[Areas around Tower, Ely, and Basswood Lake, Minnesota]: [specimens] 28925-28949. No. 324 1899

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.

28925 This is a specimen of the normal green schists from the dump of the North Lee mine. This schist is, on

the weather surface yellowish green.

c?

28926 On the dump I find pieces of a breccia with ferruginous material as cement and fragments of jasper, green schist, and a peculiar rock, see hand spec., which has quartz in it in large grains. This quartz may be either ~~in~~ phenocrysts or it may be a product of infiltration. Small ~~Thin~~ fragments of the above mentioned rocks ~~are~~ also occurs ~~here~~ with the ferruginous material cementing the larger fragments.

c?

28928 This is a specimen of a rather fine grained breccia obtained from the dump. This is more ferruginous than the rest of the breccia fragments seen here.

I.O.

28929 This is the ore taken from the North Lee showing its association with quartz. The quartz evidently owes its origin to deposition in cavities as does also some of the ore.

M.S

28930 The normal green schist occurring in great thickness to the S. of the North Lee is cut by a dike 5 inches wi

wide of a medium grained basic rock. This cuts across the schistosity of green schist and is itself fairly massive.

N.L.
29831 To the N. of the North Lee the green schist is also cut by a basic rock which [illegible], while on the whole ~~is~~ very similar to the schist, differs from it in that it is greener on the weathered ~~wat~~ surface, coarser grained than the schist, and more massive. Without giving close attention to the rocks the discrimination would not be made.

Are not these dikes just mentioned connected with the bosses which form the hills in the swamp to the N. E. and E. of Lee hill? Do they not cut across the jasper and thus form the trough for the North Lee ore body? It should be noted that this rock although very close to the schist and jasper does not contain the jasper bodies which are in a very fissile green schist, spec. 28926.

h.s.
28926

H.
28932 There occurs here at the point located on the plat by the number a dark grayish green rock which is

somewhat schistose and which probably belongs with the more massive basic rocks just described as cutting the green schists. However I cannot get clear relations. The trend of the exposure is such as to cause it to cut across the jasper bands, and it lies in one place next to the jasper in the way indicated on the accompanying sketch.

G.si

28933 Following this same spur to the N. E. from Lee hill I find other exposures of a rock very similar to 28930-31-32 except that it appears to be somewhat coarser and more massive. Compare the sections from these specs.

1.045

28934 This is a specimen of the normal jasper and ore from the North Lee.

1.045

28935 This is a ~~big~~ spec. of peculiar fragmental looking jasper and ore from the North Lee.

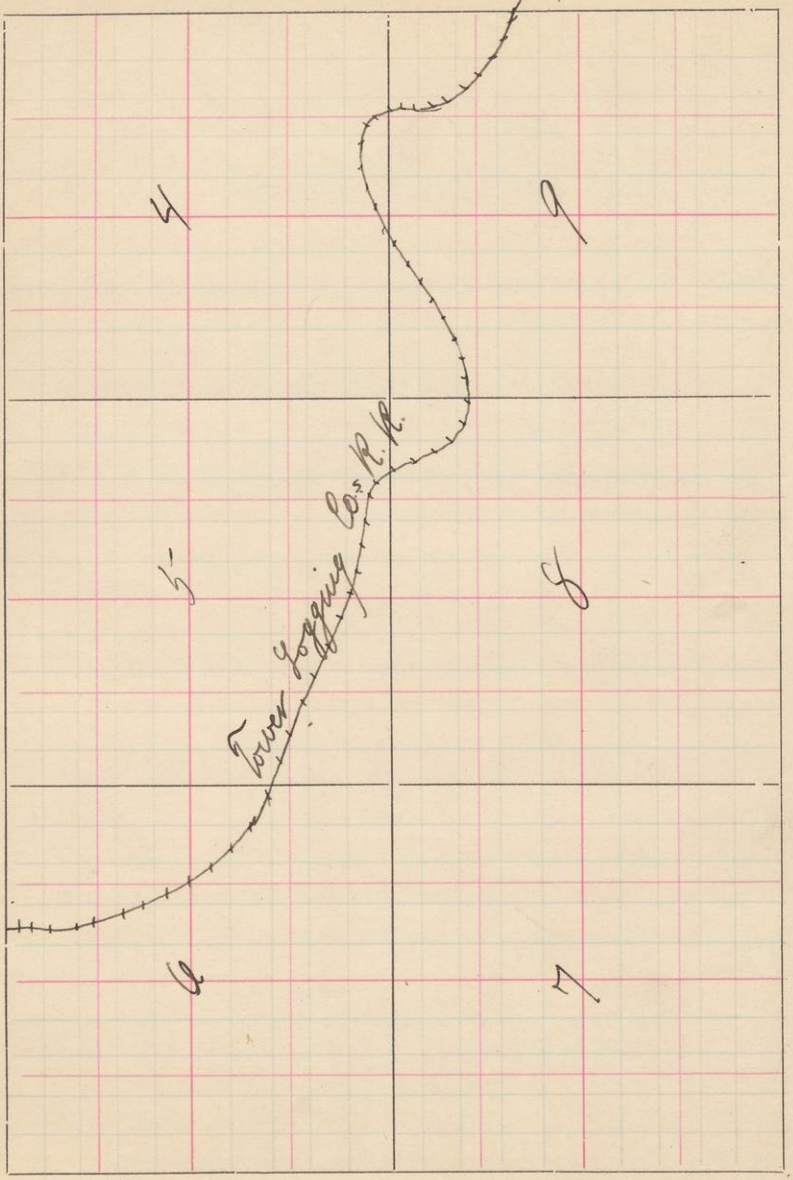
F.P.

