



Vermilion district of N.E. Minn.: [specimens]

40500-40540. No. 331 Summer of 1899

Leith, C. K. (Charles Kenneth), 1875-1956

[s.l.]: [s.n.], Summer of 1899

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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 $2 \times 2\frac{1}{2} \times \frac{1}{4}$ inches will be allowed, but in all other cases *large-sized specimens*, trimmed to a size of $3 \times 4 \times 1$ 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.

Summer 7 1899

Terrebonne district of N. Q. Minn.

C. K. Leith, Summer 7 1899.

Tim Fitzpatrick, Compassman

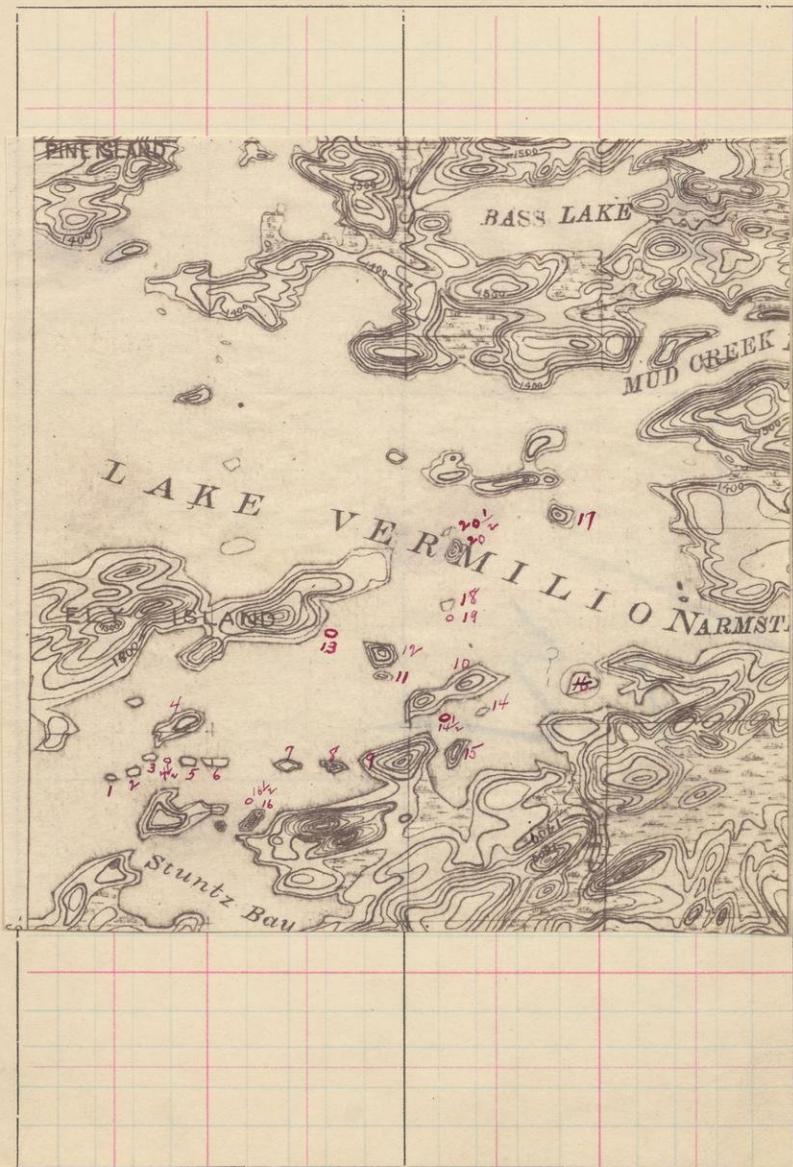
40500-40540

Notbook 378 331

S.

T.

R.



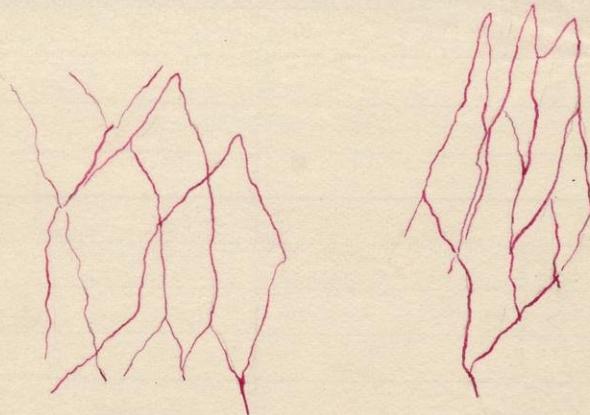
VERMILION DISTRICT. SUMMER OF 1899.

At various times during the summer, I visited the various islands and adjacent mainland in the S. E. part of Lake Vermilion, alone and with Dr. Clements, in an endeavor to discriminate the porphyry and the sediments there occurring. This was found to be an exceedingly difficult task, because of the remarkable similarity of the two at various places, and on different days different conclusions were reached concerning the rocks of certain of the areas. Therefore, instead of giving in detail each day's notes, I give below only the final conclusions reached by Dr. Clements and myself concerning the character of the rocks of the islands and mainland. The numbers of the islands below correspond to the numbers given on the topographical map opposite page !.....

Island No. 1. Most of the island is occupied by typical white-eyed porphyry with large quartzes and feldspars. The rock is very massive. On the N. shore is a narrow band of material which may be feldspar porphyry or graywacke. Clements thinks it is graywacke.

Island No. 2. Typical coarse conglomerate with jasper fragments, the pebbles ranging from those of small size to those two inches in diameter.

Island No. 3. Dense porphyry sheared into rough rhomboids and weathering like conglomerate. See complete description by Van Hise. At one place on the N. E. part of the island infiltration of iron along the cracks has made the directions of shearing particularly clear. The sketches below are accurate representations of these shearing lines.



The two sets of fractures making these rhomboid features vary from big joints down to minute rift planes.

S.

T.

R.

In the SW. corner of Island No 3 is a small
patch of gypsum,

However all belong to one of two systems, one of which strikes N. 15 E. and the other N. 80 W. Upon the S. side of this little island is an interbanded slate and iron formation very similar to that seen on the Burnt Forties. These rocks are here closely folded, and in places brecciated.

See Hartley

Island No. 4. Traversed the island from end to end. The rock is entirely sedimentary, mostly fine grained conglomerate but in places a coarse grit or graywacke. In places it might be mistaken for a porphyry. Where the conglomerate is fine grained or is sheared one sees the white eyes of quartz standing in a finer grained matrix, and perhaps, if he found it alone he would call it a porphyry, but on close examination the material may be seen to have fragments like its matrix much sheared, and from these there are all gradations into material with well defined pebbles. At one place at about the center of the island on the S. shore some of the rock was doubtful. In itself it looks like a porphyry and contains peculiar greenish fragments, 40500, but it cannot be sharply delimited from the conglomerate series, and may indeed be a part of it. If a slide shows the rock to be a true

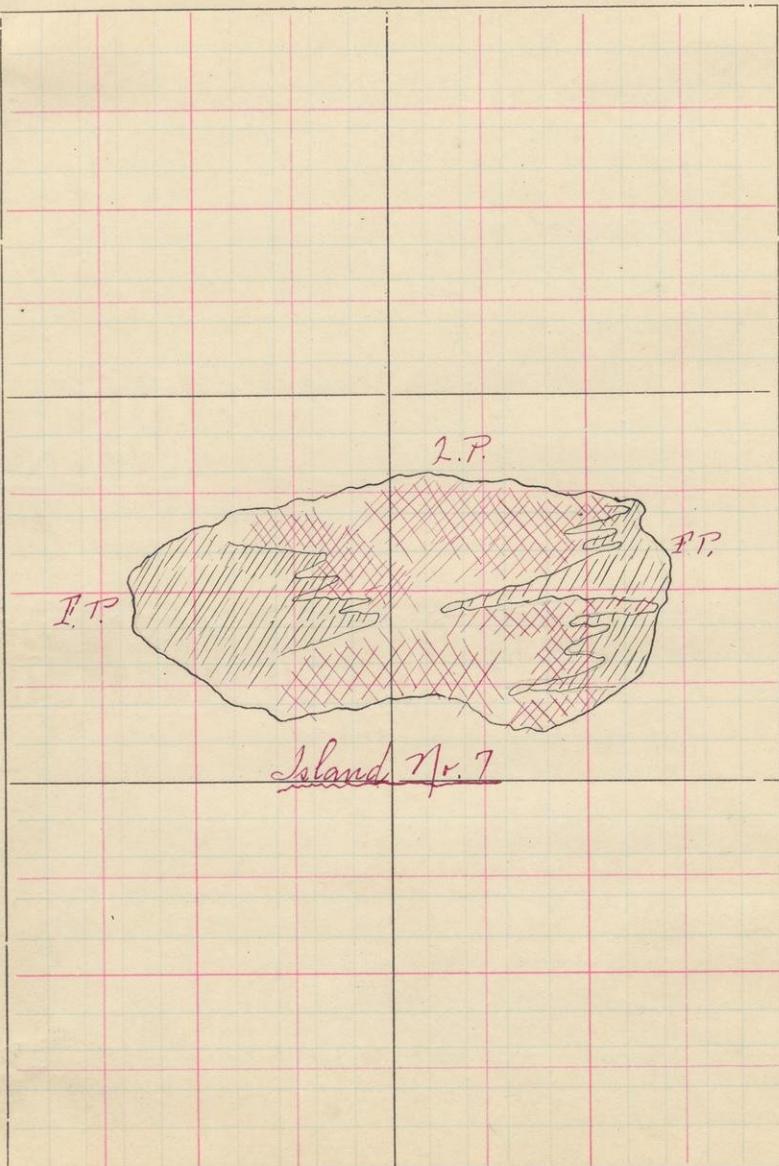
Q.F.P.

40500

S.

T.

R.



porphyry, we have here but a minute patch.

Island No. 4-1/2. Typical conglomerate.

Island No. 5. In the central and southern portions of the island the rock closely resembles the pseudo-conglomerate on island No. 3. However here a close search reveals a number of pebbles of varying character, showing that here the rock is a true conglomerate.

Island No. 6. Typical coarse conglomerate with large jasper fragments.

