Supplementary notes on the Vermilion district and neighboring Keweenawan areas of Minnesota. No. 337 1900

Clements, J. Morgan (Julius Morgan), 1869-
[s.l.]: [s.n.], 1900

U. S. GEOLOGICAL SURVEY

FIELD SECTION BOOK

9-891

LAKE SUPERIOR DIVISION.

INSTRUCTIONS.

1. Ordinarily at least two pages of this book will be devoted to one section. On the left-hand page, place a map of as much of the section as has *actually been seen.* Denote rivers, lakes, marshes, etc., by the usual topographical signs. Denote the ledges of rock, when no structure is made out, by cross-hatching, making the cross-hatching cover as nearly as possible the areas occupied by the exposures. If the rock is a massive one, but still more or less plainly bedded, use the same sign with a dip arrow and number attached, showing the direction and amount of the dip. Denote a shaly or other very plainly bedded ledge by right parallel lines, and a ledge having a secondary structure by wavy parallel lines running in the direction of the strike, with dip arrow and number attached as before. The greatest care must be taken to avoid confusing slaty or schistose structure with bedding, and in all cases where there is the least doubt about the true bedding direction, indicate it by a query. To each exposure on the face of the map attach the number of the specimen representing it. In mapping the section count each of the spaces between the blue lines as 100 paces, and twenty of these spaces to one mile, or 2,000 paces. Usually the southeast corner will be placed at the bottom of the page, or at the first black line above the bottom of the page, and at the right-hand side. If, however, for any reason, it is desirable to show portions of an adjoining section, the southeast corner may be shifted up, or the map may be turned around and the north placed at the left-hand side of the page. The ruling of the left-hand pages is also arranged so that, if desirable, a larger or a smaller scale can be used, eight inches, two inches, one inch, or one-half inch to the mile. With the two-inch scale, the squares outlined in black represent sections, and those in red, quarter sections and "forties," while the space between the blue lines is 200 paces.

2. On the right-hand page place the notes descriptive of the exposures. Begin in each case with the number of the specimen, placing the number on the left-hand side of the red line, after which give in order on the right of the same red line the position of the ledges as reckoned in paces from the southeast corner of the section and the dip and strike when observable, the latter always being expressed from the north; for instance 4025, 250 *N.*, 300 *W.*, *Strike*, *N.* 78° *E.*, *Dip* 50° *S.* Then follow with a full description of the ledge. When topographical maps are used for locations this paragraph applies only in part.

3. Collect a specimen from every ledge, or wherever there is a change of rock on any one ledge, taking care to get fresh material, unless for a special purpose the weathered surface is desired. In case of trips made on foot or in canoes, for long distances, neighboring ledges, unquestionably of one kind of rock, need not be specimened. The position and extent of the ledges not specimened should be marked on the map, with notes that each is of a rock identical with specimen so-and-so. Under the same conditions small-sized specimens, trimmed to a uniform size of 2 x 2½ x ¾ inches will be allowed, but in all other cases *large-sized specimens*, trimmed to a size of 3 x 4 x 1 inches, must be selected, in accordance with section 3, chapter IV, p. 44, Regulations of the U. S. Geological Survey. Specimens should not be placed together without protection in the collecting bag, as the fresh surfaces, important in determining the character of rocks, are thus destroyed. They should be damaged by no temporary mark, but the numbers should be at once marked in at least two places upon the inclosing paper or cloth bags. Specimens may be permanently marked in camp by painting the numbers upon them in white upon a black background, using Silver White and Ivory Black oil tubes for color, with turpentine as a diluent.

4. On the last twenty-five pages of the book give, as may seem desirable, a general account of the examination of the region mapped in the previous pages, correlation of observations, sketches, cross sections, etc.

5. Forward this note book as soon as filled as registered mail matter to C. R. Van Hise, U. S. Geologist, Madison, Wis.

No 6.

#337

Supplementary Notes on the Vermilion District & Neighboring Keweenawan Areas of Minnesota

1900

J. Morgan Clements.

Oct. 5th.

Started this morning tocoast around Brule Lake intending to get an idea of the character of the Keweenawan in this vicinity. Heavy fog lay over the lake and did not rise until late in the day and after that it was misty or drizzling for the entire time. Again coasting the lake shore from a point on the south shore just east of the section line between sections 19 and 20, T. 63, R. 3. From this point I traveled east. Found red rock like 40255 predominating as far east as the large bay in sections 13 and 24. Associated with this there is a more porphyritic facies represented
40258 by 40258.

From here on black fine grained
40259 rock like 40259 seemed to be more common. In the above mentioned bay
40260 an amygdaloidal basalt 40260 was also found. With this there is associated a coarse dolerite with some redrock. The red rock cuts the dolerite but no relations could be observed between the dolerite and the fine grained basalts.

These same rocks continue on

around the east end and the northeast shore of Brule Lake. With them is associated a great deal of a coarse
40261 porphyritic rock like 40261 in which the feldspar phenocryst not uncommonly attain a length of 2 inches. Some of this rock has a very bright red color upon the weathered surface. This porphyry grades into a more evenly granu-
40262 lar rock like 40262 in which however there are occasionally centered phenocrysts. This rock weathers very much like the gabbro. The questionseems to me warranted: "Are not these dikes or sills which are offshoots from the gabbro and are intrusive in the adjacent rocks?" Specimen 40261 was taken from the point on the east side of the bay from which the portage route leaves going north into Winchell's lake. The more granular gabbro like form of the rock 40262 is very abundant along the shore in sections 11 and 12 – 63 – 3. Farther west in section 10 an amygdaloidal basalt like 40260 appears and near it although no relations between them were seen, occurs the red cyanite like 40255. This same redrock continues along the shore to the west for some

distance. Near the meander corner between sections 9 and 10 - 63 - 3,
40263 a fine grained basalt 40263 appears and continues on across section 8 to the large North and south bay on the west side of that section.

Oct. 6th.

Rained steadily all day. Was unable to do any work.

Oct. 7th.