28927 This specimen was taken from the feldspathic quartz porphyry which outcrops in the [illegible] yard just S. W. of the

Minnesota Iron Company's office. It also occurs in the yard on the corner of the first street S. W. of the office and in the street.

28936 This is from the greenish gray conglomeratic rock which outcrops in front of the Minnesota Iron Company's office. The slates and graywackes crumpled by N. and S. folding show on the ridge in the main street of Soudan just W. of Church St.

S. T. 61 R. 14

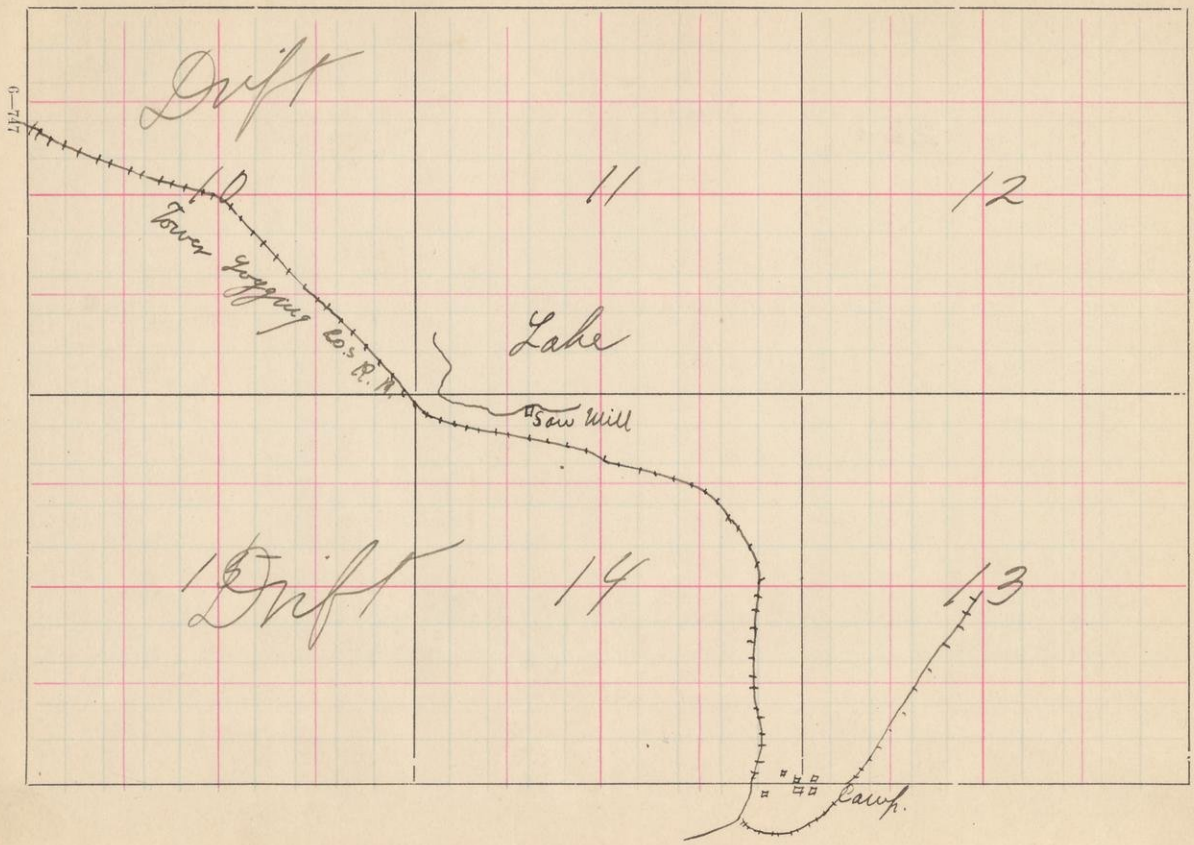


6—747

Spent a couple of days getting my mo monthly report and accounts ready and in visiting places in the vicinity of Tower. Then went ~~in~~to Allen's lumber camp intending to work from there S. & W. out to the Duluth and Iron Range Railroad. The object of this was to trace out the boundaries between the granite, the greenstones, and the sedimentaries, which it was presumed would meet somewhere in this area.

N. 0.W. 7.43.. Sec. 15. T. 61. R. 14. From Allen's lumber camp at N. E. corner of 23 ran W. reaching at the above location the first exposure seen. This is a hornblende schist similar to that seen S. of Ely which there has resulted unquestionably from the metamorphism of the ellipsoidal greenstones. This schist is cut by a medium grained gray granite which also includes pieces of schist along the contact. The area of the ledge exposed is small and it is possible that this may be but a big boulder.