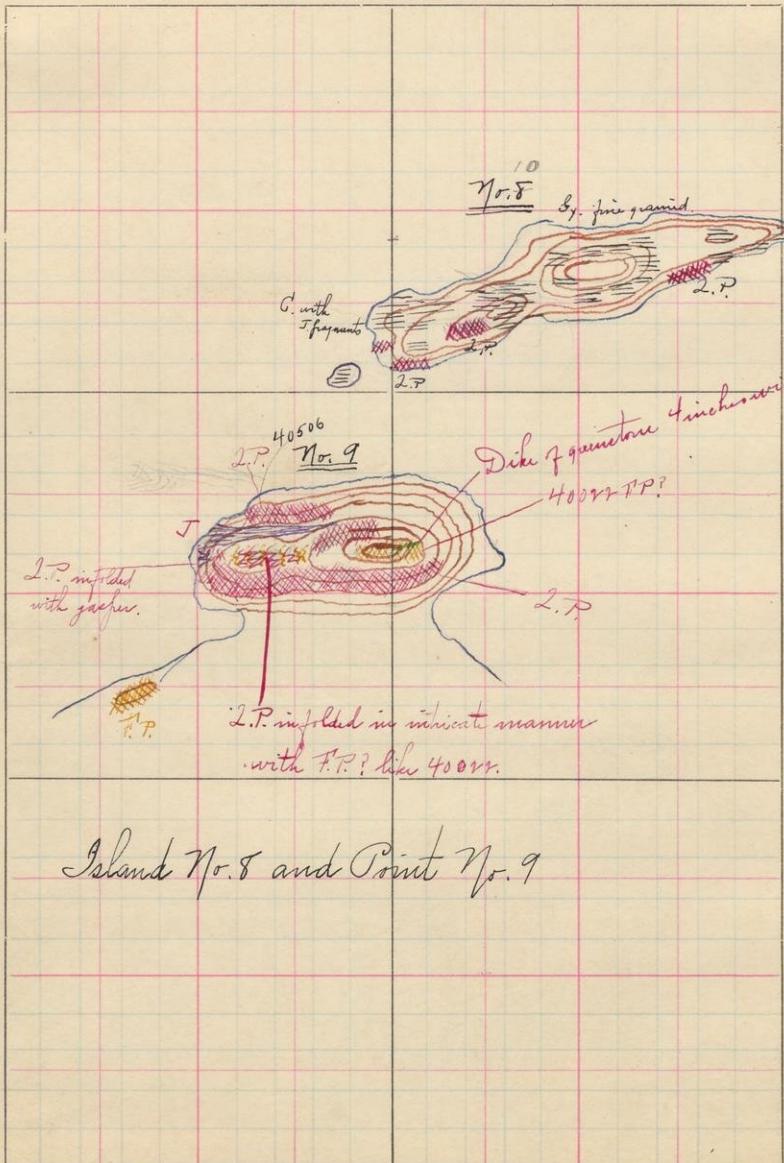
Island No. 7. Here we have an intricate infolding of two doubtful rocks which we think are true porphyries. One resembles very closely the feldspar porphyry and the other the quartz porphyry. Both of them contain the characteristic green inclusions of the porphyries. The only question in our minds is as to the possibility of the quartzose rock being a graywacke. 40022 (Clements) represents the quartzose material. 40023 (Clements) represents the feldspathic material. The following sketch shows roughly the distribution of these two

Opposite

S.

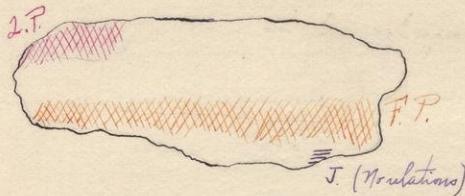
T.

R.



rocks, although in detail the relations are so intricate that it was not thought advisable to map them.

Island No. 8. This was found to be another intricate mixture of feldspar porphyry and quartz porphyry. The former predominating to the S. and the latter to the N. The exposures are poor and no relations between the two can be made out. On the S. E. shore is found a little patch of jasper about 15 paces broad.



Point No. 9 on S. shore.

The areal distribution of the rocks on this point is given on the opposite plat. The big eyed quartz porphyry occupies the major portion of the ridge. It runs all along the S. flank and N. flank. At the W. end of the hill at the top, the porphyry is intricately infolded with a fine grained rock which is similar to the feldspar porphyry, but which has lit-

tle quartzes in it. Sharp contacts can be seen. On the E. end of the hill also, this material occupies the central portion of the crest of the hill, with the typical big eyed porphyry on the N. and S. Clements has a specimen of this peculiar rock. The big eyed quartz porphyry is represented by specs. 40506 and 40501. I have taken another, 40500 (?).

40506 Q.P.
40501 Q.P.

At two places on the hill narrow greenstone dikes cut the conglomerate.

On a number of earlier visits, the peculiar material on the crest of the hill, and particularly at the E. end, was taken for a mashed sedimentary, but it is now thought probable that the slide will show the same to be a porphyry.

Island No. 10. Examined the island from end to end, Clements walking along one side and I the other. It was found to be almost entirely conglomerate and fine grained graywacke. On the S. shore, at a number of places are patches of typical white eyed porphyry, as indicated on the map opposite. In places, with the white quartzes, there are transparent

black quartzes as phenocrysts. At the S. W. end of the island, the conglomeratic characters are clear, but on the N. E. end and on the N. side in general the rock is very fine grained, and, except for very close observation, would be called a quartz porphyry. However, in places, it can be seen to grade directly into a fine grit which occasionally becomes rather coarse and contains jasper fragments.

Island No. 11. This island is occupied for the most part by the sedimentary series, slate, graywacke, and fine grained conglomerate, but on the N. side is found some of the porphyry. 40502 is a specimen of the

fw

40502

This is a specimen of the graywacke.

Island No. 12 is occupied almost entirely by a interbedded slate, graywacke and conglomerate series with the big eyed porphyry in two patches, one at the N. W. end of the island and the other at the N. E. end of the island.

Island No. 13. The center of the island is occupied by the fine grained

feldspar porphyry. On the S. side is an area of the sediments, fine grained graywacke, and novaculitic slate showing banding. This material occupies a belt about 5 paces wide, but it can be separated with great difficulty from the feldspar porphyry, which runs N. from it in continuous exposure. indeed, the line cannot be drawn sharply, but there is no question as to the determination of the main masses of the two rocks.

Island No. 14. Feldspar porphyry.

Island No. 14-1/2. Feldspar porphyry.

Island No. 15. No exposure.

S.

T.

R.

Island No 16 $\frac{1}{2}$. Completely covered
with the feldspar porphyry on No. 16

Island No. 16. Massive graywacke or feldspar porphyry with salmon colored weathering. Cutting through the center of the island in a S. E., N. W. direction is a dike of porphyry about 25 paces wide.

F.P.

40507

This is a specimen of the graywacke or feldspar porphyry.

Revisited the island October 3rd with Dr. Clements, and decided that the rock is a true feldspar porphyry. There can be little question of this. The quartz porphyry intrusive is the one with the small quartzes. It was followed all the way to the shore on both sides. Cutting the feldspar porphyry at two or three places are narrow dikes of basic rock running to the N. 70 W., one to the middle of the island and others to the E. end.

Inset
Island 16 1/2
Porphyry

Island No. 17. This is typical graywacke, slate, and conglomerate, with the exception of two patches of quartz porphyry, one on the S. E. corner, and the other two-thirds of the way down the W. side. Both patches are about 10 feet square and are flanked N. and S. by the sediments.

This island is about as Bayley mapped

it. However, I am inclined to think that some of the material, which he mapped as porphyry, is sedimentary. This would simply mean the slight shifting of the boundaries.

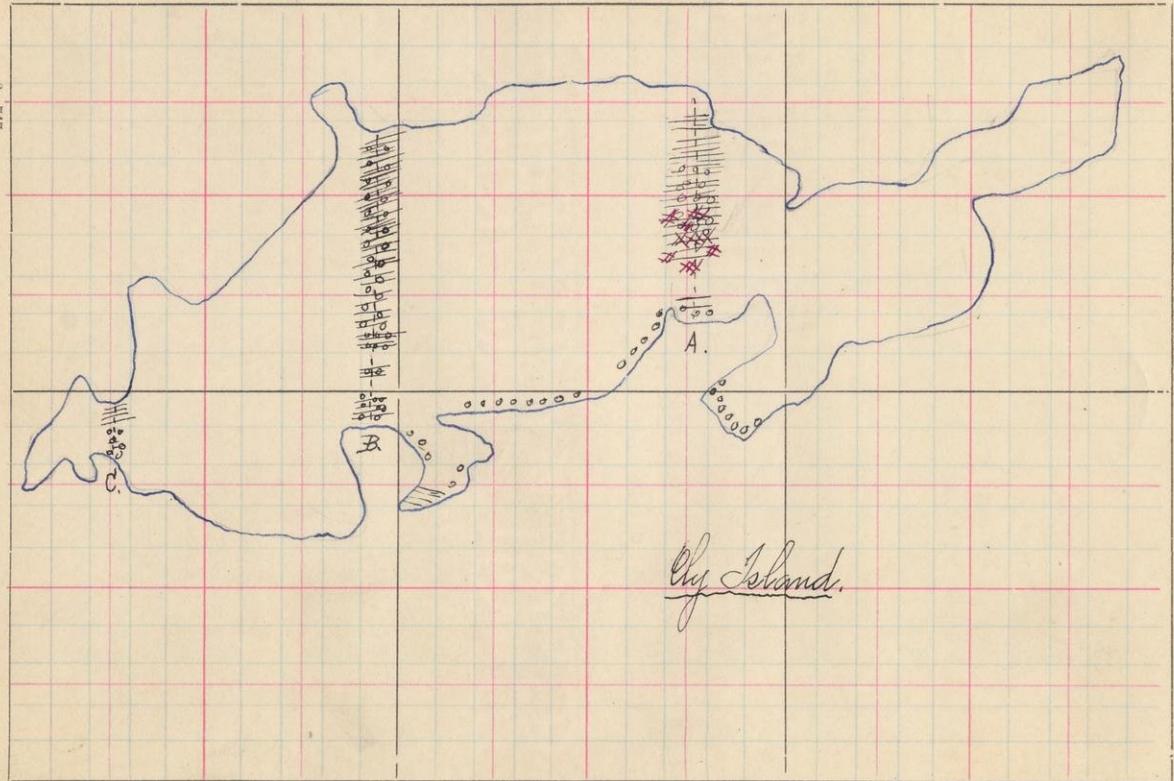
Island No. 18. Typical white eyed porphyry occupies the main mass of the island. On the S. shore is a narrow band of slate and graywacke. On the N. shore is a fine grained, dense, white rock, which Clements was inclined to call graywacke, but which could just as well be called a feldspar porphyry. It is like 40020. This white eyed porphyry runs up one-half inch in diameter. (*has quartz*)

Island No. 19 is a white fine grained rock with no quartz eyes, which I was inclined to call a graywacke, 40529; still there are no distinct sedimentary characters visible. Spec. 40020 of Clements.

Island No. 20. Banded slates, graywackes and conglomerates occupy all the shores. Some of the conglomerate contains large quartz eyes and, on hurried examination, would be like, perhaps, the big eyed porphyry. called

Min. Gr.
40529

6-747



S.

T.

R.

Oly Island.

Island No. 20-1/2. Typical gray-wacke slate and conglomerate, strike N. 70 E.

July 4th, - Ely Island.

The east end of the island was found to be occupied by an intricate mixture of sediments and porphyries. This part of the island was visited at the end of the season by Dr. Clements and myself, and a detailed, large scaled map was made of it. This detailed map and the notes of that day, found on a later page, will give a good idea of the geology of the eastern part of the island.

