quartz are identical to those seen in the little band of quartz and pyrite at the little lake north of the Iron Lake claims, and at the latter place this material is also north of the iron formation.

Returning to Paint Lake, the pyrite where most abundant near the lake has been oxidized, the iron partly being oxidized in place, but also to a considerable extent being transported as a sulphate or carbonate and precipitated on the low ground near the lake as limonite, or this with basic ferric sulphate. The limonite contains much organic material, and
42195 in some places contains charcoal.

Prof. Willmott says that the deposit of limonite has been prospected and found to contain about 5000 tons of ore.

Prof. Willmott says that material similar to the ferruginous pyritiferous quartz rock is found in the schists in many places bands, and that 400 acres of limonite have been thus purchased. In some places the limonite extends 80 or 120 acres, but most of the areas are smaller. This is a new class of ore in the Lake Superior region.

In this connection the question arises as to whether this little deposit does not give a clue to the method of formation of the original carbonate from the green-schist and greenstone. Contained in the greenstone partly as sulphide perhaps, and partly as other salts carried down to lagoons and mingled with organic matter. It is probable that if a deposit of limonite were sufficiently

deeply buried that carbonate would be reconstituted by oxidation of carbon, with the simultaneous reduction of the iron as protoxide, and union of the two.

The breadth of the Paint Lake ferruginous quartz is certainly several hundred feet, perhaps 500 or 600 or even more.

Continuing now to the north side of the ridge we find a magnetitic schist (42196) containing many crystals of pyrite. This belt of schist is a hundred feet or more in width. On its south side it seemed to me to grade toward the ferruginous quartz rock. On the north side it is in contact with and apparently cut by granite. Prof. Willmott remarked that in the high granite hill, of which I was near the east base, the granite included fragments of the magnetitic schist.

42196

I have no doubt that the magnetitic schist is due to the granite intrusion. The magnetitic schist is however much ~~xxxxx~~ richer in iron than any 100 feet of the ferruginous quartz material. But near the contact plane would be where the solutions would be active. The iron would be thrown down as magnetite, because of the reducing action of the pyrite.

A large portion would be precipitated as pyrite. From all descriptions this magnetitic material is very similar to that of the Atikoken range, and the paint rake occurrence may afford a clue to the origin of the ores of that range. (Work out chemistry of process of formation; concentration of iron, removal of silica.)

The richest specimens that Prof. Willmott could find contain about 40 per cent metallic iron.

We next went on the ice of paint Lake to the south side of Brotherton's claim. Here trenching has been done both across the broad iron formation and where the material was more than the average of richness along the strike. The undoubted iron formation is exposed in great force. The formation must be 1/4 mile across, and may be even wider. Have no doubt that same is a continuation of the iron formation of Fraces claims, but it differs from the latter in very important particulars.

First, the iron carbonate is much more abundant. In fact, it was found everywhere, except on the extreme south slope of the hill, and here no close search was made for it.

42197 Represents the banded carbonate where the iron formation is first exposed on the north brim of the hill.

42198 Represents the carbonate near the top of the hill.

Second, the rock which is not a carbonate is ferruginous gray and black chert, with some carbonate and magnetite instead of the well banded ferruginous chert of the Frances claims which contain many bands of hematite.

As a corollary to the above, much less hematite is on hand and less jasper was seen than on the Frances claims. One belt for 2 or 3 to 10 feet or more in width makes the crest of the hill.

On the south slope of the bluff
42199 cutting diorite (42199) was seen, both in bunchy outcrops and in dikes in the trenches.

The iron formation next to the main mass of diorite is banded mag -
42200 netitic slate, similar to that at Penokee Gap, where the cause is similar. No prettier case known to me of this line of metamorphism due to intrusion.

As compared with Frances claim, there is little chance of a great body of ore because of abundance of unaltered carbonate; but in one respect is more favorable, and this is the intrusion of igneous rocks to help form troughs; but in the Marquette district where similar conditions obtain east of Negaunee, with the carbonate no ore body is found.