N. 10 W. 11.30. S. E. corner Sec. 15 T. 61 R. 14. I find here a number of good exposures of a fine grained hornblende mica-schist similar to that derived from the greenstones. The band-

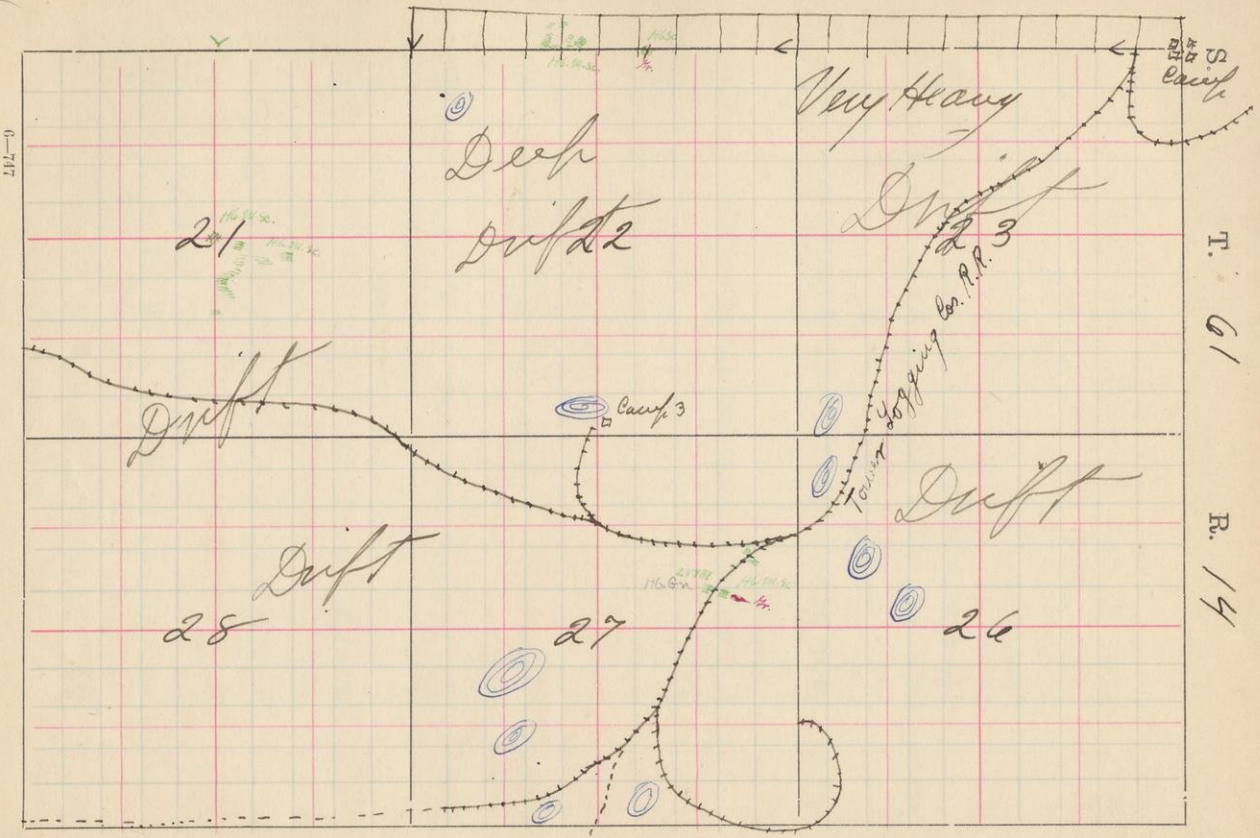

S.
T. 61
R. 14
Drift
10
11
12
Lake
Tower
Logging
Co's R. R.
Saw Mill
Drift
14
13
Camp.

ing of the schists strikes a little S. of E. showing some plication. In places iron has been infiltrated along the shearing planes and this ferrugination of the schist may have given rise to the report of the occurrence of jasper in this area. See Winchell's old map. Running S. I passed over a number of outcrops of similar schists at one place where the drainage had been sufficiently strong to remove the very deep drift.

The logging railroad cuts up the S. western part of this township very thoroughly and I traversed the township very thoroughly by means of these roads.

Hb. Sm. 28937 Met. Sw.?

At the place located ~~from~~ on the railroad ~~I took~~ in the S. E. 1/4 of the N. E. 1/4 of Sec. 27 T. 61 R. 14, there are a number of exposures of a hornblende mica-schist ~~here~~. This consists of alternating bands of coarse and fine material. These bands are cut by dikes of gray granite from 1-1/2 inches to 3 feet in width. Examined closely these sections and specimens of this rock in order to see whether or not it does belong with the hornblende schists derived from the greenstone. If so, then the greenstone