It continued raining part of this forenoon , ceasing about 11.30 when I managed to get to work. Went up the bay of Brule Lake which projects north into sections 17 and 18, T. 63 R. 3. Both sides of the entrance to this bay there are exposures of fine grained dense b lack basalt like 40263 To the north of this comes then the
40264 redrock specimen 40264, which is exposed in large outcrops occurring on the steep slopes of the high hills which occur on both sides of the bay. This redrock continues on north on both sides of this bay, and also north and on both sides of the lake lying to the north of this bay, and emptying by a stream into it. We approached

from this bay of Brule into this little lake and then continued on north up the stream which flows into the northernmost bay of this lake. We continued as far up the stream as to the point where a fair sized water fall occurs on a tributary stream flowing from the west into this. The waterfalls in a series of steps down the hill side of red rock. Ascended this hill very nearly to the crest following along side the stream and then turned going due north over this high hill of redrock to the steep cliff which marks its northern boundary. From the top of this cliff I get a splendid view to the north. At the foot of this cliff there is a small lake upon whose shores are exposed the same redrock over which I have been crossing. As far to the east and west as I can see there is a high ridge upon the cliffs of which one can see the bright red color of the redrock. The area underlain by this redrock exhibits wherever seen these strong topographic features. To the north of this I can see for a considerable distance an area of irregular topography but several hundred feet lower than the area underlain by the redrock.

To the north of this comes the characteristic topography of the animikie sediments with intruded sills. Descending this cliff I continue north around the west side of the lake but remaining well upon the hills. At a point about even with the north shore of this lake I find a dark colored coarse grained rock represented by
40265 specimen 40265, which is much darker colored than the normal redrock. It has a great deal of black hornblende in it. This redrock continues to the north for about 200 paces when the normal gabbro begins. This presumably underlies the low area above referred to and continues on to the north up to the animikie sediments. In this gabbro I noted two narrow dikes of fine grained redrock. The zone underlain by rock like 40265 I consider a contact phase of the redrock on the gabbro. From the presence of the dikes of redrock in the gabbro it is clear that the redrock is the younger of the two. I could not notice however any marked diminution in grain of the redrock as I approached its contact line with the gabbro. The gabbro is coarse grained and of normal character as soon as the contact zone is

passed.

Now turned and followed southwest along the contact zone for a short distance seeing nothing different. Then turned back and returned to the canoe and on back into camp. As the result of today's observations and those made on the 4th inst, and also judging from the evidence presented by Grant in the annual reports of the Minn. Survey, it seems to be clearly established that the relation of the redrock to the gabbro is that of an intrusive the redrock being younger than the gabbro and being found in dikes cutting it.

Oct. 8th.

Coasted the northwest shore of Brule Lake from camp to the river which is the western outlet of this lake. Along this shore there occur amygdaloidal rocks like 40260 and also a porphyritic rock similar to 40262. Portaged into the river and started down stream. At the portage the porphyritic amygdaloidal rock 40256 occurs. About 150 yards down the river I find upon the north shore of

the stream gabbro represented by
40266 40266 exposed. Got out at this exposure and went inland to try and get the relations of the gabbro and the adjacent amygdaloidal rocks. Going north I crossed about 100 paces of this gabbro. To the north of the last exposure there lies a depression now filled with water. Beyond this to the north lies the amygdaloidal lava like 40256. Turning I now followed the gabbro which trends about Northeast Southwest to the east and found that it narrowed quite rapidly. Within about 100 paces it has narrowed to a width of about 23 paces with amygdaloidal rocks on both sides of it. As the gabbro is followed still farther Northeast it is found to run down in a depression in which there is no exposure. At one place upon the south sidethe amygdaloidal lava is only about 12 inches distance from it. At no point was the basal contact between them observed. As the gabbro is followed to the east it was seen that as the width of the wedge diminished the grain of the gabbro correspondingly finer and the rock also became porphyritic. Where the

gabbro wedge was narrow and the amygd aloidal lavas occurred on both sides it was noticed that the rock got finer away from the center of the wedge showing the development of a
40267 saalband. Specimen 40267 shows a rather fine grained porphyritic ophitic phase of the dolerite. At one place not far from the contact of this dolerite with the amygdaloidal lava, it was found to be cut by a narrow two inch dike of redrock.
40268 Specimen 40268 shows the two rocks in contact. Followed out to the west this gabbro is found to widen and across the river upon a point similar gabbro was observed. This point is separated by another body of water on the west from the main gabbro mass. Without question this gabbro wedge above described is but a wedge shaped offshoot projecting northeast from the main gabbro and partly surrounded by the amygdaloidal lavas. The relations indicate that it is intrusive of these lavas. Moreover the increasing fineness of the rock from the center toward the edges is further evidence of its intrusive character.

Elfman has indicated upon his map (Amer. Geologist, Vol.22, Pl.7) certain basic dikes known as his "Later Diabase member" which are younger than the redrock of northeastern Minnesota. This mapping of Elfman is certainly correct to a certain extent, as my own observations have shown. One might possibly be inclined to place the wedge of gabbro grading into dolerite above described with this later dikes. It must be remembered however that the presence of the redrock dike in this basic mass clearly shows the relations of these two rocks. There seems to be no escape from the conclusion that this wedge is a continuation of the main gabbro mass and of younger age than the lavas which partially surround it. Continuing west down the river after passing the tabbro wedge we pass an area underlaid by the amygdaloids and then another gabbro which , but for a small area on the northeast side where these amygdaloidal rocks occur, completely surrounds Lake Georgia. Have portaged into Surveyor's lke from Lake Georgia. Gabbro occurs along the portage and

part way around the southeast shore of Surveyor's Lake. Just before reaching the extreme end of the southeasternmost bay there begins a
40269. very fine grained basalt, 40269, which in places is amygdaloidal. This basalt was found to continue across to Lake Georgia where it appears at several places upon the shore of the northeast bay as above stated. On the west shore of this southeastern most bay of Surveyor's Lake, just opposite a small rocky island, there is a dike 3 feet in width of fine grained redrock with a trend about north and south, which cuts the basalt 40269. I went inland following this basalt across the land to Lake Georgia. At one place in a depression I found an exposure of a rock varying from fine basalt to medium grained dolerite with the basalt like 40269 occurring both to t the north and south of it. No contact was observed. I could not connect this with the main mass of the gabbro which lies only a short distance to the west, but it seems highly probable that it is an offshoot from this mass. I attempted to follow the contact between the

basalt like 40269 and the main gabbro mass, but was unable to get absolute contacts there on account of the intervening depression, or else because everything between was covered with soil. I was able to get them within about 10 paces of each other, and found the gabbro then fairly fine grained in fact almost a basalt. Indeed all along the side next the amygdaloidal lava 40269 the gabbro is decidedly finer grained than it is farther away from this. This would seem to indicate that the gabbro was intrusive in the amygdaloidal rocks and tends to confirm my view with reference to the gabbro wedge above described.