As compared with the Iron Lake claims, it is less favorable, because at the latter place there is less carbonate, but the conditions there are adverse because of the interbedded slate.

Denudation may be much deeper at the Brotherton than at the Frances claims, and this very unfavorable to an ore body. As evidence of the denudation of the glaciers is the abundant carbonate. Possibly the partial or complete explanation lies in the intrusives, the same as Marquette.

On return to camp at about 1/4 mile east of the S. E. corner of the Frances claims found many ledges
42201 of carbonaceous and pyritiferous felsite similar to that south and north of ore formation at Iron Lake and south of the Helen mine.

Why are there so many similar ore formations in the Lake Superior region? Because of the great continuous unique greenstone formation containing much iron. Whenever conditions become favoranle for development of iron carbonate and pyrite, whether in Archean, Lower Huronian, or Upper Huronian time, these develope. Naturally developing from same source and in similar manner, makes like formations. These when altered in similar manner, give similar products.

Have held the source of the ores is iron carbonate. This must be modified to include glauconite (in Mesabi district) and pyrite on the north shore of Lake Superior. Perhaps on the south shore, if denudation were deeper might find the sulphide also important. At any rate, it is present at the Republic Riverside mine.

Visited again the Frances workings. In addition to the shaft in ore, the places where the boulders of ore in trench were found had been bottomed as requested, and ore had been found. Requested that men be taken off of other work, and this trench continued. The result was to show ore for 20 feet or more down the slope. However this is at the place where the jasper turns to the south and this ore may po sibly be along the strike of the jasper bands at that place, and therefore be only a narrow layer. Suggested to Mr. Edey that he cross-cut after following same N. S. as far as ore shows, in order to find width of same.

Examined again the jasper at the lower slope of hill; also on hill to the S. E. of the main hill. This former contains considerable quantities of hematite. The latter is broken into a breccia in places; in places is folded intricately. Contains as a matrix much ore, some bands and sheets being several inches across. It seemed to me that the depression between this small jasper ledge and the great jasper ledge is an unsually favorable place to explore; as also the place in the swamp where the valley between the jasper ledges joins same.

Suggested to Mr Edey that he do three things; (1) continue shaft which is 27 feet deep, and the bottom of

which is in ore; (2) to follow up by surface workings the ore developed to the east; (3) to explore valley.

Nov. 17, 18, and 19.

Visited the Michipicoten Range, following same from S. W. end of Long Lake to about 3/4 mile east of Park Lake. Got into the country by following the tote road from Lake to near Josephine Lake; then took trail to Josephine Lake; then across ice to Josephine; thence through Goetz Lake to Parks Lake on the west end of which is Josephine location, No. 571. On the way out we saw nothing but greenstone until Josephine location, No. 571 was reached. Much of the greenstone is dense, some amygdaloidal, and in one or two places spheroidal.

On the 18th, with Mr. Barton, Foreman of the camp, followed the iron formation and studied the adjacent rocks. At Long Lake, the so-called iron formation is the peculiar pyrififerous quartz rock so characteristic of the Michipicoten country. On the southeast side of the lake one may see almost solid bands of pyrite with bands of quartz rock. The pyrite as usual has weathered, producing streaks of hematite and limonite. In the weathered quartz are the cubes of pyrite. The same peculiar formation is seen at the water's edge at the northeast end of the lake and on small island near the north side of the lake at the middle of the east half.

The greenstone-schist, or rather the peculiar calcareous and ferruginous schist, which bounds the iron formation is found on both sides of the lake, all the way along on the N. W. side and near the ends on the S. E. side. All these facts appear to indicate that the pyritiferous quartz formation occupied the main part of the lake. Going S. E. from near the N. E. part of the lake a large fragment of chert and iron oxide was found, and on top of the ridge a schist. According to Brotherton,s mapping this place is the belly of a swing. At any rate it is low, and the iron formation is not exposed.