Skirting the south shore from the east to the west in the canoe, conglomerate was found to continue for the entire distance. Jasper fragments were found at a number of places.

Made section across Ely Island at the place marked A on the opposite plat, running from south to north. The main

mass of the rocks crossed is the graywacke-conglomerate series, but intricately mixed with this series are irregular areas of porphyry, both the white-eyed and feldspar. These areas were not mapped out in detail. Indeed, it would have been impossible to do so without spending a day or more on this one section. The location of the graywacke-porphyry complex is indicated on the opposite plat.

Skirting to the west along the shore, I landed at the point marked B on the opposite map, and made a section north across the island. At the shore, and for several paces inland, is the typical conglomerate.

At 300 north, the schist conglomerate

again appears in a small exposure.

At 500 N. from the shore, typical conglomerate appears, rather coarse grained and containing numerous jasper fragments. This continues in frequent exposure N. to the lake. However, it becomes steadily finer grained, being coarsest in the center of the island. The conglomerate is, in most ledges, very much sheared and the conglomeratic characters are not apparent., but close search will reveal fragments.

There is no question that the main mass at the W. end of the island is conglomerate. ~~Superior~~ ^{subordinate} quantities of porphyry may be present but these were not discovered.

Made another section across the western end of the island. See plat opposite page 11..... Running S. at the shore is typical banded slate and graywacke. The bed is distinctly N. and S. while the schistosity has the normal direction for the district, about N. 80° E. This is followed immediately to the S. by the schist conglomerate, which continues throughout to the S. shore in frequent ex-

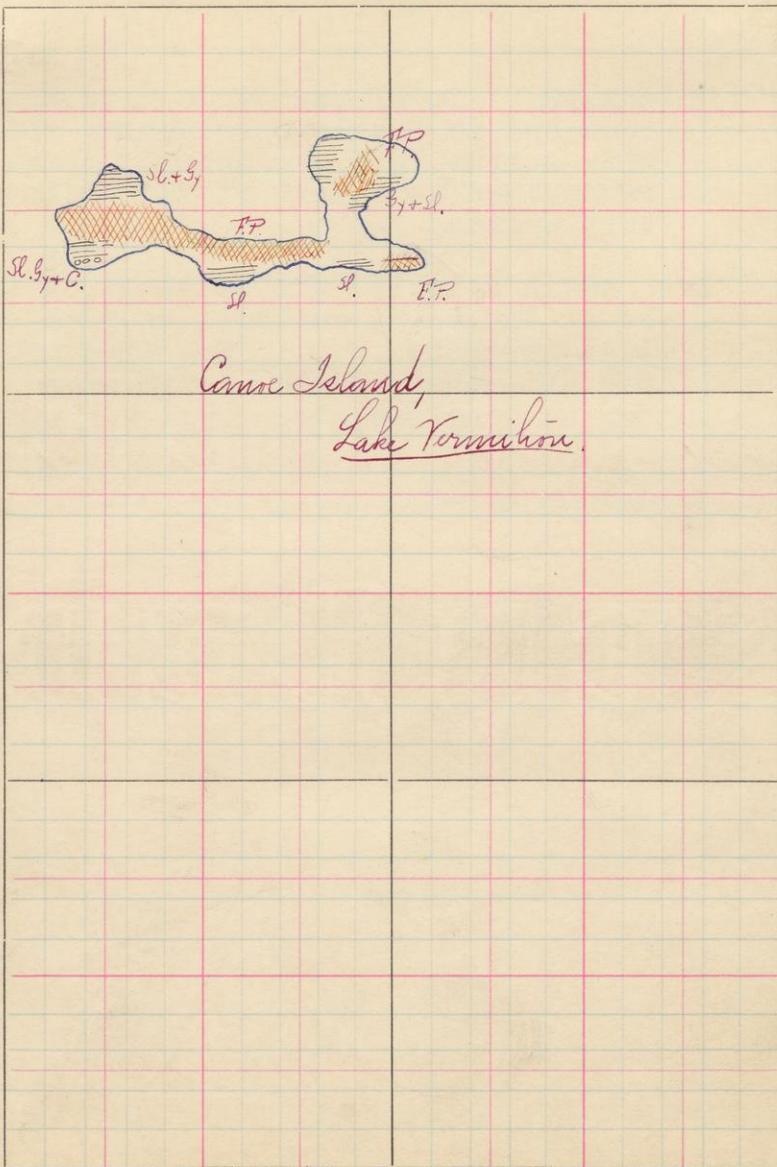
posure. In places it is very schistose and is little more than a sericite schist, and everywhere it can be recognized as a part of the sedimentary series.

Again skirting the S. shore, I landed at the point marked A on plat on page opposite and examined the big hill there found. The same is schist conglomerate.

S.

T.

R.



Canoe Island,
Lake Vermilion.

July 5th.

Visited Canoe island on Lake Vermilion and traversed it from end to end. See map on opposite page.

Both on the N. and S. of the island there are broad belts of undoubted banded slate and graywacke, with a uniform strike of N. 60° E. At the S. side of the island there is also a belt of undoubted conglomerate at the shore. However, forming the belt running through the center of the island is a white porphyry. This is very schistose and in places looks as if it might be conglomeratic, but of this I could find no certain evidence. I mapped the rock as porphyry although I would not be surprised if it were really a part of the sedimentary series. Both on the N. and S. near the W. end of the island, this porphyry can be found in sharp contact with the graywacke slate series. In both cases this contact is strikingly parallel to the bedding of the slates and graywackes, as would be the case if the rock were really a sediment, although infolding might possibly bring about the same relations. If the porphyry is intrusive, it has followed along the bedding with remarkable regularity considering the broad

breadth of the belt of porphyry. The porphyry contains numerous inclusions of green schist, which has elsewhere been found to be characteristic of the porphyry.

On the S. E. corner of the island at the place marked A is slate and graywacke in a narrow belt on the shore in sharp contact with material, which resembles the white porphyry, but which is here believed to be sedimentary.

At the very S. E. corner of the island is porphyry, very schistose and containing numerous greenish fragments. It contains no quartz eyes and would be called a feldspar porphyry, although I was not certain that it may not be a part of the sedimentary series. The porphyry for most of the island is the feldspar porphyry. although at about the center of the island at the place indicated, a small patch of the quartz porphyry is found.

Point A 17
Point A

Worked from the point just S. of Mud Creek bay. This point was visited at the close of the season by Dr. Clements and myself and a large scaled, detailed map was made of this area.

This work was much closer than that of the preliminary visits, so that these earlier fragmentary notes are not written. Only such as apply to specimen numbers will be given.

40?

28503

This is a specimen of the green-stone from the E. part of the point.

40?

28504

A piece of the granite fragment included in this greenstone. The green stone contains many pebbles of granite. The pebbles are well ~~round~~^{rounded} and do not resemble inclusions, although others are found which are slightly angular and more nearly resemble inclusions. Some of the fragments are 4 or 5 inches across. Also contained in this greenstone are fragments of jasper. These are, for the most part, very small and rare, but at one place a piece of jasper 2 feet across was found. This seems to be an undoubted inclusion.

F.P.?

40505

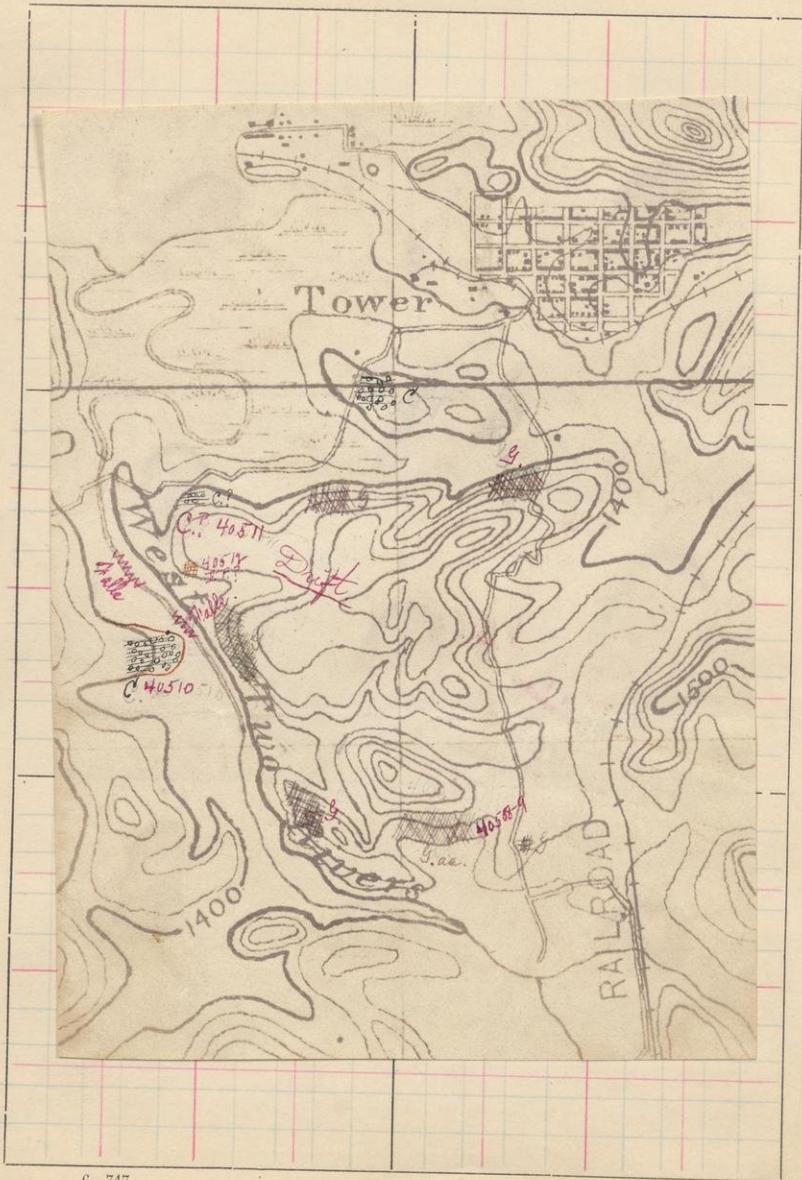
Feldspar porphyry (?) from the S. eastern part of point. See map.

A. 7/16. { Landed on the S. side with Clements on a later day and saw the banded sediments there. The white rock occupying the core of the island was visited, and was found to be the feldspar porphyry. The mapping is, therefore, correct.

S.

T.

R.



July 8th.

Took train on Duluth & Iron Range Railroad, and went S. of Tower junction to Two Rivers. From here, worked along the contact of the greenstone and sedimentary series to Two Rivers as far as the road, and then E. into Tower. At the S. the greenstone in places shows traces of this spheroidal structure. Here also are certain facies of the greenstone which look like tuff. Two specimens of this were taken, 40508 and 40509. This apparent tuff was found to continue rather uniformly along the southern margin.