Another interpretation of the gradation from the gabbro into a finer grained rock and the occurrence then of the amygdaloidal lavas adjacent to is is possible, but it does not seem to me to be probable. This interpretation would be that the amygdaloidal lavas are the surface flows directly connected with and grading into the gabbro by an intermediate fine grained facies of the gabbro which has already been mentioned.

A serious objection to this view would be that the gabbro changes apparently at one place into an amygdaloidal like 40256 and at another into a rock like 40269. This objection would be hard to overcome unless the said amygdaloids proved to be essentially the same rock and chemically and essentially similar in composition to the gabbro.

The normal coarse grained gabbro occupies the southwest shore and Surveyor's lake. At the west side of this lake there is a long east and west trending bay about 150 yards in width and into the west end of which the portage from Found lake enters. This bay seems to run along the contact between the gabbro on the south
40270 and the redrock 40270 which forms the north shore of this bay. I followed along the gabbro hills hunting for intrusive dikes of the redrock in the gabbro, but was able to find only one such. This occurs on the hill just to the south of the west end of the bay. Upon this hill I found a very large gabbro boulder cut through by a 3 inch dike of fine grained red rock. This block does not seem to be in place. It occurs on the south edge

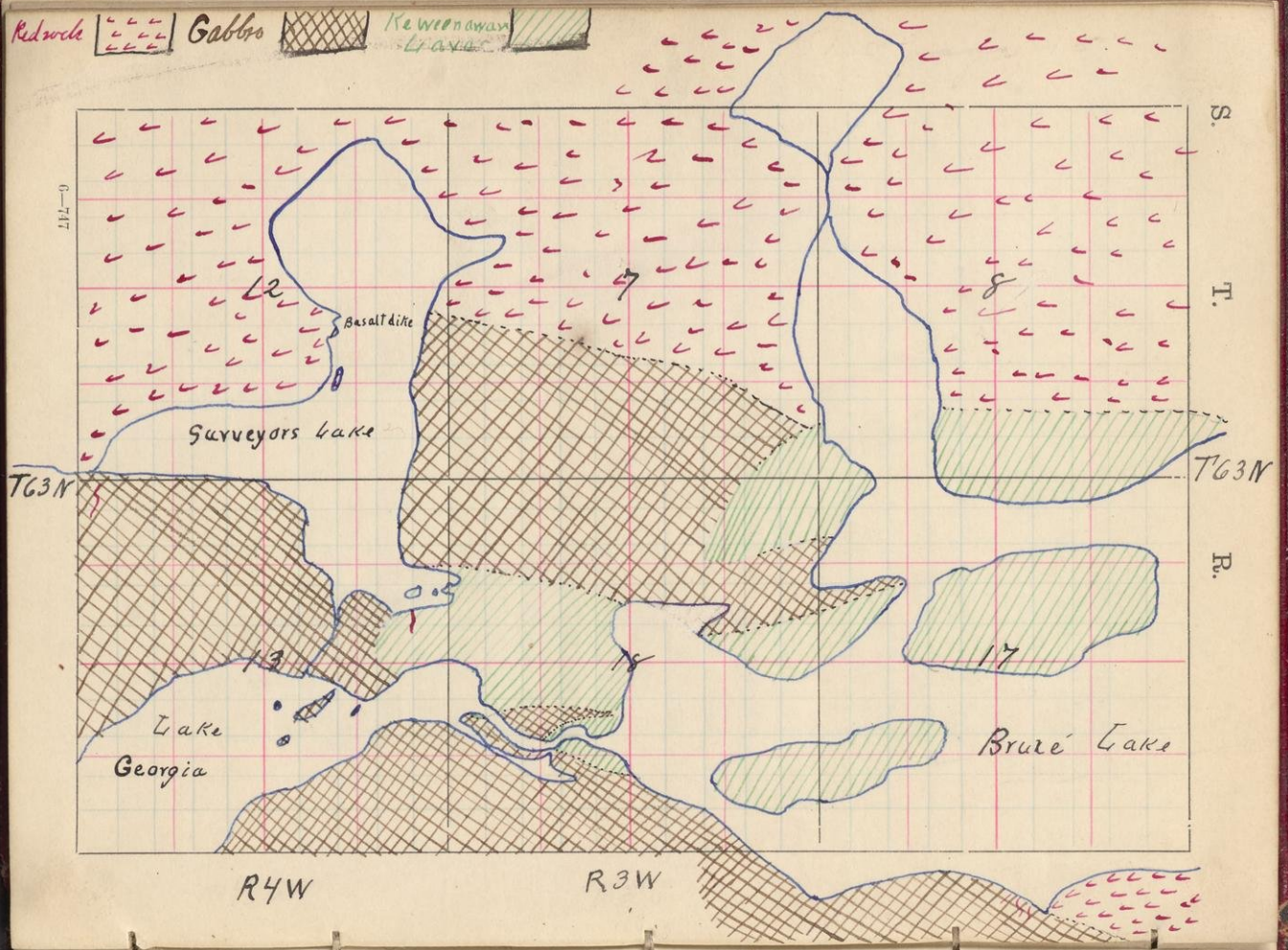
of the redrock area but whether the block is one of disintegration or an erratic from the northern border of the redrock area is immaterial. It still shows clearly the relations between these two rocks. This is confirmation of the facts already seen and described by myself in previous pages, and also those mentioned by Grant which all tend to show that the redrock is intrusive in , therefore younger than, the gabbro.

I now coast back to the east following along the north shore of this bay upon which only redrock is exposed. On the first point on the west shore of Surveyor Lake north of the island on the north side of the mouth of this bay, I find an 8 inche dike of basalt cutting the redrock. Eric Ericson, my canoeman, reports that redrock occurs in high hills east of the east end og Long Island (Kiskadinna Lake), also coming down to the shore. He says he has either there seen cutting this redrock on the hillside sloping down to the lake a narrow band 4 inches in width of black rock. Moreover this band comes down to the lake. He followed it thinking it was

black iron (magnetite) as he says. Evidently this is another dike of basalt cutting the redrock.

The redrock continues on up the west wide of this northernmost bay of Surveyor's lake, and was also seen upon the east side of the stream entering this bay. Just to the north of the mouth of this stream a contact of the red rock with the black dolerite was seen. Only a very small area about 1 foot in length of this contact was exposed by digging with a rotten log. I could not be absolutely sure that the dolerite grew finer grained toward the redrock, although such seemed to me to be the case. The redrock occurs on the north side of Surveyor Lake, and upon the islands in this lake. At one place upon the north side of one of these islands near the north end XXX a thin mass of dolerite lies against the redrock. This is presumably a remnant of a dolerite dike. The redrock continues part way down the east side of the lake and then the gabbro begins and continues on down to the southeasternmost bay where the tongue of amygdaloiadal rock like 40269 occurs.