This is therefore the only place on the land which would warrant any exploration. If any ore is in this locality, it appears to be in the lake

At the Josephine location, just west of parks Lake, is broad band of iron formation material,- Barton says 200 feet across. At the lake this rock is white chert and iron oxide, banded and broken; but when traced to the west under a thin skim of iron oxide is found iron carbonate. At many places along the southeast side of this ridge of iron formation trenches have been made to the peculiart carbonate schist to the S. E., but no ore shown at any place. Also the top of the hill has been tested

by several trenches running across the hill and parallel with same, but no ore has been found. Carbonate schist to the N. W. of the iron formation as well as to the S. E. To the S. W. this formation narrows to a wedge.

The northern of the two islands on Parks Lake has the same broken iron formation as at the west end of the lake, but with this at the west end is the pyritiferous quartz rock also. This is the island from which drill holes have been run to the S. E. and N. W. The cores were examined and found to consist largely of the white cherty quartz rock with seams of iron oxide from a fraction of an inch to an inch across. At one place the iron oxide seams are numerous. Two papers contained red powder, and the record showed each to be 8 ft. thick. probably called ore on the record, but the two 8 ft. seams of soft stuff are separated by many feet of the lean banded material. However, these two seams of ore may be the source of the boulders, to be mentioned presently.
(Get record of drill hole)

The next island to the south and the shore on both the N. W. and S E. sides of the lake, show the carbonate schist so frequently mentioned. This is exposed at many places near the water and developed at many others by trenching. At one place on the north

side of the bluff on the south shore is a little of the pyritiferous quartz rock.

On the south island and south of the lake to near the west end of Location, No. 209, and perhaps at east part of Location, No. 571, are found boulders of ore many of them large, one according to Mr. Barton 6' across. This is good ore. To the west, and for some distance to the S. W. along the ridges adjacent to the little lakes between Long Lake and parks Lake, are found many boulders of the iron chert, but none of the pure iron ore. This gives evidence of the character of the movement of the ice. The west end of the iron formation did not yield ore. The east end, that which is last found on the island where diamond drill work was done, must have yieled the ore fragments. It appears therefore probable that it came from about the cross section of the islands. It may all have been derived from the two 8 ft. seams of ore cut by the diamond drill.

The iron formation examined N. E. of Parks Lake. At the lake where first exposed is gray carbonate with deep rust of iron oxide. On following the ridge around to the N. E., so as to get on the N. W. side, the pyritiferous quartz rock was found, containing many solid bands of the pyrite. In places these weathered to limonite so as to give strings of lean ore several inches across. These lean, but the texture is somewhat similar to the boulders, so that possibly these derived from such layers.

On account of the heavy snow which had fallen, did not examine the top of the ridge of pyritiferous quartz rock; but Barton says same, so far as exposed, is like that seen on the north side and end of the ridge. The width of the pyritiferous quartz-rock, according to Barton, is 500 to 600 feet, but I suspect that a close examination would show schist between. However I suspect that much of the carbonate would be found. At the shore the carbonate-schist comes in south of the pyritiferous quartz-rock at the first point beyond the little bay; but the actual contact was not seen, nor was the same followed up because of the snow. To the N. W. of the pyritiferous quartz-rock is a valley , to the north of which is greenstone-schist. In the valley are two or three outcrops, and these prove

to be the carbonate-schist and a gray slate. I suspect the depression is due to the rock rather than to an ore body.

Barton says he had made careful cross-section at the lake i mile east of Parks Lake, and that the same pyritiferous quartz-rock with limonite was found both to the S. E. and N. W. sides of same. Did not visit the locality because of limited time and deep snow, Barton saying everything would be covered.

He says however that he has followed the belt of pyrtitiferous quartz-carbonate rock, and the same continues for 3 or 4 miles, being the same nature all the way.

They were running a diamond drill toward camp; i.e., south of east. Same may possibly find ore at the contact with schist; for the little bay at the S. E. end of Parks Lake may make a fold, giving a basin. However the trend of the island toward the pyritiferous quartz belt to the N. E. But the direction of the drill pierces perhaps the best of the various purchases to develope a big body of ore. But it is certainly possible that a body as large as the Helen may exist S. E. of Parks Lake. I feel that this was once certainly the case; but the question arises as to the

depth of erosion, how much of same removed. Certainly the character of the rocks gives evidence of deep denudation, but not deeper than that at the Helen mine. The question also arises as to the depth of the Helen ore body. I suspect that it will not be found to be a large ore body.