40508
40509

40510

40512

The large hills are largely covered by drift and Norway timber but, on reaching the Falls about a quarter of a mile S. of the road, see map, a conglomerate, 40510, comes in W. of the river close to the Falls. On the E. side of the Falls is the massive greenstone.

A little farther N. along the E. side of the creek is a ledge of feldspar porphyry (?), 40512.

Reaching the road, ran E. to the town.

At 325 paces from the bridge along

C
40511

the road, on the S. side of the road,
is a ledge of schistose material which
I would call conglomerate, 40511.

At 825 paces E. along the road is
the massive greenstone.

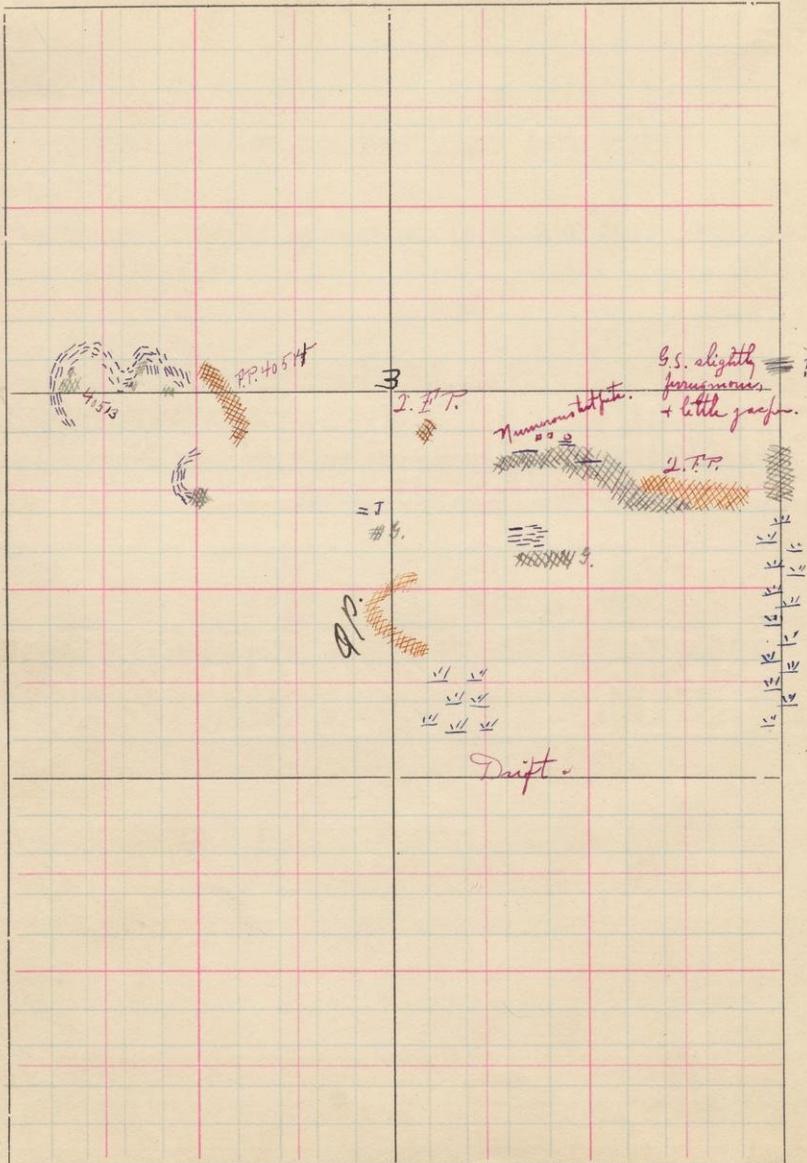
On the little hill just S. W. of
the town, see map opposite page,
is typical conglomerate containing
numerous fragments of feldspar rock
which may be a phase of the porphyry.
I saw no quartz in it. Jasper frag-
ments are also seen.

This ledge was visited again July
11th. See notes of that day.

S. 3

T. 61

R. 15



July 10th.

Went into the S. half of Secs. 3 and 2, S. E. of Tower junction, to trace out the jasper belts there occurring. I began at the trail near the W. quarter post of Sec. 3. The post was not found and the location was gotten by the compassman pacing from the N. W. corner.

At 100 E. of the quarter post begin a series of large exposures of jasper. The jasper apparently follows around the contour of the hill. It is found to be in a number of small rolls as indicated on the opposite map. Closely associated with the jasper are a number of patches of greenstone. The relations I was unable to make out. Greenstones of at least two different ages are present. The highest portion of the hill is composed of greenstone, altho a little jasper appears here also.

Mr. Cobham's

40513 This is a specimen here occurring. Certain of the greenstones contain fragments of the jasper.

Mount A

Q - P.

40514

From 375 paces to 500 paces E. along the ridge is the jasper: then appears a feldspar porphyry, 40514. This con-

40515 Not Collected.

tinues around the slope of the hill to about 600 E. 100 S. of the quarter post.

At 500 E. 225 - 265 S. is jasper on the W. flank of the hill striking to the N. and S. parallel with the slope. Test pitting has been done in this jasper. Here also greenstone may be seen, apparently cutting the jasper and enclosing fragments of it.

A

This series of ledges was visited on a later day with Van Hise and Merriam, see Van Hise's notes.

40516

The greenstone also contains fragments of a white-weathering granitic-rock, substantially composed almost entirely of feldspar. This is found at 500 E. 265 S.

The N. and S. $\frac{1}{4}$ line crosses the W. end of the hill, which is flanked by quartz $\frac{6}{6}$ feldspar porphyry, ~~and~~ the "white eyed" porphyry. This occurs from 500 to 600 S. This porphyry contains undoubted fragments of greenstone, and also one or two fragments of jasper were seen.

At 700 N. 1050 W. on the N. slope

of the long flat hill is a small ledge of jasper striking E. and W. and dipping slightly to the N.

All along this hill, which is composed mainly of drift, there are large pieces of jasper but this is the first I would call undoubted jasper though some of the others may be.

At 1350 E. 1350 S. of the N. W. corner of the section is jasper in a number of small exposures. The total width of the exposures N. and S. is 75 paces. On the N. the jasper is intricately mixed with greenstone. The strike, in general, is N. 75° W. but it is very much contorted.

Just N. across a little valley is another ridge of jasper and green schist in intricate relations. In this complex there has been large test pitting. Both the jasper and greenstone have been folded together. The general trend of the ridge is N. W., S. E. and it extends for 300 paces. At 1750 E. 250 S. to 300 S; - The greenstone continues this far E. - when on the N. side of it the massive white eyed porphyry appears as shown on the map. I followed the contact

E. and W. for 50 paces. The two rocks can be traced between 6 inches of each other but no actual contact is found. Each is very massive and contains no fragments of the others.

A little farther on, 1775 E., at the E. end of the ridge, the continuation of the greenstone is found as a narrow dike 4 feet wide cutting the porphyry. There can be no question as to the relations. At one place also the greenstone apparently contains large fragments of the porphyry, although this occurrence is obscure. The contact of the two rocks is very sharp. Near the contact the acid porphyry is red because of the introduction of iron from the basic rock.

The porphyry continues to the E. to the section line.

The line is struck at 2100 E.

At 750 N. 0 W. on the E. line of Sec. 3 is greenstone.

At 1060 N. is a test pit in ferruginous green schist. There may be here a small lens of jasper, but this does not appear in the rock exposed. A little jasper is thrown out on the dump.

July 11th.

Started at the western end of the little hill just E. of the road running S. W. from Tower. Worked the conglomerate there found, then followed along the N. face of the ridge S. of Tower to a point S. W. of Tower junction.

At the western end of the hill (see topographical map) is the large exposure of schistose conglomerate noted on a previous day. It contains jasper fragments and a great many of the white feldspar porphyry. These pebbles are peculiar in that they contain no quartz. Cutting the conglomerate are undoubted dikes of greenstone, and also of some acid rock now represented by an acid schist, 40517.

40517
*very schistous
 & with them
 on Sondan Hill.*

Some of the conglomerate is very ferruginous and simulates jasper. Immediately adjacent to the conglom-

erate, also, are numerous large masses of jasper but no true jasper is found in place~~s~~. Most of the hill is drift and, lying just S. of Tower hill, naturally would have large masses of the jasper.

Going E., the hills are of drift with numerous boulders of jasper until we reach the hill S. of the White Hotel S. of Tower, where the massive greenstone comes in, showing spheroidal forms.

The ridge was followed around to the S. of the bridge on the railway S. of the junction. The course was around the upper escarpment of the ridge. Nothing but greenstone was crossed.

July 12th.

Took trail at Tower junction and ran down the W. line of Secs. 3 and 10 into the center of Sec. 15, where the farmer's shanty stands: thence S. into the northern part of Sec. 22. The object of the run was to find the contact of the greenstone and the sedimentaries.

On the N. line of Sec. 22, an old shanty was found, which the compass-man located at 1200 W. of the E. line. From here we ran S. into 22 about 1200 paces where we find the beginning of the ~~entire~~ swamp. There is a trail for the ~~entire~~ distance from the junction, and it continues farther.

West Two Rivers is wrong on the map. We crossed the river just before reaching the quarter line. The farmer's shanty is on the quarter line and this lies S. of the river.

S. of the river no exposure is reached until we reach a point 1650 S., in Sec. 15. The country is heavily timbered and mostly drift covered. At this point we find a rock which looks like a sedimentary, 40518.

40519

Going farther on along the trail to

~~c H. S~~
 40519 1750 S., we find a rock, which has the
 40518 aspect of a hornblende-schist, 40519,
 although this may also be sedimentary.

Material like 40518 is followed in practically continuous exposure to the S. line of Sec. 15. S. of the line it is again found in frequent exposure, until a point 600 S. is reached.

Here is a typical greenstone conglomerate schist. On fresh fracture it might be called a hornblende-schist, but on weathered surface its conglomerate character plainly appears. The fragments are well banded and some of them are as large as 12 ^{tiny} inches in diameter.

At 800 steps S. specimens were collected to show the character of the rock, 40520, 40521 and 40522. They, however, do not give the typical conglomeratic aspect of the flat, weathered surface.

No exposure was found S. of here. We reached the swamp at 1200 S. and did not go farther.

Returning, we again looked out for

greenstone near this sedimentary rock but no undoubted greenstone was found along the trail until the S. half of Sec. 3 is reached, where the typical spheroidal greenstone comes in.

July 14th.

With Clements went on steamer to the outlet of Vermilion lake and then S. to the narrows. From here worked along the N. shore back as far as Pine island.

The object of the trip was to study the contact of the granite and hornblende schist, and the relations of the hornblende schist to the green schist of Pine island.

M.S.

40523

sel.

This is a specimen of the hornblende schist taken from the N. shore of Vermilion lake a little E. of the W. line of Sec. 32.