I now returned to Brule By way


Redrock
Gabbro
Keweenawan Lavas
S.
T.
R.
12
Basalt dike
Surveyors Lake
7
8
T63N
T63N
13
18
17
Lake Georgia
Brulé Lake
R4W
R3W

No Page 15.

of Lake Georgia, and the river, and coasted along the southwest side of Brule over that portion of the shore which I had not yet touched. Near the outlet amygdaloidal rock occurs along the shore but bacl of it lies the gabbro which is finer grained near the amygdaloids. Continuing east along the shore the gabbro is exposed up to a point about south of the east end of the first small island near the south shore of the lake about up to the place where the north and south section line between sections 19 and 20, T. 63, R. 3, touches the lake shore. Here the fine grained gabbro with the coarser grained phase farther inland is cut by ramifying dikes of redrock. To the east along the shore as shown by previous work, the redrock comes in in full force just across a small bay which marks the contact between the main mass of gabbro and the main mass of redrock. The map opposite gives in a rough way the climits of the various kinds of rocks observed on the west end of Brule. From the facts observed and noted above, it seems to me that the following conclusions are warranted

concerning the relations of the amygdaloidal lavas the gabbro and the redrock. The oldest rocks around the lake at the west end of the lake are the amygdaloidal lavas. They were intruded by the gabbro which at least in one place has shown by my studies has sent a tongue of gabbro into the amygdaloids, this tongue getting finer garined away from the gabbro and also along its sides both as it is followed away from the main mass of gabbro and as one goes from the center towards its sides. Since the intrustion of the gabbro the redrock has been erupted and is now found cutting through the amygdaloidal lavas and also the gabbro. No attempt has been made to trace out the gabbro beyond the immediate vicinity of the west end of the lake. Presumably, however, the portion now occurring north west of Brule lake originally connected with the main mass of the gabbro from which it is now separated by the hills of redrock. The redrock in some places followed approximately XX along the contact between the amygdaloidal lavas and the gabbro, that being presumably the line of least resistance. Near the

west end of the lake it gradually left this line of contact and from there on has a trend more slightly to the north of west. Upon the south side of the lake the redrock also followed the line of contact between the amygdaloids and the gabbro but it there runs out to a wedge shaped mass which finally disappears as it is followed to the west.

It is somewhat difficult to explain the presence of the amygdaloidal lavas so far inland and so widely separated from the main mass of the Keweenawan lavas which occur to the south along the lake shore. Presumably this mass which is in reality of relatively limited extent represents a great mass included in and bodily uplifted by the gabbro mass. It is presumed to lie upon this gabbro. The lavas are not sufficiently well bedded to enable one to distinguish with any certainty the various flows and still less to determine the dip of these flows. I am strongly inclined to think, however, that the general structure is a synclinal one and that Brule is essentially a structural lake lying in a syncline of lavas.

This synclinal structure has been emphasized by the fact that the lavas more readily alter than the surrounding gabbro, and redrock, so that erosion has still further emphasized the basic character of the Brule area by removing the lavas leaving the prominent hills of gabbro and red rock surrounding it.

Oct. 9th.

It rained last evening just as I got in from work, and this morning there was a heavy fog. Having finished the work on Brule Lake I broke camp and started east along the shore of the lake en route for Grand Portage, about 75 miles distant. Going north from Brule over the regular route we pass redrock which is exposed along the portage trails and on the small lakes. At the north end of Sham lake (see Gunflint lake, plate, Geology of Minnesota, plate 82) gabbro comes in just north of the redrock. This continues to be exposed on along the south shore of Winchell lake the large lake immediately north of Sham lake. This gabbro weathers somewhat reddish and

is very coarse grained. This reddish weathering may be due to the fact that it has been affected by the contact of the redrock and that there is here produced an orthoclase gabbro similar to that described by Irving and which from studies made this summer upon Lake Superior appears to be the result of contact action of the acid redrock upon the basic gabbro.

No relations were seen between the gabbro and the redrock but it is known elsewhere that the redrock cuts the gabbro and is presumed also to cut it here. We go east through Winchell lake to the portage on the north side at the east end. This gabbro continues to be exposed across this portage and also through Gaskanas Lake (Since the last few years this lake has been known as Johnson's Lake after the man who has done some diamond drill exploring through this country). Gabbro continues on through North Brule and through Caribou Lake. Camped at the end of the portage on the north side of Caribou lake at 5.15.

S. T. R.

View looking NE. from about midway Rose or Mud Lake, Minn.
Shows topography of "Saw-tooth" mountains.

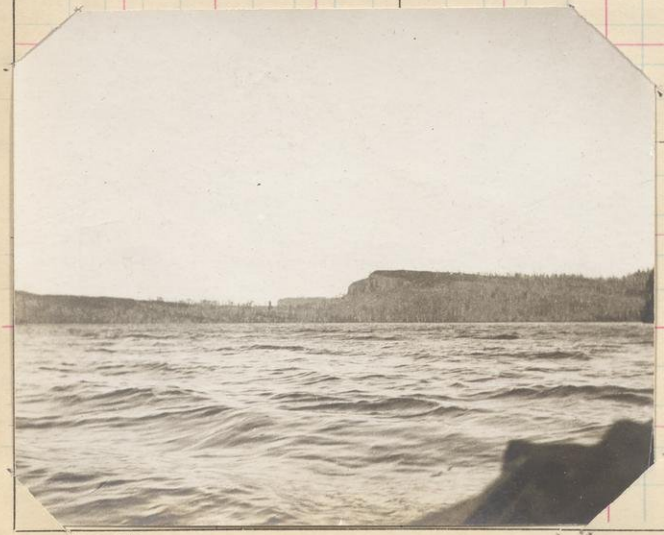
No. of negative:

Oct. 10th.

Have clear weather this morning with a favorable West Southwest wind. Moved through Poplar Lake and a small lake north of that, both of these lying in the gabbro area. We then crossed the grand Marais road which is here impassable for wagons and entered a small lake and went northeast through this into Hungry Jack Lake. Since crossing the Grand Marais the topography is that of the animikie and there are in several places exposures of dolerite similar to that forming the sills around Gunflint. I see no slates exposed however. From Hungry Jack we go north to Birch Lake thence northwest through this into Duncan Lake and northeast through this by way of Stair portage into Rose or Mud lake. The stream from Duncan Lake empties into Rose lake by a series of very broad falls. The portage is known as Stair portage on account of its very precipitous character. Went east through Rose Lake thence over the great new portage about 1 1/2 miles long of good traveling though it passes up alongside of high hill formed by a sill of animikie, and thence over drift

S. T. R.

Looking east from west end of Rove Lake Oct 1900 Photographing of Saw Tooth Hills



East end of Rove Lake International Boundary Oct. 1900

deposit to the east end of Rove Lake. Camped on the south shore of this lake just around the point in front of the end of the portage.