42202 Carbonate-schist from N. W. side of Long Lake.
42203 Carbonate-schist approaching limestone from S. E. side of Long Lake.
42204 Siderite rock altering to iron oxide, from south side of Josephine location, near west end of main showing of iron formation.
42205 Schist from drill core at island of Parks Lake.
42206 Carbonate-schist from island south of above island.
42207 Carbonate-schist from mainland south side of Parks Lake.
42208 Ore from boulder south side of Parks Parks Lake.
42209 Sideritic rock altering to iron oxide at point west of iron formation ridge where it reaches Goetz Lake.
42210 Quartose phase of rock on north side of iron ridge east of Goetz Lake.
42211 Pyritic rock from same locality.
42212 Very pyritic rock from same locality.
42213 Iron ore in thin seams forming from pyritic rock. The formation of small quantities of iron ore from pyritic rock as plain as formation of large ore bodies from iron carbonate on the south shore.
42214 Slate from outcrop in valley between iron formation and green-schist east of Parks Lake.

A geological map of the various ranges should show:

(A) Iron-bearing formation.
(B) Greenstone-schist.
(C) Calcareous or carbonate-schist.
(D) Slate and conglomerate.
(E) Intrusive greenstone.

(A) The iron-bearing formation should be divided into:

(1) Iron carbonate.
(2) Pyritiferous quartz rock.
(3) Ferruginous chert and soft ore jasper.
(4) True jasper.
(5) Chert or jasper with hematite bands.
(6) Interstratified slate.
(7) Magnetitic belts (due to contact metamorphism.)

(D) The slate andconglomerate should be divided into:

(1) Slate.
(2) Conglomerate.

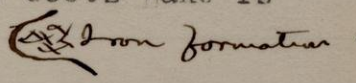
(E) Granite.
(F) Diorite (massive greenstone).
(G) Hornblende-schist or gneiss.
(H) Injections of hornblende-schist or gneiss with granites.

Monday, Nov. 19th.

Examined the north side of the iron formation west of Parks Lake. Found this to be the quartz-rock containing considerable pyrite. Made cross section along trench, and found the banded quartz formation containing very little iron oxide.

This formation is very well prospected apparently by test trenches, both cross and longitudinal, except at the west end.

Mr. Barton says the schist entirely surrounds the iron formation at this end before Goetz Lake is reached, thus:



Could not verify this by personal observation on account of the deep snow. Asked Mr. Barton if this end of the iron formation had been thoroughly explored, and he said not. Advised a thorough test trenching of that part of the formation to find if possible the west [illegible]. If no ore body is found, comparatively little chance for ore in the belt of iron formation west of Parks Lake.

Possibly also test trenches should be made between the iron formation and the green-schist south of the iron range. However this in places is very narrow valley, and doubtless underlain by the soft variety of schist

General principles concerning deposition of ores applicable to the Michipicoten district, and in part to the entire Lake Superior region:

(1) Iron formation should be in force Any big bodies of this formation are likely to contain ores.

(2) Ores likely to be found in association with the ferruginous chert, as at the Helen mine and on the south shore.

(3) The presence of pyrite and carbonate unfavorable, but ore may occur near the place where the carbonate is found.

(4) Question of depth is one of great difficulty. Possibly the relief being so much more marked, the ore may go deeper than on the south shore, and the Helen body go to considerable depth. The more marked the topography the more marked the erosion, but surface waters are certainly effective to greater depth than on the south shore.

At the Helen mine there is a wall of schist on the south side, dipping at a steep angle, or at least wall is at a steep angle to the north.

The ore body follows next to, or at least is very near the wall of schist. To the north is the banded ferruginous chert. Suspect that as the mine is developed it will be found

that a minor folding schist analogous to the Menominee folds in the limestone makes a pitching basin.

It is difficult to tell which way the body will pitch, because one cannot get the boundary of the schist and ore formation because of the lake.