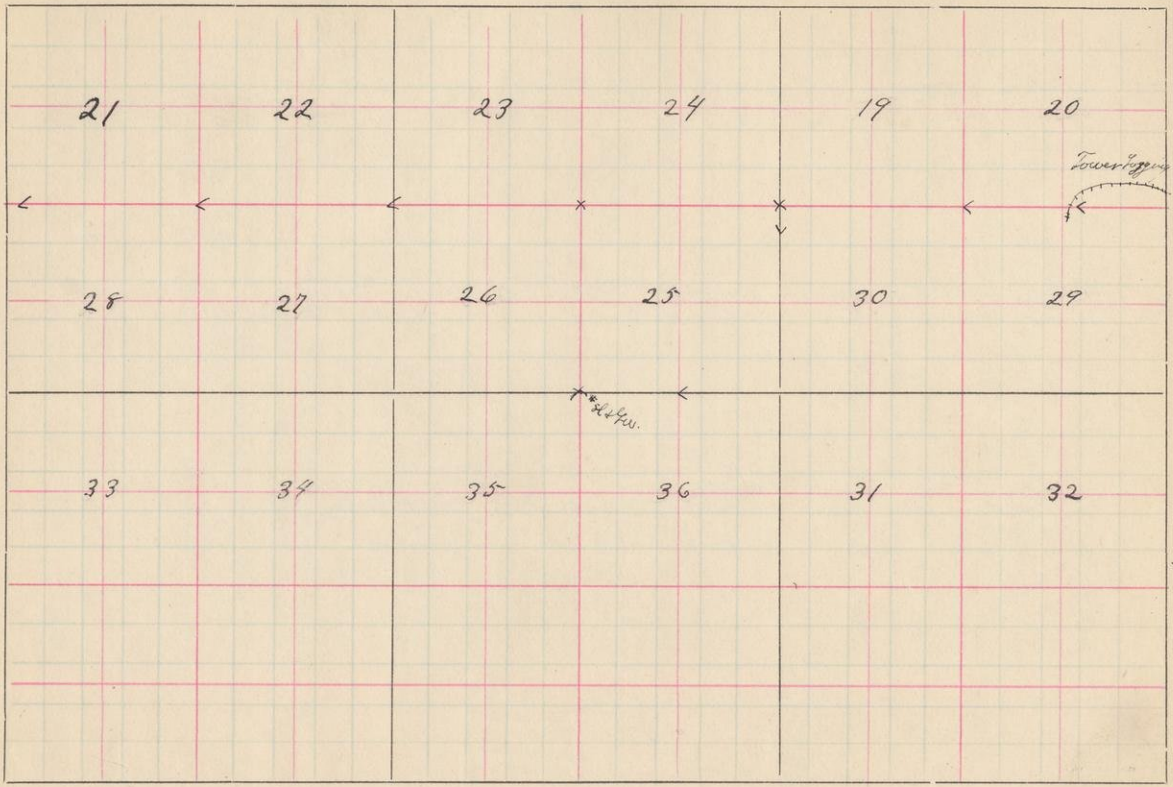

Very Heavy
Drift
Deep
Drift 22
23
21
Drift
Camp 3
Logging Co. R.R.
Drift
Drift
28
27
26
S.
Camp
T. 61
R. 14

boundary line must go S. of here. How far I do not know. The area is so deeply covered with drift or else consists for the most part of broad open swamps in which no exposures are to be expected, that I concluded it best for this season not to attempt to examine the area S. any further.

28937

Should this rock, 28937, prove to be a schist derived from a sediment, slate, or graywacke then it should be put with those rocks exposed on the railroad near mile post 92, and the boundary line of the schist derived from the greenstone would go N. of these exposures. After traversing 27 moved from Allen's camp out in the rain to Sec. 29. Were rain bound the following day and, the next day, in spite of the threatening appearance of the clouds took our packs and traversed the section line as shown on the accompanying plat. The country traversed is either covered with heavy drift in which no outcrops appear or else is low ground, either swamp or just ~~below~~ above the level of the swamp.

N. 1950 W. 1740 S. E. corner Sec. 36 T. 61. R. 15. At only one place



S.

T. 61

R. 15-16

G—747

did I find an exposure. This consisted of somewhat metamorphosed though still clearly recognizable slate and graywacke on which I could get no ~~further~~ very reliable strike and dip. The rock seemed to strike to the E. and W. and to dip 65° to the N. This is practically a continuation of the sediments on the railroad S. of mile post 92. This shows that these sediments continue on down to the S. E. as I anticipated. The country does not promise well, however for the finding of any contacts between the greenstones, these sediments, and the granite. The following day followed the section lines indicated out to the railroad, passing no outcrops whatever. From the railroad caught the train to Ely.

Spent one day in Ely going over the mine plats in the office of Chandler mine and visited the other mine officers.

28938 Upon the map made in 1898 sediments are represented as occurring on the point lying W. of the ~~boat~~ house and projecting N. E. into Long lake in Sec. 29 T. 63 R. 12. This is represented as having a conglomerate to the S. with finer sediments to the N. I visited this point in order to see whether or not there was a basal conglomerate here of upper sediments ~~running~~ resting upon the green schists and jaspers. I could not find a conglomerate. The rock exposed seems to be a schistose graywacke interbedded with slate. The exposures are very much broken so that I could not be sure of the strike of bedding. The schistosity seems to run about N. E. To the N. E. along this point the graywackes unquestionably grade up into slate which strikes N. 45° E.