Oct. 11th.

We start early this morning, and the day promises to be a pretty one. Go through Rove lake and then across the portage into Mountain lake. In Mountain lake got some magnificent trout fishing. From Mountain we pass through the series of small lakes known as Upper Lily and Lower Lilly lakes, with the intervening portages, and then into the large lake known as Moose Lake. From there we pass by Portage into North Fowl Lake. Formerly this lake had large rice beds in it, and was the favorite resort of the ducks some of which we anticipated getting this year. Smith & Alger are now logging on the Canadian side, and have placed a dam at the foot of South Fowl Lake which raises the water in both of these lakes, and has flooded all the rice beds. Throughout the day we have been passing very nearly parallel along the faces of some great dolerite sills intrusive in the animikie slates. These sills occur

S. T. R.

Looking west down Mountain Lake. International Boundary.
Oct. 1900.

East End of Mountain Lake
Oct. 1900.

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on the south sides of the lakes mentioned, with precipitous cliffs facing north. The scenery has been very pretty.

Oct. 12th.

We left camp this morning at sunrise, paddled in a dense fog across North Fowl Lake, and tried to follow the river connecting that with South Fowl lake. The water has been raised so high however that we simply went across country and got into South Fowl Lake. From the south side of this we made a long portage of nearly 2 miles into Pigeon River, down which we went. The canoeing on Pigeon River was very good on account of the extremely high water. There were three small portages between Fowl Portage and the end of the Grand Portage. Just after the first one the river is full of rapids although not dangerous ones on account of the high water. We were somewhat surprised to get into these, however, but fortunately managed to go through without accident, with our loaded canoe. ~~Pigeon~~ Partridge Falls is caused by

S. T. R.

Partridge Falls from south side of River

the river flowing over a sill of dolerite which cuts through the animikie slates. Below the Pigeon Falls, the river runs between banks of drift. Grand Portage was reached sometime after noon. The end of the Portage at the river is an insignificant little path very nearly overgrown by hawthorne bushes. Just below it down the river a short distance there is another falls, the roar of which could be heard as we got out at the portage. At the Pigeon River end of Grand Portage we ate the last of the food which we had, consisting of a slice of bread apiece a can of tongue and half a fish, and then loading up set out for the village of Grand Portage. The portage for about the first mile is merely a narrow trail. From there on to Grand Portage it has been cut out to the width of a wagon road. At the time I went through no wagons had been over this but it had been cut out for use by Smith & Alger who were expecting to get supplies in to one of their camps over this road during the winter. The trail is very well laid out, and follows an easy course to the lake

S. T. R.

Partridge Falls from South Bank of Pigeon River

shore. We reached the lake shore in about four hours, having been walking for 3 1/4 hours and with 3/4 of an hour of rest taken in 10 minute spells. From Grand Portage we were ferried to Grand Portage island where we were compelled to stay until the noon of the 14th, when we caught the steamer "Bonami," for Duluth, which port we reached next morning about 4.00 AM.

S. T. R.

Gorge below Partridge Falls

The following four photos on pp 27 & 28 are taken from the Grand Portage trail. They show the topography, caused chiefly by great dolerite sills.

October 22.

I visited with Leith and Merriam the slates on the west end of Soudan Hill, which were seen by Van Hise and Leith some weeks previously. This Van Hise was inclined to interpret as slates below the ore and jaspers of Soudan Hill. At one place there occur several small exposures of black graphitic slate, Specimen
40271 40271. This could not be brought closer than 20-25 paces to the jasper. As no bedding planes could be observed in the slate it was impossible to get their strike and dip, and to state positively whether they dipped under the jasper or not. To the south of this slate there occurs a sediment like Specimen 40273. This looks very much like ~~the~~ sheared porphyry which could be traced to within about 8 feet of the jasper. ~~This porphyry is very similar to 40275, to which reference will be made later on.~~ Immediately next to the jasper there lies a paint rock which appears to me but a ferruginous facies of the sediment like 40275 40273 which looks like the sheared porphyry. The schistosity of all of these rocks, the black characteristic slate included, dipped nearly under the jasper, but in no instance was I able to determine accurately the true bedding. Coming down the hill away

S. T. R.

from the characteristic slates, we pass over alternations of sediments of coarser and finer grain. All of these are very much altered. We continued on down to the dump from the old mine located near the end of the railroad spur, and collected specimens from it to illustrate the various phases of the sediments which lie to the south of the jasper, and were cut through in sinking this shaft.

40272 Specimen 40272 represents a conglomeratic facies of this sediment. Some of these specimens show pebbles whic h are presumed to be of quartz porphyry. No. 40028 is a specimen taken from this dump last ~~night~~ season. This should