The granite has typical intrusive relations with the green schist and many dikes are found over a white ~~wide~~ zone near the contact, so that it would be hard to draw the exact line of demarkation. Dikes of granite are seen to cut straight across the hornblende schist and, where there are large masses of the granite, they frequently contain masses of the hornblende schist. On the other hand, the green schist never contains masses of the granite.

In skirting along the shore it is not possible to sketch the contact. For almost the entire distance, the granite and green schist are both seen. The lake shore boundary seems to be approximately the boundary.

H.S.
40524

From the N. side of the little point in the S. half of Sec. 33 T. 63. R. 16. This follows down the shore for some distance, striking parallel with the hornblende schist on the N. shore and is, I think, a green schist. In it there is a banding similar to that of the hornblende schist.

July 17th.

In the morning, visited the Burnt Forties and examined them again with many interesting results.

Starting in at the first large hill S. of the lake, I took up the porphyry belt there found just S. of the jasper and traced it to the E. On the second knob there is a contact of two porphyries. Here, at last, we have found the basement porphyry, which has furnished so many fragments to the conglomerate. The contact is a sharp one and can be easily followed for 100 yards. There is a marked difference in the weathering of the two porphyries, and the one which weathers smoothly has much the largest eyes of quartz. The other porphyry is more schistose. The more schistose porphyry, that is, the later porphyry, contains a large number of fragments of green schist. The earlier one contains absolutely none so far as I could see.

OP.

40525
40526

These are specimens of the older porphyry.

Closely associated with the older porphyry, at a number of places, are belts of jasper and greenstone close-

ly intermingled. These cannot be traced out in detail, but their general occurrence is indicated on the map. Their area is small. These jasper belts are infolded with the older porphyry but the younger one is not interrupted by them. This continues straight along without any break.

The relations of the older porphyry, the jasper, and the green schist, are hard to decipher but the jasper seems to be undoubtedly intruded by the porphyry. The green schist does not occur as fragments in the porphyry and may perhaps be younger than it. The succession would then be jasper, porphyry, green schist, conglomerate, later porphyry, and green schist, again.

Q.F.P.
40526

Taking the belt of younger porphyry I followed it W. along the S. slope of the hill. Here it apparently grades into what we have heretofore called the feldspar porphyry, 40526, which has a slightly greenish tinge, although in most places quartz also may be seen. This gradation is of interest as showing the relations between the two porphyries. Throughout, the porphyry contains numerous

fragments of green schist ranging from those of minute size up to those several feet across. Also, on the S. slope, several undoubted dikes of greenstone are found cutting the porphyry. There are, therefore, unquestionably two greenstones, one younger than the later porphyry, and one older.

Going S. through the conglomerate belt I here found the later feldspar porphyry intruding the conglomerate. Narrow basic dikes also cut this conglomerate. Examining the conglomerate closely, I found at several points small fragments of green schist. These are small but have unquestionable character, and show conclusively that there must have been a greenstone older than the conglomerate.

Just before reaching the conglomerate, going S., I passed a patch of intricately folded jasper, green schist, and porphyry, which is indicated on the map. It is impossible to map these irregular patches in detail without spending a day on a few square yards. The green schist here shows apparently intrusive relations with the jasper, containing large and

small fragments in the greatest abundance. From this exposure alone I would say that there could be absolutely no question as to the intrusive relations of the green schist in the jasper, but examining the exposure on a later day, in view of the facts discovered in other parts of the region, it was concluded that the intricate relation here shown, while simulating intrusive relations to a remarkable degree, might be really a case of close infolding. At one place, near the E. end of the first hill S. of the lake, the older porphyry is seen to partially include small jasper fragments about 12 inches long. About this jasper is a zone about 6 inches wide of porphyry, which has been made green by the introduction of iron from the jasper. With those, we have here in this zone the unusual sight of a greenstone with large quartz phenocrysts. The sketch below shows the relations.

24.

The morning's work has shown that
(1) There are two porphyries, one
older, one younger, than one of the
green schist. These are found in
actual contact. They can be dis-
tinguished by the lack of greenstone
fragments in the one and by the
weathering.

(2) There are two green schists,
one younger than the oldest porphyry,
and one younger than the latest por-
phyry and the conglomerate. The
first may possibly be the one which is
found intrusive in the jasper. In
this case the jasper and the porphyry
are the oldest rocks. This is shown
by the fact that the younger porphyry
contains fragments of the one green-
stone and is intruded by dikes of
another.

(3) The later quartz porphyry and
the so-called feldspar porphyry are
found to grade into each other and
are, therefore, of practically the
same age.

S.

T.

R.





July 19.

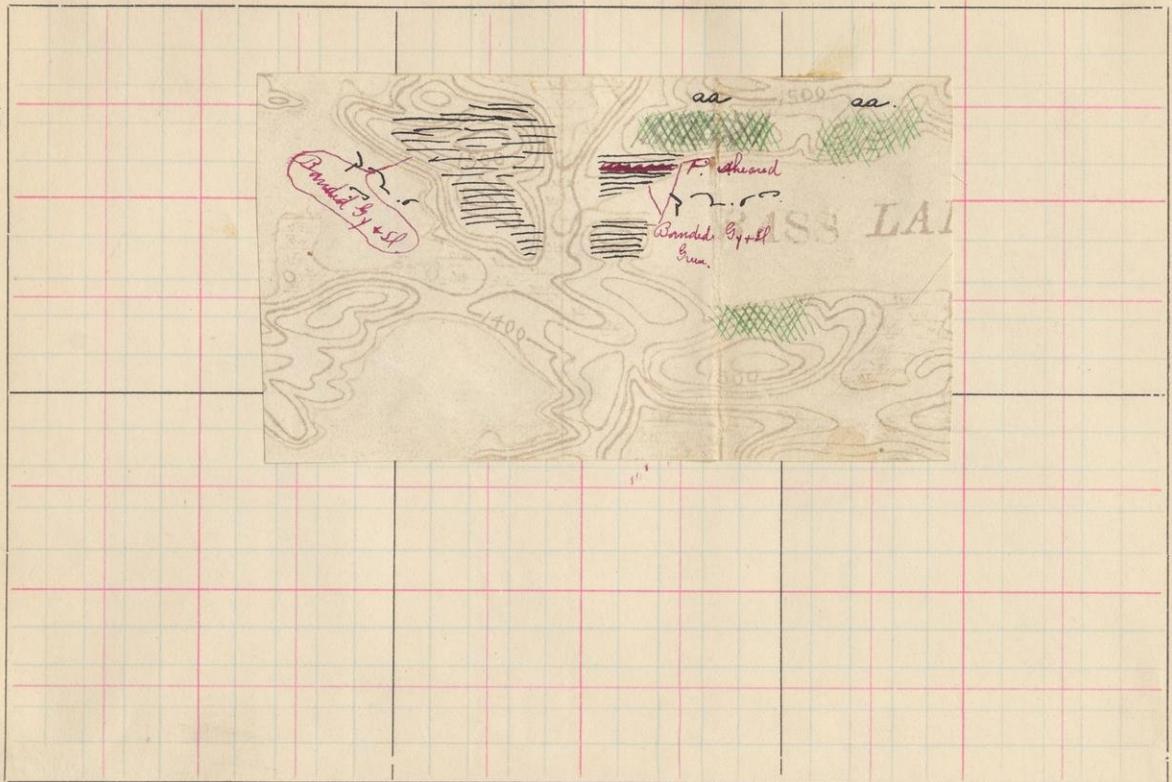
With Bebbs' topographic map sketched in the geology of the Burnt Forties. The completed map is found opposite page ³⁶..... The coloring was done in the field.

40527 Conglomerate showing greenstone fragments from the top of the conglomerate knob in the Burnt Forties about 300 paces E. of the line. Here are any number of greenstone fragments ranging from those of minute size to those two or three inches across.

The big greenstone mass in the center of the area is perfectly massive on the surface, although really schistose when broken, and shows no spheroidal forms. I take this to be the same as the rock which intrudes the porphyry a little to the W.

40528 Material at the point at the shore. The quartz eyes are not large nor abundant, and the material has many protuberances which might be sheared pebbles. However, the rock is so uniform throughout that I believe it should go with the porphyries, although a slide may show it to be a sediment.

6-747



S.

T.

R.

July 22nd.

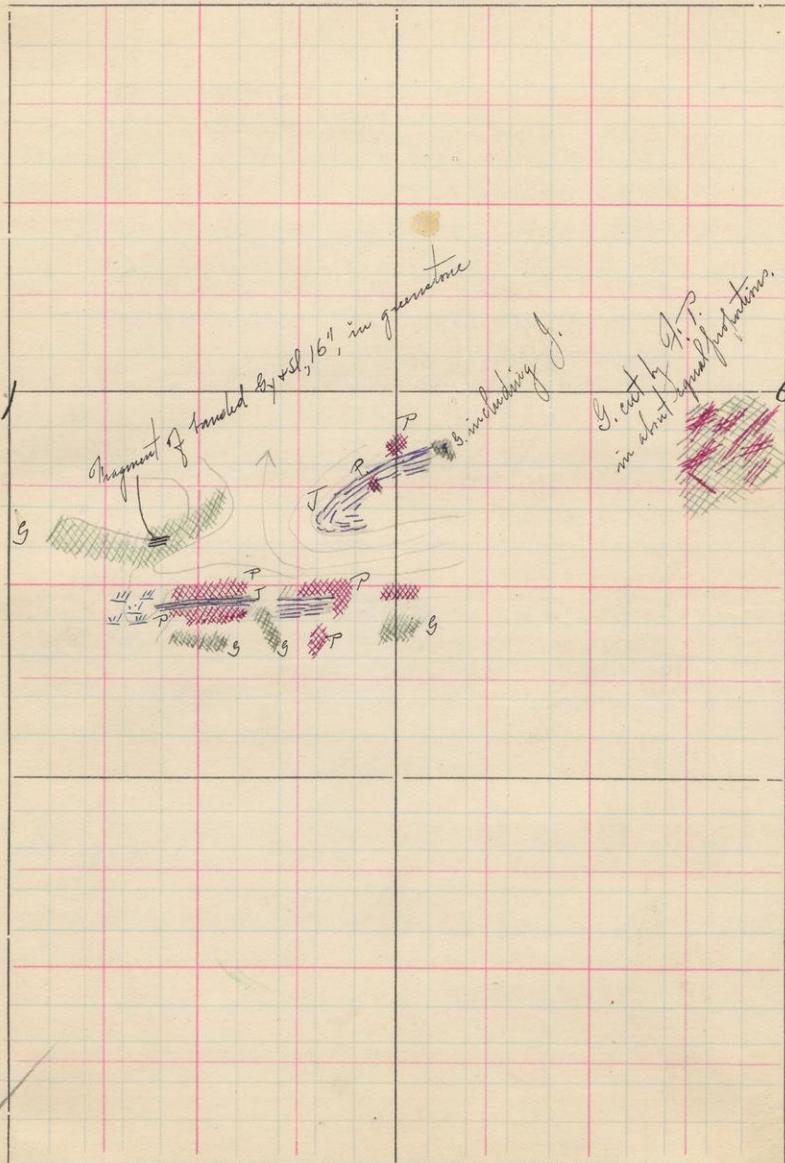
In the afternoon visited Little Bass lake N. of Mud Creek bay and examined the sedimentaries at the W. end of the lake. They are found to be banded graywackes and slates with a decided green tinge occupying the low ground on the N. shore, with the spheroidal greenstone forming the high bluffs behind them. To the W. they are found to form the entire big hill so far as rock is exposed here. See topographic map. Going back, the sediments are found to compose the small knob running out into the lake, from the S. shore at the W. end of the lake. These were called greenstones in a previous year but the banded character can be seen on the surface. On fresh fracture I would call the rock a greenstone, so close is the resemblance.