28939 S. E. 1/4 N. E. 1/4 Sec. 25. T. 63. R. 12. These specimens of jasper

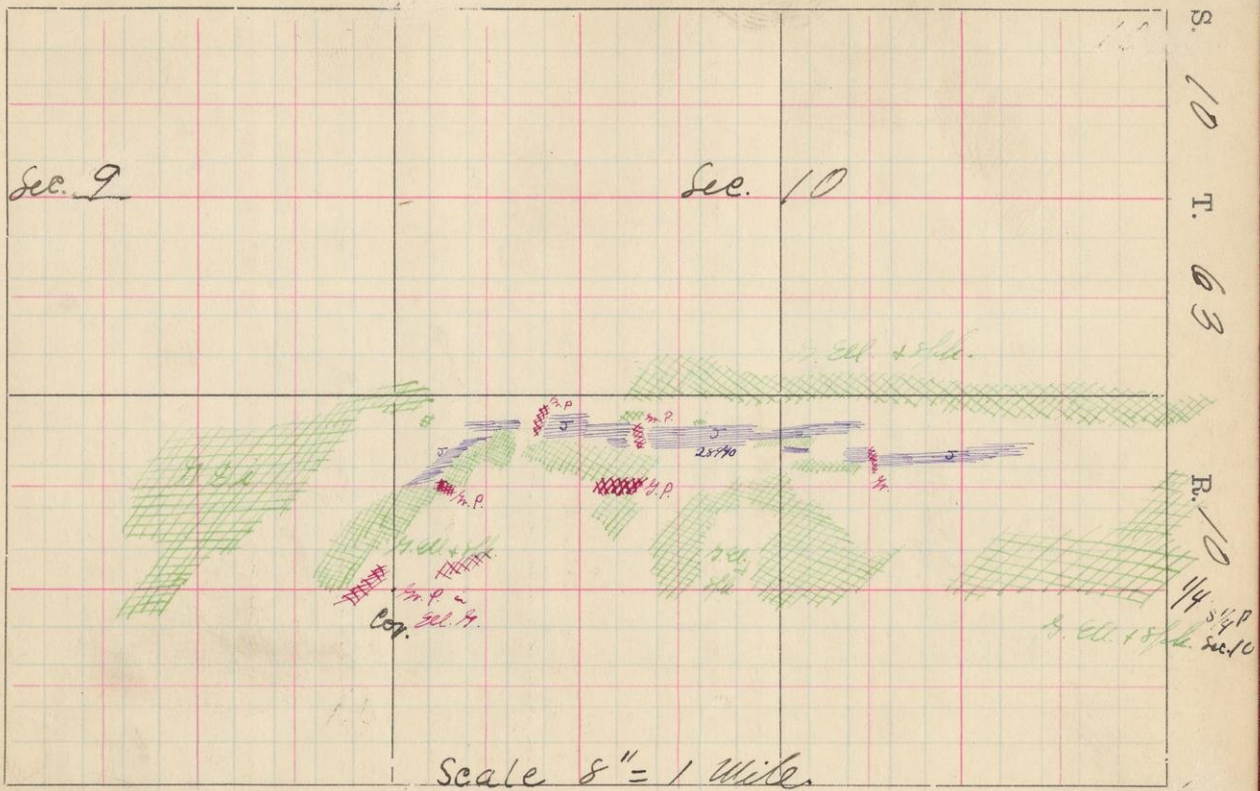
showing the alternating bands of jasper and ore were taken from the hill (is at work) where / ~~from~~ Cole and McDonald's drill. This hill lies just N. of the road and is almost continuous with the large jasper outcrops in Sec. 30, & the E.

Moved to-day away from Ely. Sent Leith with his compassman up through Basswood to do some work there with directions to meet me at Moose lake as soon as he could finish the work. With the rest of the party went from Sullivan's bay through Farm lake up the Kawishiwi river. The name of this river according to Merriam, who got the name from the Indians in the early eighties, should be Mishiwishiwi or Big Beaver House river. On the way up the river visited the point marked by Bayley's No.28137. This point is at the mouth of the Kawishiwi where it empties into Farm lake. The rock here certainly seems like a metamorphosed fragmental rock with granite pebbles in it. I am unable, however, on this exposure to see all the kinds of pebble enumerated by Bayley. Is not this the Western continuation of the same conglomerate which occurs on the islands farther up the Kawishiwi river E. of here? Is it not a basal conglomerate overlying the green schists and jaspers? Is it not probable that this rock, originally a sediment ~~—~~ but now extremely metamorphosed by the intrusion of the White Iron granite, was originally connected around or ~~from~~ S. of the green

schists S. of Ely with the metamorphosed sediments, conglomerates, and slates S. of mile post 92 on the Duluth & Iron Range Railroad? the rock which originally occupied the place between these widely separated outcrops, the one on the railroad and the one on the Kawishiwi, having been removed either by erosion or by the intrusion of the granite or probably by both together? This conglomerate along the lower part of the Kawishiwi river reminds me very strongly of the conglomerate seen farther up the river to the S. W. of Snowbank lake. Should not these sediments be connected?