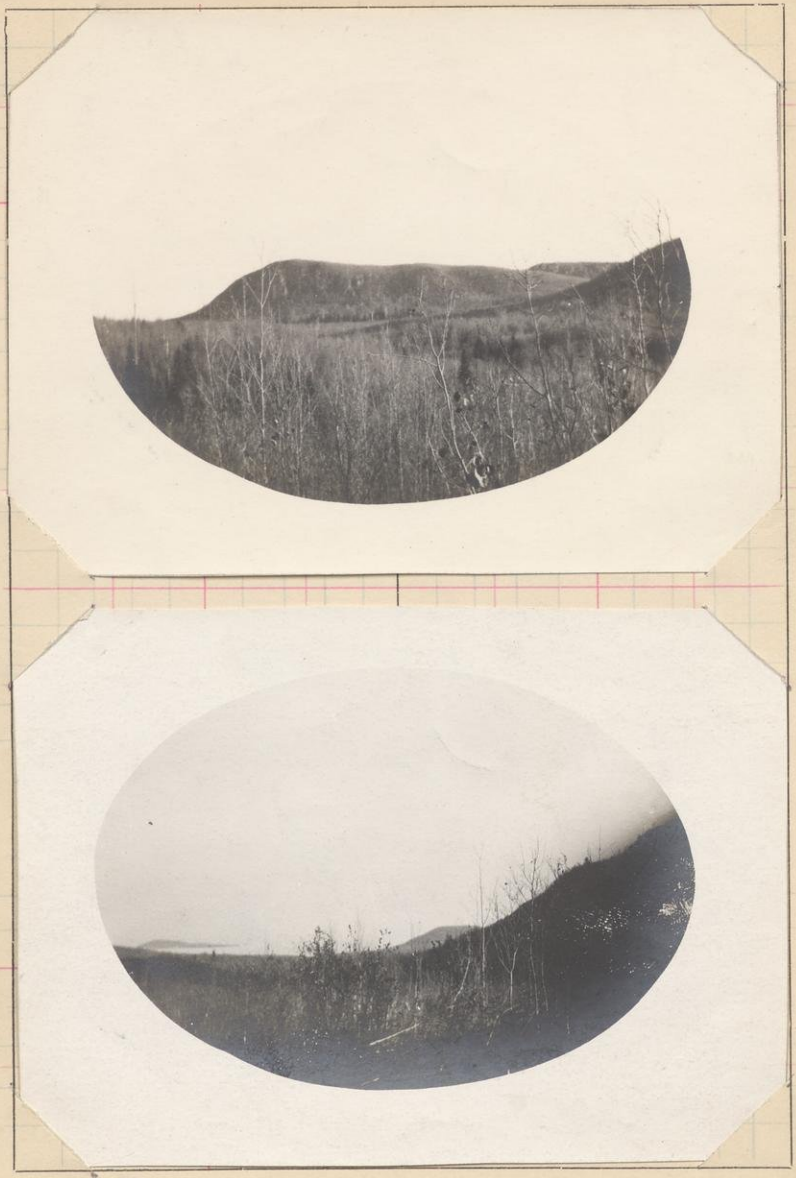
40272 be compared with 40272. Specimen

40273 40273 is a finer grained grey wacke-like phase of the sediments, and is connected with and grades up into a

40274 rock, 40274, which is very nearly a quartzite. It will be noted upon examination of this specimen that very fine parallel lines along which iron oxide have been infiltrated occurred in this sediment. May not the infiltration of the iron here be indicative of the way in which the more jasper like bands in the slates in the railroad cut just south of this dump are formed? Such rocks are represented by Specimens 40299-301. This is followed in turn by a still

40275 finer slaty phase, 40275, which is discolored by iron and in places contains

S. T. R.



enough iron to become a paint rock.

The exposures of the sediments above referred to as occurring upon the southwest side of Soudan Hill near the jasper are very poor, and the relations are by no means satisfactorily shown. It is perfectly possible that the black slate may be below, or at any rate associated with, the jaspers. This could not be conclusively shown, however. The coarser grained sericitic grey wacke, which so closely resembles sheared porphyry, the conglomerates, etc., south of the slate and jasper, are certainly not older than the jasper. These can be traced to the east along the south flank of Soudan Hill, and are there found to lie to the south of the main mass of the iron bearing formation. Just at the west end of Soudan Hill we are near the line of contact between the iron formation and the overlying sediments, and as a result of this and of irregular erosion we find the sediments wrapping around the jaspers, and in places the relations might be interpreted as those of interbanding., for instance upon the small hill just west of the railroad cut west of the warehouse of the Minnesota Company. Here a small amount of mining has been done in an isolated knob of jasper. This knob of jasper is almost completely surrounded by overlying sediments which are well

S. T. R.

Grand Portage from Grand Portage Island.

Mt. Josephine. Grand Portage Bay. Lake Superior. N.E. corner of Minnesota.

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exposed in the railway cut.

After examining the west end of Soudan Hill returned to Tower. In the railway cut on the Tower branch of the D. & I. R. Railroad, I noted two basic dikes, the largest 18 inches in width, cutting through the rock of the cut. Spec. 40276.

40276

Now visited the conglomerates and grey wacke exposures which occur at the west end of Lee Hill, immediately to the north of the westernmost houses of the town. These sediments lie almost as a thin film upon the iron formation. The entire series of rocks have been very closely folded, and since this folding erosion has truncated them. As a consequence the sediments in many places seem to be infolded with the jasper, the bands of sediments lying parallel with the bands in the jasper. The relations, however, are very distinct. Moreover, a difference in the degree of folding can be noted. The jaspers, which would be more correctly called black cherts, are very much contorted, whereas the associated sediments possess, for the most part, straight banding, with very slight and almost no flexures. The iron formation here has a somewhat different character from that ordinarily observed. With the black jasper there are alternating interbedded

S. T. R.

Spit on Grand Portage Island, with Bay and village of Grand Portage in back-ground.

Grand Portage village looking up the creek.

6—747

40 62 : In the compound above the

bands of material which appears to have been originally quite siderític.. As a result of weathering the siderite has to a very great extent been removed, and instead of the massive jaspers having been formed we get very friable sandy brown colored rocks. Such friable rocks are represented by specimens 40277-80. At one place a black graphitic slate was found alternating with black, somewhat slaty jasper. This slate is shown in Specimen 40281. The presence of this graphitic slate associated with the jasper at this place shows clearly that during the time when the iron formation was being deposited there was occasionally at least the formation ~~or deposit~~ of clastic material. The band of slate here observed is very small, but its presence is of importance as proving the occurrence of clastic material. If we get these thin bands there is no reason why at favorable localities there should not have been formed much greater masses of similar material, although at the present time we do not know positively of such an occurrence in the Vermilion district. The sediments above referred to as being so intimately associated with the iron formation are clearly younger than it is, for we find in them

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40282: See the conglomerate above the jasper that has fine pebbles of a black slate 40282 which seems to be identical with that occurring intermingled with the jasper.

fragments of the black graphitic slate which can be identified with the slate associated with the jaspers, and also fragments of the jasper itself.

Caught the freight to Ely and reached there in time to visit, accompanied by Leith and Rohn, the iron bearing formation exposed south of Ely in Sections 3 and 4. Here the jasper is associated with very finely banded rocks. The green stone lies both to the north and south of these banded rocks.

40283 Specimen 40283, taken from the N.W. quarter of Section 3, shows the normal black jasper and the slaty bands associated with it.

40284 Specimens 40284-6 represent the
40285 bands which show the gradations from
40286 the sediments into the cherty or jaspery bands.