Mixed in with the graywacke and slate on the N. shore is a much sheared acid rock, which, on close examination, turns out to be a quartz-feldspar porphyry. The feldspar is greatly in preponderance.

S.

T. 62

R. 14



Sunday, July 23rd.

Traced out jasper belts in Secs. 1, 6 and 5, north of Mud Creek Bay. Starting in at the bay, on the east section line of Sec 1, I ran north for something over 500 paces, to the complex of jasper, greenstone, and porphyry. The location is indicated on the general topographic sketch map opposite p. 39.~~40~~ At this point the exposures were looked over with some care, and the results are indicated on the large scale plat on the opposite page.

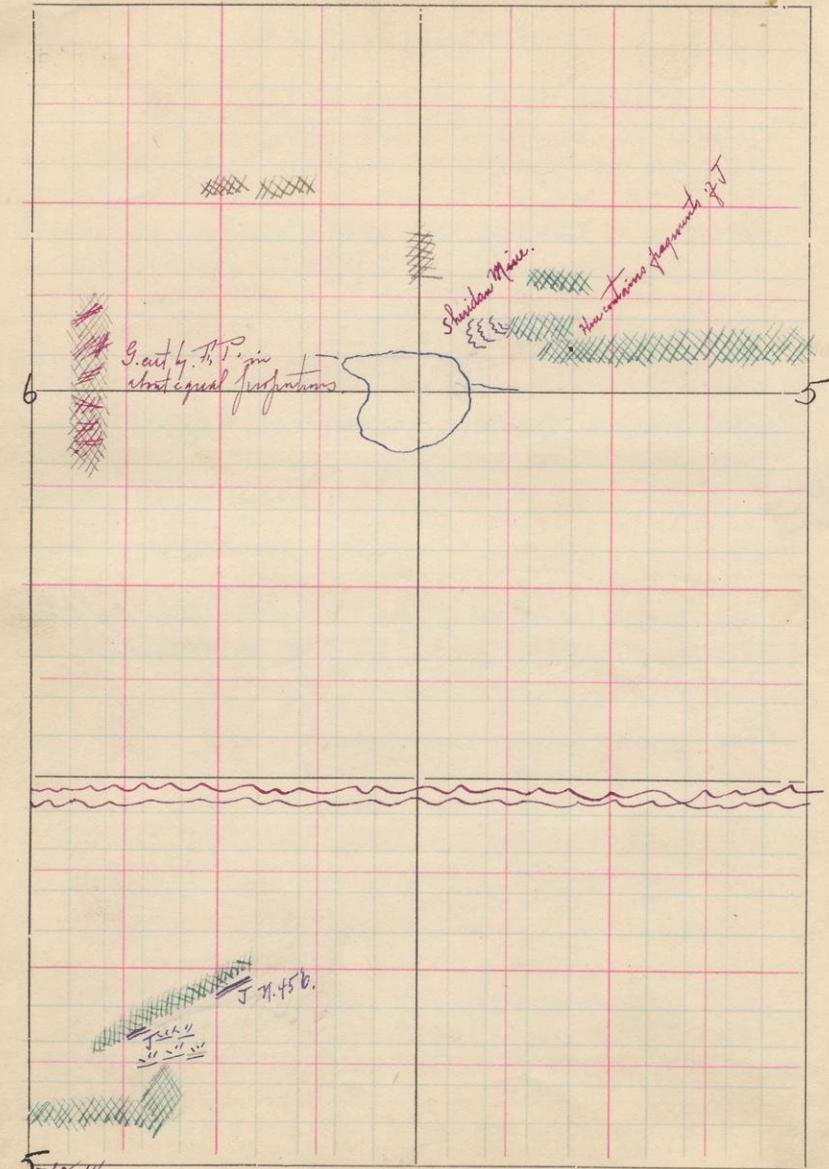
At this place, in Sec. 1, the porphyry was found cutting the jasper. The greenstone was also in sharp irregular contact with the jasper, and was supposed at the time to cut it; but later work, showing most of the greenstone of the area to be below the jasper, indicates that the greenstone here may also be lower than the jasper, and that the relations are the result of close infolding. At one place in Sec. 6, 100 east of the west line, and 800 north of the lake, the greenstone is seen to completely enclose fragments of the jasper.

As to the relations of the greenstone and the porphyry, no decisive evidence was found, although most of the facts observed seem to accord with the idea of the intrusive relations of the porphyry in the greenstone. On the big

S.

T. 62

R. 14



hill south of the center of Sec. 6, greenstone and porphyry are in about equal quantity. Where the relations can be observed on this hill, the porphyry is apparently intrusive in the greenstone. On the hill in the northwest quarter of Sec. 6, the two are again in equal proportion. Here, undoubtedly dikes of a greenstone can be seen cutting the porphyry, but it could not be determined on the ground whether or not these greenstone dikes were a part of the main greenstone mass of the area. Later work would indicate that they are not.

The jasper at the Sheridan mine was hurriedly examined. The structure seemed to be somewhat as follows:



1 J. 0 Here were taken a number of specimens.

40530 specimen of the jasper from the mine.

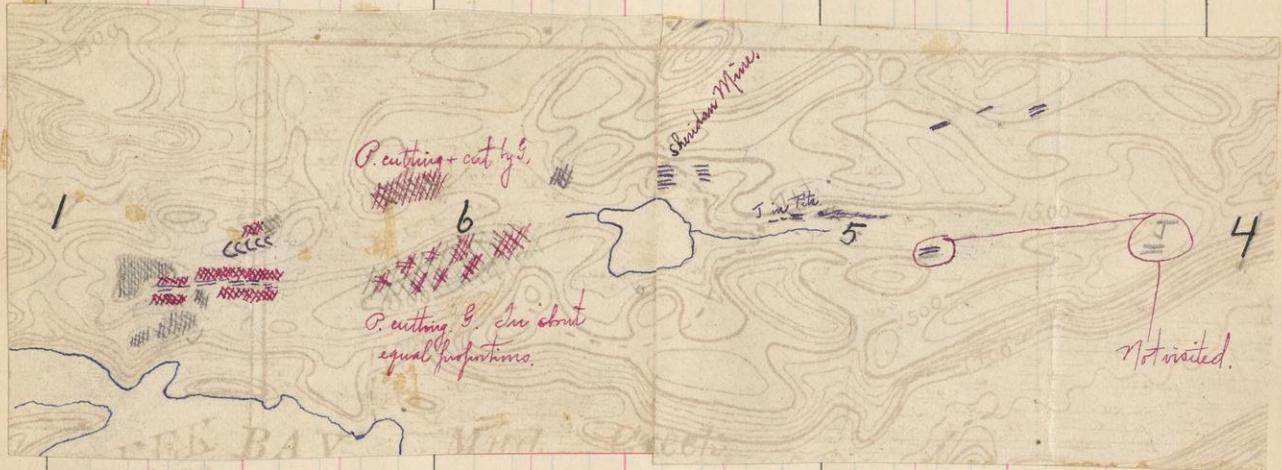
40531 pipe ore from the Sheridan mine.

40532

40533 a specimen of quartz and iron ore from the Sheridan mine. The quartz is closely crystalline, and in cavities can be seen to have crystal forms. These

62-15

62-14



crystals have been covered with a thin coating of iron ore, which, chipping off, shows how the clear crystal of quartz have been thinly veneered.

Beginning at the Sheridan mine, and extending east for a long distance, is a low swamp, with a road running through it. On the north side of the swamp is a big greenstone hill, and on the south escarpment of this hill is Jasper outcropping at a number of places. There are a number of test pits in the Jasper along this horizon. Test pits are also numerous in the center of the marsh.

July 24th.

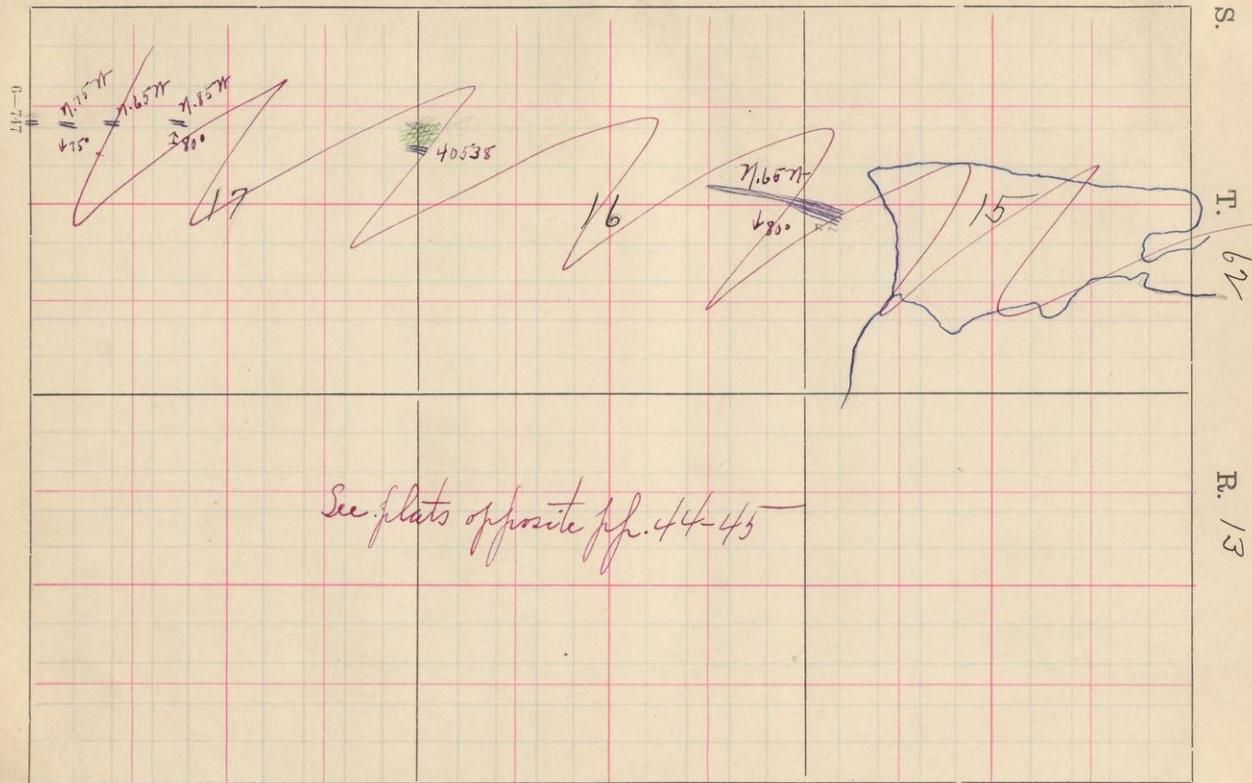
Worked the point just N. of the Burnt Forties E. of the section line. The results are shown on the topographic map opposite page 36....