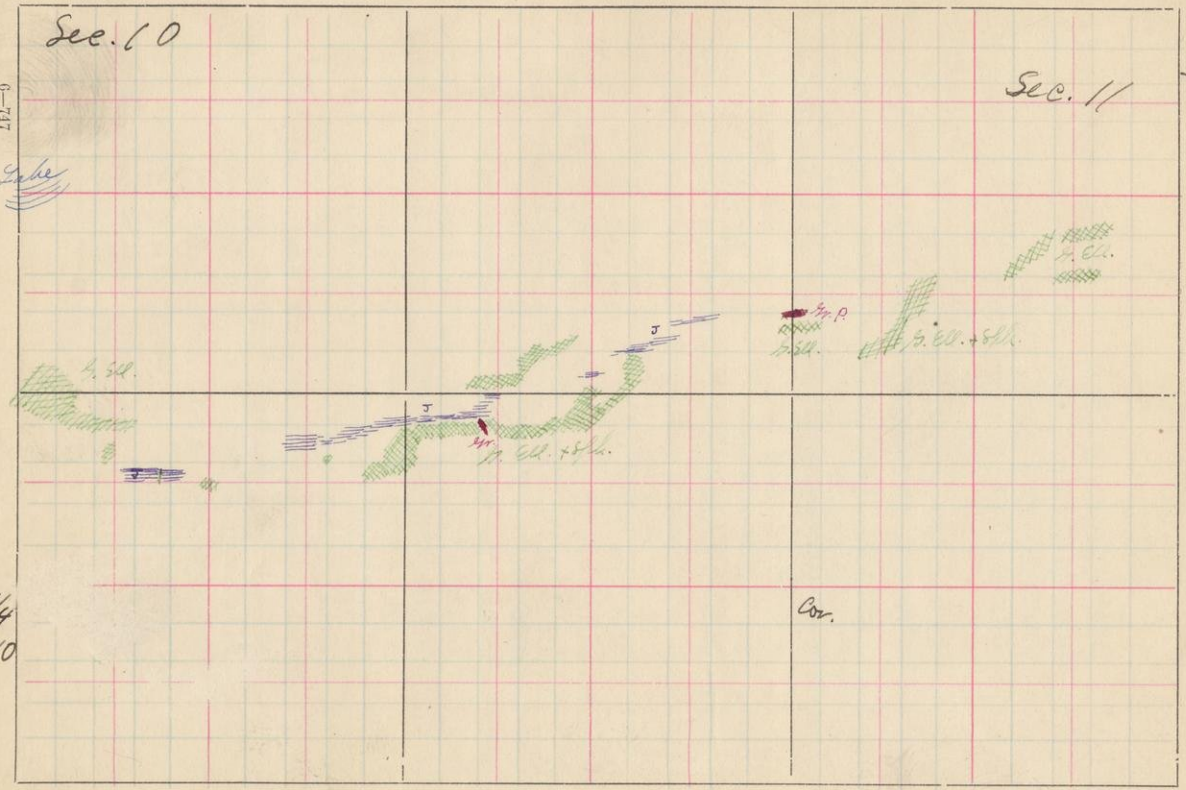
Continued up the Kawishiwi river in a cold rain which made the moving day very disagreeable. Camped ~~to the~~ midway ~~of~~ the long portage on the river. Next day moved everything up the river and into North Twin lake where we made our camp. The following day went W. from the old logging camp along the road examining the outcrops of greenstone. This greenstone shows very prettily the ellipsoidal parting which is so common throughout the Vermilion Range and in addition to this I find quantities of beautiful spherulites. These spherulites vary in size from minute ones in which a

radial arrangement cannot be seen macroscopically to those which have a diameter of 2-1/2 inches. In these the radial arrangement of the minerals can be readily observed especially upon the weathered surface. Most of the spherulites seem now to consist of a chloritic mineral which has a dark green silky appearance. In a few cases the lighter colored mineral may prove to be feldspar. These spherulites are arranged in a general way in concentric circles parallel with the periphery of the ellipsoids. The small spherulites occupy the periphery, larger and larger ones appearing as we approach the center. Upon the weathered surface the interference of the spherulites with each other is very prettily shown. Very rarely are they perfectly round. In most cases they overlap, and in some cases we will have complete spherulites bordered by segments of spherulites. It is evident that they did not all begin to form at just the same time for, if such had been the case, everything being equal, we would get in cross section through such masses of spherulites a structure resembling that of a honeycomb. As soon as the original round spherulites had reached a sufficient size to interfere with each other they would gradually develop


Sec. 9
Sec. 10
S. 10 T. 63 R. 10
Scale 8" = 1 Mile.

hexagonal forms. These spherulitic greenstones are both fine grained and coarse grained, the ellipsoidal and spherulitic portions being continuous with the non-ellipsoidal, non-spherulitic greenstones. My idea is that the ellipsoidal and spherulitic portion of the greenstones represent the surface of the greenstone flows or the outer portion of the greenstone sheets ~~which they~~ are to be considered as ~~intrusions~~ effusive. The greenstones are cut by dikes of granite-porphyry.