40287 Specimens 40287-92 show the various
40288 bands which occur associated with
40289 the jaspers. The rocks represented
40290 by Specimens 40289-91 especially
40291 are almost without question of
40292 clastic origin. Specimen 40292 represents a fine conglomeratic phase of the fragmentals. With the above rocks there are conglomeratic phases with pebbles, some of which reach 3 inches in diameter. These pebbles, so far as seen, were all of green stone, varying from the dense kinds to those which were

amygdaloidal. The conglomerates are interbedded with the finer sediments. The jaspers occur associated with the fine sediments, and are separated by the fine sediments from the conglomeratic phases. The greater portion of the banded rocks occurring with the greenstone in this vicinity are believed to be of sedimentary origin, but with these greenstones and sediments there are other banded rocks which I believe are schists derived by shearing from the ellipsoidal and amygdaloidal lavas. In several instances a gradual passage from the ellipsoidal lava through forms of lava which have been very much sheared, over into the banded schists can be followed, making the relations clear beyond doubt. The general relations here seem to be ~~of the~~ as follow~~ing~~: Relatively thin bands of sediments about 25 paces across strike east and west, and are interbedded with lava flows. The exposures in this vicinity are very good; still they are not sufficiently numerous to enable one to trace out the different beds in the greenstones, and there still remains some question as to whether these sediments are actually interbedded with the greenstones or infolded. The relations existing above may well be the re-

sult of either mode of occurrence. Presumably the iron formation here exposed is of the same age as that occurring in much larger quantity ~~nearly~~ in the vicinity of Ely and at other places in the green stone. These sediments certainly do not bear any strong resemblance to those which occur in large quantity farther east, and are younger than the iron bearing series and the associated greenstones.

Upon the bare hills in Sections 3 and 4, south of Ely, beautiful examples of igneous rocks cutting each other can be seen. Numbers of acid dikes, derived without doubt from the white iron granite which lies immediately to the south, were observed cutting both the greenstones and the sediments and jaspers.

40293 Specimen 40293 shows the character of the white iron granite. As the border ~~barrier~~ of white iron granite is approached, the dikes or offshoots from it, become more numerous, and with this approach to the granite the metamorphosed condition of the green stones increases. By passing from greenstones in the vicinity of Ely southward to the border of the white iron granite, one passes ~~away~~ from the greenstones, ~~the normal approach~~, ~~through~~ to those rocks which approach more and more closely the

hornblende mica schists of the region, which have been interpreted as being metamorphosed forms of these greenstones.

The white iron granite is not the youngest rock in the region, however, as is shown by the fact that it is cut through by dikes of red aplite,
40294 Specimen 40294. Such dikes may be seen south of Ely and were also noted upon a previous occasion in the exposures along the railway south of Embarrass.

The dikes of white iron granite found cutting through the greenstones and sediments were found to have been cut through in several instances by still younger dikes of dolerite, from which specimens having been taken during the field season of '97, none were taken upon the present occasion.

Returned this morning to Tower, and taking a rowboat, rowed up to the bay north of Birch Point, and outlined the east side of the granite which occurs there. This granite,
40295 Specimen 40295, forms a large boss at the northwest end of this bay. (See Winchell's Map, Vol.4, Minn. Natural History and Geological Survey). This granite is a medium, rather even grained rock, and is very similar to the granite south of Embarrass (compare Leith's specimens) and the White Iron granite. This same granite also occurs upon the island south of Birch Point, and upon that Point also in one small exposure. Upon this Point it is about 200 yards distant from an exposure of the sediments. In the bay north of Birch Point where the large boss of granite first referred to occurs, the granite is found to include and to cut through the grey wackes and slates which are so well developed in the Vermilion Lake Basin. Contact of the boss with the sediments, as well as dikes of the granite in the sediments, proves conclusively the relations existing between the granite and the sediments. Especially near the contact of the sediments with the large mass of granite the sediments are altered, the schistose form of which is rep-

40296 resented in Specimen 40296. Shearing has in some cases produced very marked schistosity in some of the softer bands lying between the more resistant ones.

40297 Specimen 40297 shows such a band between harder ones, and shows the gradation from the non-schistose to the schistose rock.

40298 Specimen 40298 was taken from the sediments somewhat farther away from the granite than were the specimens just given above, and is apparently somewhat less metamorphosed. In noting strikes upon the sediments it was found that near the boss the bands are contorted and the strike varied very much, but farther away from it they became more normal and strike approximately east and west.

Spent the day in checking up at various places the 4 inch Tower map. Studied again the slates northwest of the warehouse north of the Minnesota Company's office, which Van Hise had considered to be jaspery. These cannot be classed with the jaspery rocks of the iron bearing formation proper, but are, in my opinion, the very siliceous phases of the slates which have in places been discolored by iron.

40299 Specimens 40299-301 represent several
40300 facies of these slates which are
40301 interbedded with the grey wackes like 40273 (grey wacke or sheared porphyry--?). I took also a specimen of the characteristic slate,
40302 40302, which is interbedded with these sediments and is very similar to that occurring north of here quite near to the jasper, and which was studied some days ago and from which Specimen 40271 was taken.

I learned in Tower that the Pike River Land Company, owning the following property: S.1/2 S.W.1/4, Sec. 5; S.E.1/4 S.E.1/4, Sec.6; N.E.1/4 N.E.1/4 Sec.8, all in Tp.60--15, have done some drilling upon their property, and are represented to have found jasper and ore. I saw the officers of the company, but they had kept no records and were unable to

give me any definite information.

Presumably if jasper and ore were found it must have been in very small quantity. I would not, however, be at all surprised to find that the greenstone formation had a certain development in that portion of the district in which the land above mentioned is situated. The most of that portion of the district is covered by great muskegs, and where these are absent the heavy drift covers the most of the country rock.

40303 Specimen of siderite rock given me by Robin? Location unknown!

Ely

Returned to ~~Tower~~ last evening and spent today visiting the mines and getting some additional information concerning them. The new shaft of the Savoy, of the Oliver Mining Company, is located 205 feet north of the quarter line and 375 feet east, location given from the 16th corner upon the quarter line west of the center of the section. They began sinking the shaft November, 1899. The following is the log of the shaft as well as I could determine it from the dump and from what the mining captain told me: 20 feet of surface; 200 feet of greenstone, Specimen
40304 40304; 100 feet in various sediments, slates and grey wackes, more or less
40305 carbonaceous, Specimens 40305-8;
40306 90 feet in rock represented by
40307 Specimen 40309, with which is asso-
40308 ciated the sediments similar to those
40309 just above. The shaft is bottomed in these sediments. The mining captain could tell me nothing concerning the dip in the sediments, and the walls of the shaft were covered so that it was impossible to get any information myself. As well as I can interpret the occurrence of the rocks it seems that the greenstone represents the foot wall of the iron formation, and dips, according to determinations made in the Savoy mine, 75°-85° south. The slates

which the new shaft passed through below the greenstone probably represent the sediments stratigraphically overlying the greenstone, but which have an abnormal position under it as the result of an overturn. This overturn we know exists in this region, from underground operations, as indicated by the change in the dip of the ore formation from north, at the west end of the Ely trough, to south, at the east end, in the vicinity of the

40309 Savoy. The rock 40309 is a quartz porphyry which is intrusive in these upper sediments. The presence of this dike in the sediments at the east end of the trough is of very great economic significance. Since we find it intrusive in the sediments, similar dikes must have also intruded the greenstones, iron formation older than the sediments, and may have had a very important bearing upon the formation of the ore deposits. At the Savoy the ore is very much brecciated, especially at the east end of the ore body.