Both porphyries are present and the small eyed one is found at one place cut by a dike of greenstone. The country is so drift covered that it is hard to get relations, but, from the general position of the rocks, it looks as though the porphyry cut the conglomerate. The relations of the two porphyries it is impossible to state, as no contact can be found.

This point was visited late in the season with Professor Van Hise and Dr. Clements, and it was then decided that specimens from the porphyries could be matched in some of the pebbles of the conglomerate near by. The porphyries are therefore older than the conglomerate.

40534

This is a specimen of the doubtful rock, containing no quartz eyes which I have marked on the map as sedimentary. Location is given on map.



See flats opposite pp. 44-45

July 27th.

From the railway track ran down the W. line of Sec. 17 T. 12. R. 13... until we strike the jasper at 470 S.; then zigzagged E. and S. across Secs. 16, 15 and 14.

At 470 S. on the W. line of Sec. 17, just the eastern part of a westward pitching anticline can be seen.

At 584 S. 184 E. is jasper. The strike is N. 75° W: the dip 75° S.

At 584 S. 400 E. is a black jasper exposure 25 paces wide. The strike is N. 65° W. The dip is vertical.

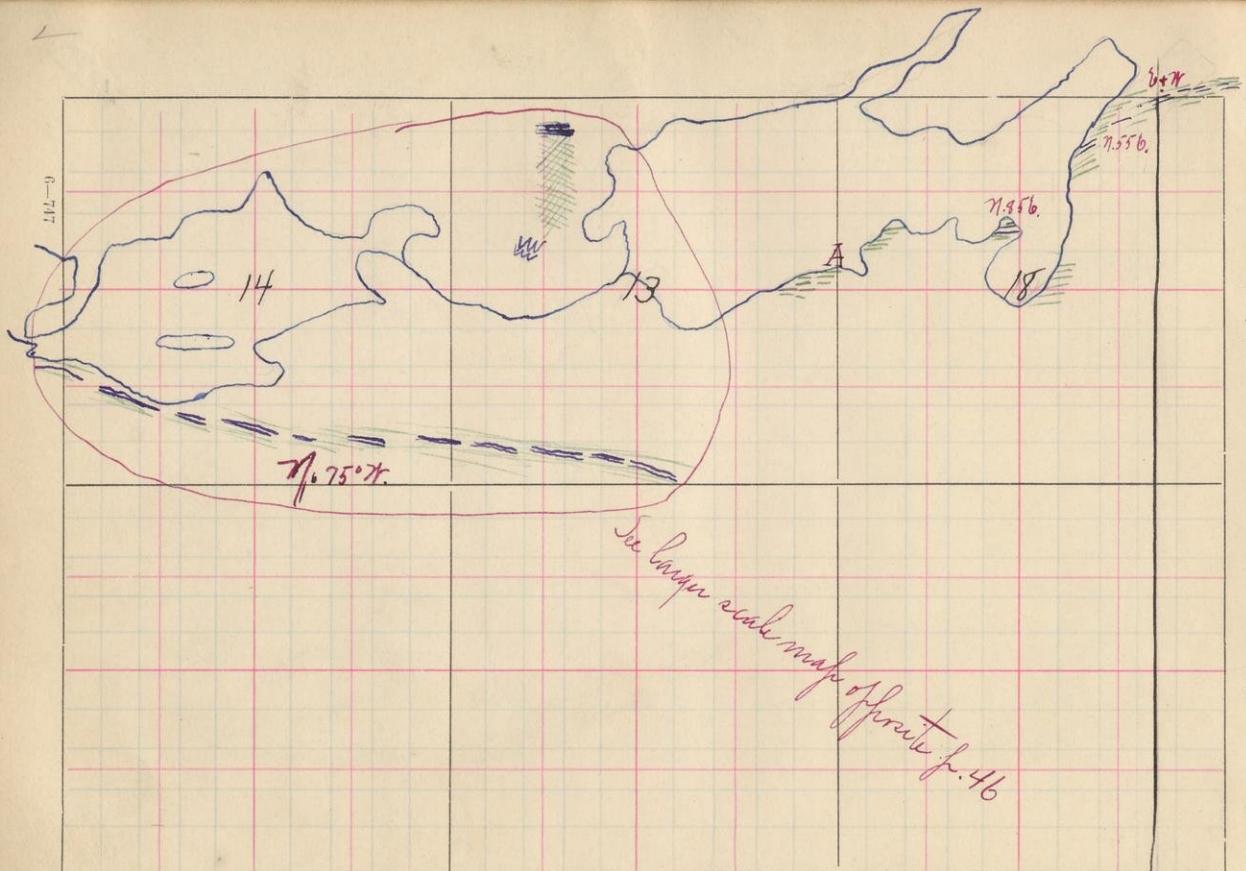
584 S. 754 E is a jasper exposure 20 paces wide. This is the black jasper. The strike is N. 85° W. and the dip 80° to the N.

At 2000 E. in Sec. 17, 700 S., is an exposure of jasper with greenstone on the N. side, where there is an apparent gradation of the greenstone into the jasper. The greenstone on the N. is massive but, in approaching the jasper, it becomes banded showing the discoloration and alteration, and still farther S. it passes into the

८२

T. 62

R. 13-12



1.5
true jasper. There is, apparently, every gradation from the massive green-stone to the typical jasper. In the entire distance of continuous exposure I could find no contact of one rock on another. The jasper is very plainly here a replacement product. The jasper itself is mostly of the black variety. A number of specimens were collected here to show the gradation but all but one were lost by Tim, the compassman, from his pack.

40538

This specimen only was kept.

From 1500 E. to 2000 E. in Sec. 16, 900 to 1000 S., is a fine blowout of jasper. This is in flat even exposure, only partially covered by drift, and can be followed along the strike for 500 paces with scarcely a break. The strike is uniformly N. 65 W. and the dip practically vertical. When it varies from vertical it dips to the S. at a very steep angle, 80° .

Greenstone is found both on the N. and S., apparently in intrusive relations, although of this I could not be certain. Parts of it seem like dikes but nowhere was any decisive ~~nature~~ ^{evidence} seen. The jasper forms the S. es-

S.
17

T. 62

R. 13

61

$$\begin{array}{ccc} \swarrow & \searrow \\ \parallel & & \parallel \\ 11.75^{\circ} & & 11.65^{\circ} \\ \text{top wide} & & \end{array}$$

$$\begin{array}{c}
 \text{A } 65^\circ \text{ V.} \\
 \parallel \qquad \qquad \qquad \parallel \\
 20 \text{ ft. wide}
 \end{array}
 \quad
 \begin{array}{c}
 71.85^\circ \\
 \parallel
 \end{array}$$

$$\begin{array}{r} 21.85^{\circ} \\ \hline \end{array}$$

$$\equiv \text{var} \hat{\equiv} 0 + \eta,$$

under

Narrow band of *J. ac*
with *manzanita* & *quercus*

111 11.806. Black

17024

180°
n. 85° N.

16

17

limit carpment of the hill, and the southern limb of the jasper is not well defined. However, the belt here is at least 150 paces wide, and still S. of this some test pitting has been done, although I cannot see that it has been bottomed in jasper.

Starting in at the hill swinging SE. from the lake in the S. half of 14, I followed the jasper and the green schist belt continuously along the strike down to 1000 E., and nearly to the S. line of Sec. 13. The strike was uniformly 15° S. of E. This jasper is like that seen in the ~~mining~~ morning but there is more of the green schist associated with it. The jasper is in well defined bands in the green schist, and, in a number of places, gives suggestions of being a replacement product in the green schist, as one can see frequent bands of ferruginous green schist. The jasper is in a number of bands in this ferruginous green schist, but the total width of the area containing these bands is about 50 paces. The uniformity of strike is remarkable. For three-quarters of a mile the jasper is followed in almost continuous exposure with the strike varying with but a ~~foot across~~ few degrees.

S.

T. 62

R. 13

6-747

1/6

N 65° W
1.80 ft.

≡

80°

□ □ Cat.

Lake

15

11

11
7.75 ft

I ran N. between the two lakes in Secs. 14 and 13; off-set W. 200 paces and ran to the S. The results are given on the map. In the S. W. quarter of the N. W. quarter of Sec. 13 is a little mass of contorted jasper having, in general, the strike given on the map. Greenstone was found in contact with it on the W. and S. I circled around the exposure but could find its continuation nowhere.

Ran around the S. shore of the lake in Secs. 13 and 18. Nothing but green schist is found, striking a little N. of E., about 10° . On the point projecting N. into the lake, the green schist has certain silicified bands, which are in places slightly ferruginous, but nothing which could be called jasper here occurs.

At the S. shore of the E. end of the lake, the jasper to the S. seems to strike N. 65° , while, at the extreme N. E. end, it strikes nearly E. and W. The dip is to the N. at a steep angle 75° to 80° . All along the S. shore of this ^{east end} lake the jasper is mixed with green schist, just as it was found to be during the earlier part of this run. At the place marked A on the map the green schist is cut by granite.

6-747

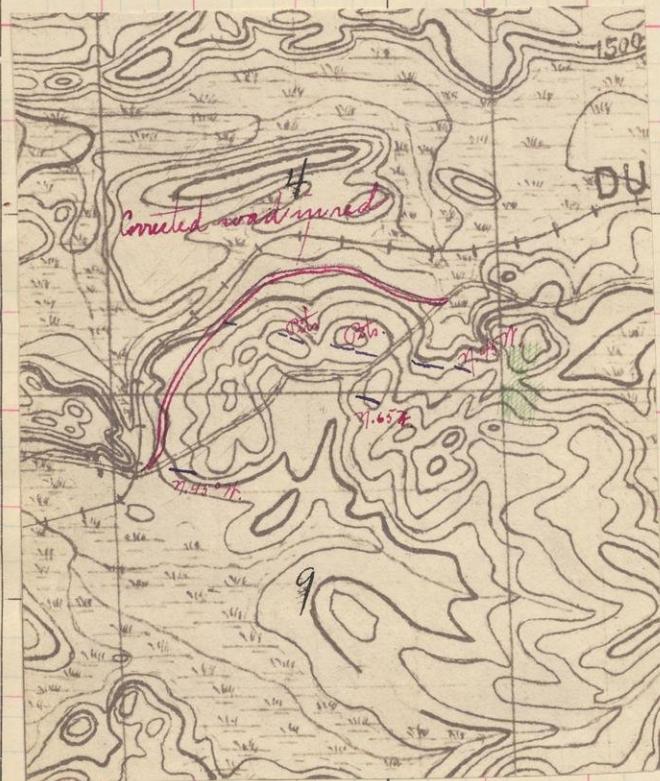
Popple covered country, but exposures are fairly numerous, only a few short intervals being found in which no gypsum appears.