My chief object in coming in to this place was to begin at a place where jasper had been located on one of the runs of the previous year and attempt to trace the jasper belt to the E. and W. Found this jasper near the road. See the accompanying plat for location. The iron bearing formation consists of black, white and gray cherts which are interbanded with chloritic and hematitic bands. No true brilliant red jasper was found in this belt. The white and gray and sometimes the black chert show a minute banding which is very commonly observed in the iron bearing formation of the range. A chip of jasper was taken showing this character with the idea of studying it under the micros-



S. 10/11 T. 63 R. 10

S 1/4 Sec. 10

cope and attempting to find out the reason for it. The hematite bands are not present in very large quantities with these cherts. The formation is very much crinkled although having in general an E. and W. trend. This jasper near the road has greenstone lying to the N. separated from it by a depression about 60 paces across. Immediately to the S. of the jasper and in contact with it occurs a mass of greenstone of a width varying from about 5 paces up to 15. To the S. of this lies jasper and across an area of no exposure occurs more greenstone. This greenstone continues on to the S. for a long distance. From this point on the road the iron bearing formation was traced to the W. by zigzag lines back and forth across it. It was followed out for about one half mile by means of continuous exposures. In the course of this distance it had begun to bend around to the S. W. slightly and then all exposures were stopped by a swamp following a stream which ran with a strong S. W. course into a lake. Across this stream, that is on the W. side, greenstone occurred in numerous almost continuous exposures. This greenstone cuts off the Western continuation of the formation ~~for~~ it is supposed to go due W. There is, how-

ever fully space enough for the formation to bend to the S. W. and run across the lake. No exposures of jasper W. of the lake, having been found in previous years, with which this formation could be connected, I did not attempt to follow it farther. The iron formation is cut by granite porphyry dikes similar to those which have been frequently specimened. As the iron formation is followed to the W. I get it in close contact with the greenstone. Here the bands seem to agree in strike with the trend of the edge of the greenstone. This relationship one may ~~determine~~ consider as produced by secondary deposits of the jasper in the greenstone or else as the result of sedimentary deposition of the jasper on the greenstone. I was unable however to find any clear cut sediments between the jasper and the greenstone.

I.J

28940 N. 200. W. 1600. S. E. corner Sec. 10. T. 63. R. 10. This specimen shows the typical bands of the iron formation.

I now started at the road and followed the iron bearing formation to the E. Just after starting E. I find a granite dike cutting across

the strike of the jasper bands. The strike of the jasper is approximately E. and W. Although the strike seems to be E. and W. there must be a number of rolls for in places the greenstone goes to the S. almost far enough to cut out the jasper. However it does not cut out the jasper as, when the greenstones lying N. and S. of the iron formation approach each other, there is invariably left between them sufficient space for the formation to pass through. When in such case the exposures are wanting it is necessary to go only a short distance farther a along the general strike of the belt when exposures of the jasper would again be found.

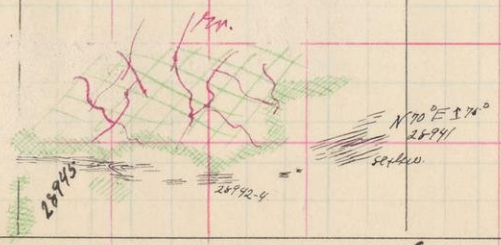
At one place, shown on the plat, a mass of greenstone about 2 feet wide appears to go across the banding of the jasper. The exposure was not sufficiently good to enable me to be absolutely sure of the relations. This jasper formation was traced to the E. and found to bend up to the N. E. The last exposures were found near the E. side of the S. E. 1/4 of Sec. 10. The sun was obscured here by clouds and no farther work was possible for this afternoon. See Merrians work in vicinity of Jasper and Twin lakes for continuation of this belt.

The maximum observed width of exposure of the iron bearing formation in the belt traced out to-day was about 75 paces. There was in all cases opportunity for a wider belt, that is, the distance between the greenstone on the N. and the greenstone on the S. of the belt was always more than 75 paces, running up at times to as high as 200 paces. I am inclined to think that the belt would average at least 75 paces in width over the greater part of its extent.

Cor. Cor.