40310 Specimen 40310 represents this brecciated ore.

40311 Specimen 40311 represents the brecciated greenstone or paint rock. The two, the ore and the greenstone, are in places mixed, though as in the above instance we find them also occasionally free from intermixture.

This brecciated material is cemented by haematite and by siderite.

According to the report of the mining captain a drift has been run from the last level for 300 feet due east into the adjacent property, passing all the way through greenstone, no ore or indications of ore having been observed.

The Sibley is the new shaft of the Oliver Iron Mining Company, which is at present in process of sinking. This shaft is located 200 feet north of the iron formation. Its exact location is 650 feet north of the quarter post and 460 feet east of the above point, measured from the north and south section line. According to the mining captain in sinking the shaft the following rocks were passed through: 20 feet of surface; 200 feet of green rock, similar to that occurring in the Savoy (the Sibley green rock is
40312 40312); 140 feet of paint rock,
40313 represented by 40313-4; and 30 feet
40314 of greenstone in which the bottom of the shaft was when I was there.

The ores in the different mines along the Ely trough seemed to differ in respect to their hardness. For instance, the Savoy, the easternmost

mine, furnishes an ore which is more nearly like the hard Tower ore than any other mine on the range. The Sibley, which is west of the Savoy is somewhat softer than that obtained in the Savoy, and the Zenith, still farther west, appears to be more broken and somewhat softer. In all it should be noted that the ore is in reality in all cases a hard ore, but that the different degrees of softness, so-called by the mining men, is the result of different degress of brecciation and cementation, the ore in the easternmost mine, the Savoy, having been very much brecciated, as is that at the west end of the trough, but having been thoroughly cemented again, whereas that to the west is still thoroughly fractured, and can be, as a result, more readily mined.

Upon the Zenith dump a very much altered porphyritic ~~granite~~ greenstone, 40315 40315 is being thrown out as a result of the present work. As they are represented to be drifting north in this mine this greenstone must come in somewhere to the north of the greenstone lying to the south of the ore formation (the shaft is on the south side of the ore formation), and may be a dike in this. There appears to be something the matter with this mine as I am unable to get any information whatsoever from the engi-

neer or those in control of the operations.

The Pioneer Mining Co. (Oliver Mining Co.) is sinking a shaft, (new) "B". This is located 1105 feet north and 500 feet east of the south west corner of Section 27. The locations which have been given of the various shafts of the Oliver Mining Company were obtained from their engineer and are to be relied upon. In conversation with the engineer of the Pioneer I learned that a small anticline of greenstone comes up on the Ninth Level in the Pioneer mine.

This afternoon I worked in between the mines and the lake, mapping the two belts of jasper which occur near the lake shore north of the Chandler mine. No true clastics were found associated with these jaspers. Although a connection could not be made between the two small belts of jasper, their occurrence almost end on leads to the conclusion that they were originally connected. I judge that originally the eastern end of the western jasper belt bent down slightly to the south, and continuing to the east, joined on to the eastern belt, but that this original belt is now separated into the two as the result of erosion, which has removed the thin jasper and exposed the underlying greenstones.

I now went down to the lake and

studied the patch of slates which were mapped by Bailey some years ago. It was found necessary to change the location of these, as has been done upon the map. The slates are fairly well exposed along the shore. They occur almost as a thin skin upon the nearly perpendicular face of the greenstones, and have been so broken down by weathering that it was impossible to get the exact strike and dip. Presumably the strike coincides closely with the general trend of this greenstone face, which would make the strike somewhat north of east. I examined the exposures closely, trying to get the exact contact between the sediments and the underlying greenstones, but in no case was the absolutely exact contact to be found, although only a few inches separated them. In no case could I find a well developed conglomerate lying between the two kinds of rocks, that sediment nearest to the greenstone showing its normal characters. However, interbanded with the slates I found small bands of grey wacke, and in one place I noted a pebble, represented by Specimen 40316. A very finely conglomeratic phase of the slate is shown in 40317. Specimen 40318 shows the slate with a pebble, presumably of greenstone, in it, and 40319 shows the slate

slate/

the slate is/

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enclosing an unmistakable banded jasper pebble. The presence of this jasper in the slate gives conclusive proof as to the relative ages of the slates and the greenstones and jaspers. These last are undoubtedly older than the slates.

At one point upon the shore in contact with and lying to the north of the slate there occurs a rock whose character I could not satisfactorily determine, although I took it to be a grey wacke. This is shown in 40320.

b.
40320

The slates above referred to as occuring on the shore of Long Lake are without doubt connected with those at the Savoy, from which specmens were collected earlier in the day. Since as shown by the jasper pebble in the slates, the slates are younger than the jaspers, there can be no doubt now but that the Savoy slates, although at present lying below the greenstones and jaspers, are stratigraphically above them, their present position being due to an overturn which has thrown them below the greenstone.

40321 - This is a specimen of the banded Animikie sediments which occur in the first cut on the Duluth, Port Arthur & Western Railroad, west of the International boundary. Gunflint Mem.

40322 - Specimen of the same kinds of sediments taken 100 yards west of the above cut.

40323 - Actinolite-magnetite schist which with bands of iron ore forms the greater portion of the iron-bearing formation at the base of the Animikie. This specimen is from the southeast 1/4 of Sec.22, T. 65 N, R. 4 W.

40324 - Represents a band offine grained magnetite ore such as occurs associated with the above mentioned actinolite-magnetite schists in the lower portion of the Animikie. From S. E. 1/4 of Sec.22, T. 65 N., R. 4 W.

40325 - A somewhat coarser grained phase of the magnetite ore. From S. E 1/4 of Sec.22, T. 65 N., R. 4 W.