The jasper was carried some distance N. E. into Sec. 8.... I then returned and ran up the quarter line of Secs. 11 and 12 to the railroad track. ~~The results are given on the map opposite page~~

S.

T.

R.



July 31st.

Visited the knob of sedimentary slates at the east quarter post of Sec. 4, T. 63, R. 13. This had been previously mapped ⁶² by Bayley, but as slates are rare in this part of the district, I went there to check up.

I find the north escarpment of the hill, and for about twenty-five paces northward on the top, to be composed of a cherty slate, striking N. 75° W., and ~~at~~ dipping very steeply to the north 80° or more. The slate is banded, being composed of cherty and less cherty layers. The less cherty layers weather red, and in many cases the exposure simulates jasper to a remarkable degree, due to the weathering of layers alternately richer and poorer in silica and iron. ⁴⁰⁵³⁹ ~~4539~~ and ~~4540~~ ⁴⁰⁵⁴⁰ are two specimens of the slate.

⁴⁰⁵³⁹ ~~40540~~ On the north slope of the hill, apparently cutting the slates, is a belt of white-eyed porphyry; also at another place is a small area of hornblende porphyrite, rather coarse grained. Its relations to the slates are doubtful. From its massive character, it would seem to be a later intrusive. (See location on map)

I now looked up the jasper belts in the south half of Section 4, and in the north half of Sec. 9, ~~R. 62~~ R. 13

Starting at the diamond drill explorations near the south quarter line of

Sec. 4, I followed the belt to the south-east across the hills, as indicated on the map. The topographic map is very poor here, but the belt can be traced in fairly continuous exposures as indicated. There are many sharp breaks, and high knobs, showing the jasper, which the map does not bring out. In general, the drift occupies the depressions, although here some test pitting has been done. The jasper is intimately associated with the typical spheroidal greenstone, and in places gives a suggestion of being a replacement in the greenstone. The greenstone itself at these places weathers to a reddish brown color, due to its large content of iron. A characteristic feature of the occurrence of the jasper is that the jasper forms big south and west facing escarpments, and invariably pitches gradually off to the southeast. The strike of this belt averages about 25 south of east.

The jasper marked on the map south of the ridge is a single hill, standing up in the greenstone with no continuation east or west so far as I can see.

Going west, to near the west line of the section, where the road crosses the railway, there is a high knob of jasper forming the western facing escarpment of the hill, overlooking the road and the railroad. This jasper was before mapped

as doubtful. The strike is N. 45° W. It soon dies out to the southeast in drift and swamp. The belt was traced, however, about 100 paces.

The county road on the topographic map is absolutely wrong. Its true position is sketched on the map. This is only approximate; but is more nearly right than it was on the topographic map.

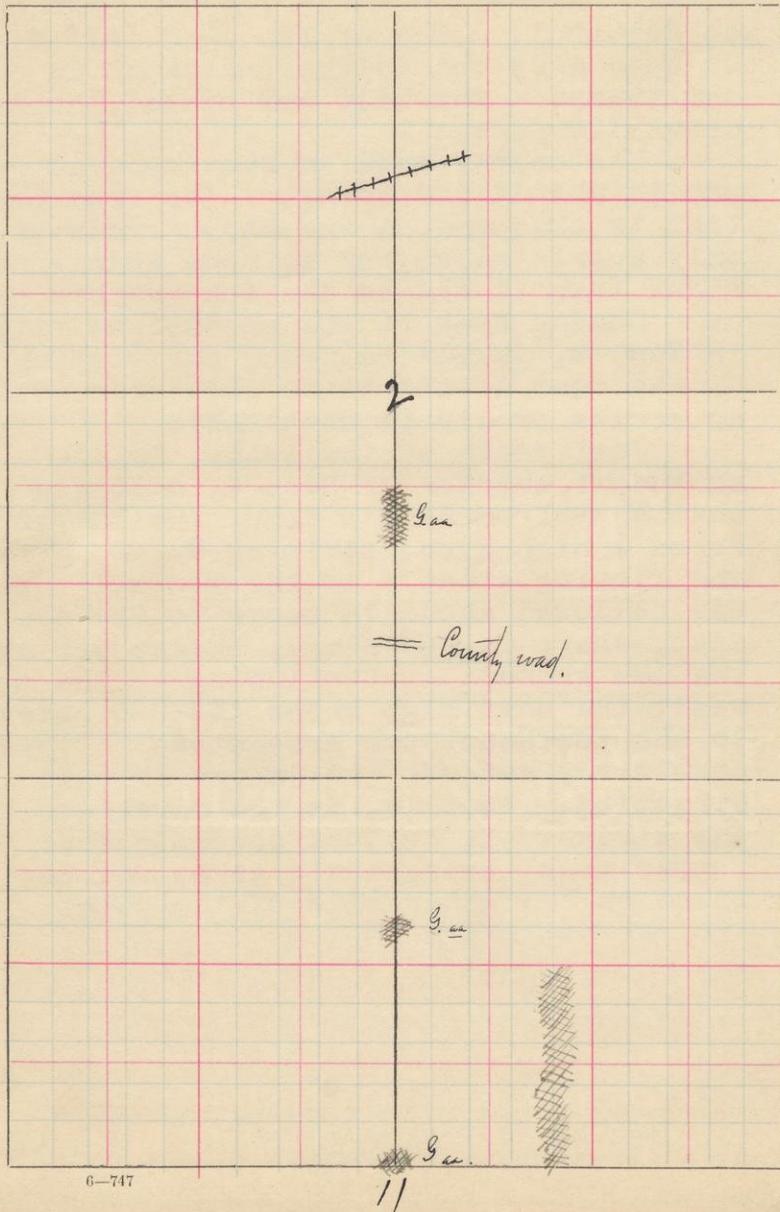
Coming back to the greenstone ridge in Sec. 4, jasper is found outcropping on the road at the place indicated, but no strike or dip is obtainable.

Just south of the swamp, in the southeast quarter of Sec. 4, a little southwest from Bale's camp, the jasper forms a high knob, striking N. 45° W., and dipping steeply to the south. This was followed about 75 paces to the southeast, where it, as usual, breaks off at the low ground. Continuing to the southeast, the next high knobs 150-300 paces to the southeast are greenstone. These completely cut off the jasper in this direction, - that is, in the direction of the strike. It is just possible that the jasper might swing south here, and be found on the other side of the swamp.

S.

T. 62

R. 13



50

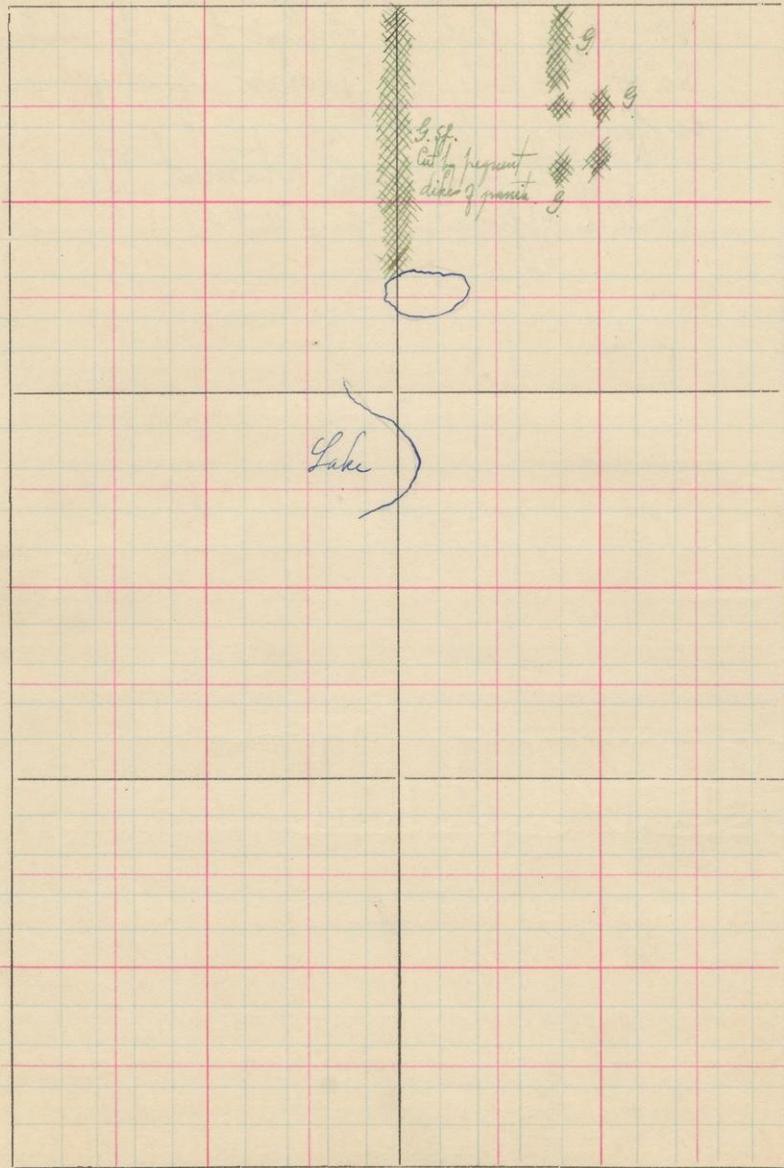
Ran down the quarter line of 7 + 11
62-13 to lake in Northern part of lake
Sec. 14, to cut off Jasper if any was to
be found.
Offset east and returned N.
Result opposite pp. 50 + 51

S.

T. 62

11

R. 13



Sunday, July 30th.

Walked down track to the quarter line of 2-63-13. First looked up sedimentary found there by Bayley. Going west across the swamp and bridge from the N.E. corner, the first knob is found to be composed of a coarse dolerite on the north side 40535 and toward the track it grades into a regular mica-chlorite-schist. (40536) Where this occurs on the north it is seen to have round, table-like areas of the same material enclosed in it. It looks to me like a greenstone tuff or conglomerate, although the fragments are very well rounded; but there is complete absence of fragments other than the coarse dolerite.

Continuing along the track, the next cut is found to be sericitic and chloritic schist (40537), which has been much sheared, showing intricate folding in the railway cut. Should not call this sedimentary. The same thing is followed north for 50 paces where it goes into the swamp. From here west there is nothing near the track but low swamp. No exposure.