S. 16 T. 65 R. 9

16

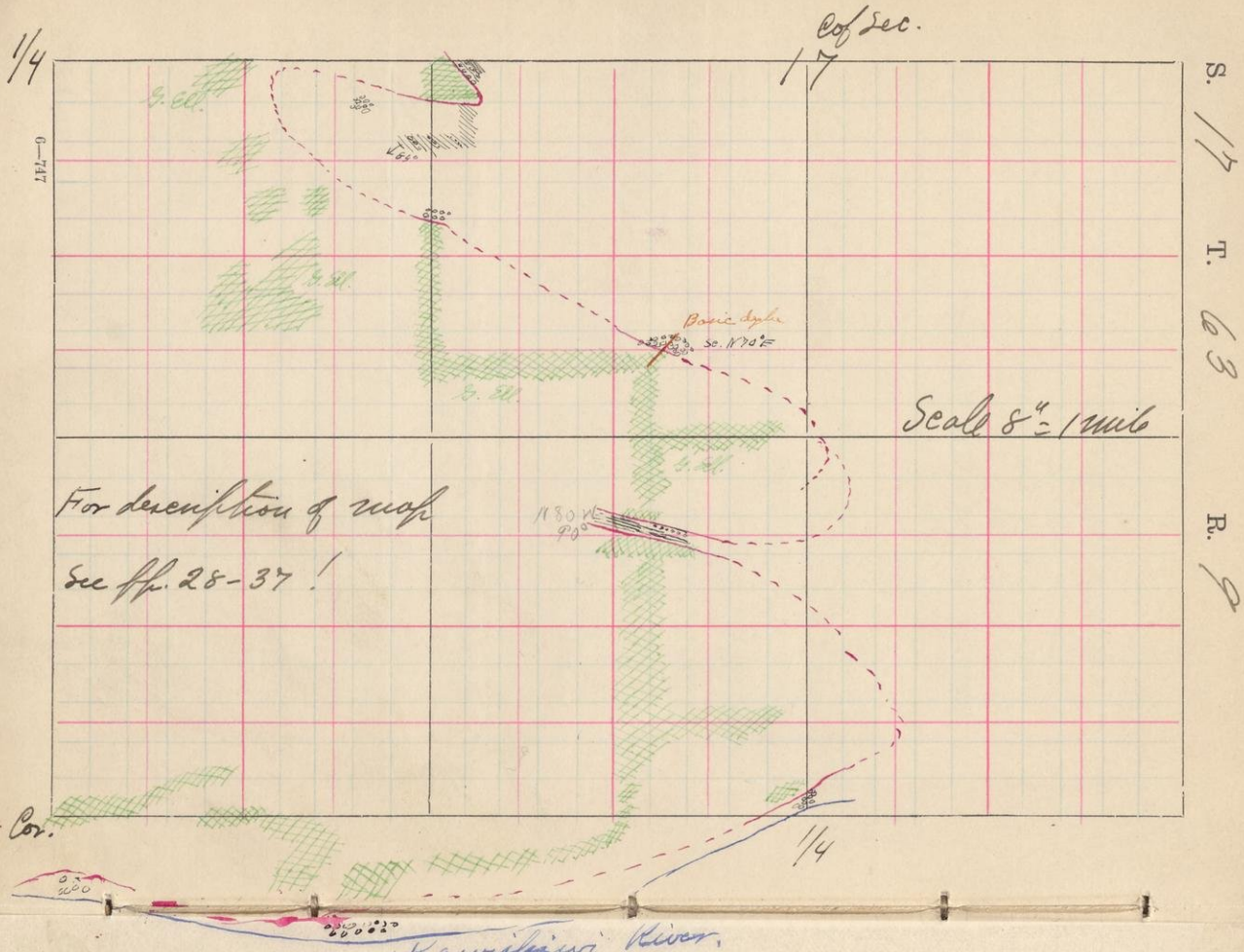


Cor. Cor.

Moved to-day E. into Moose lake. Then in the afternoon went up to Newfound lake to study the relations of the granite, greenstone and the sediments occurring in the S. E. corner of Sec. 16. T. 64. R. 9.

Gw.
28941 N. 250. W. 50. S. E. corner Sec. 16. T. 64. R. 9. This is a specimen of the coarse feldspathic fragmental taken from a bold exposure overlooking a swamp which runs down to Newfound lake. This rock is unquestionably a fragmental. It is here interbanded with fine grained slatey forms. Is it not essentially the same rock as that which to the S. W. on Moose lake is developed as sericite schist with feldspar cores, and which looks under the microscope as though in some cases it was derived from a feldspar porphyry? This coarse graywacke while interbedded with the slate has also patches of a graywacke in it which is coarser than that represented in the specimen. Interlaminated with the slate there is found in places narrow bands up to 3 inches in width of a black chert similar to that seen in various places in the greenstone W. of ~~the~~ Moose lake. This jasper is conformable with the slates and seems to be a sedimentary

strongly resembles a Q.F.P. !!!


1/4
of Sec.
17
S. 17 T. 63 R. 2
Scale 8" = 1 mile
For description of mark
see pp. 28-37!
Basic dyke
So. N 70° E
1180 W
90°
Cor.
1/4
Kawishiwi River.

band contemporaneous with the slates. It may possibly have been a ~~later~~ carbonateous band. Such continuous jasper bands were not ~~seen~~ longer than about 3 feet. They then thin out on the edges and disappear. The strike here of the sediments is N. 70° E. and they have a dip of about 75° to the N. Lying to the N. and slightly W. of this exposure about 100 paces, there occurs near the top of the big hill massive greenstone. This greenstone is cut by a few red granite dikes. They are much smaller in size on this slope of the hill and in much less quantity than similar ones on the N. side of the hill whose characters were noted in 1898. The intervening space is occupied by drift and talus. I attempted to trace these sediments to the W. and to get the relations of the greenstones to the sediments.

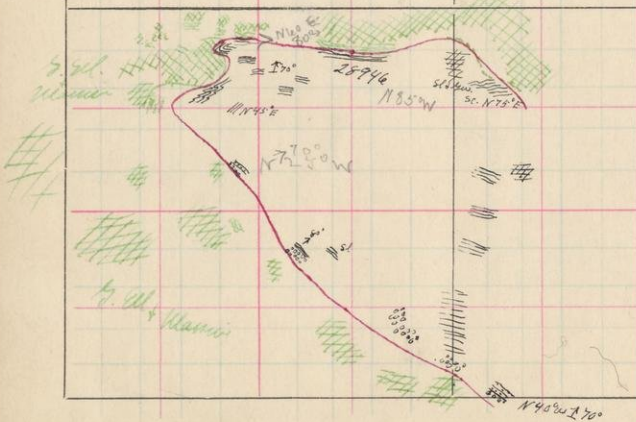
28942-3-4 N. 125. W. 500. S. E. corner Sec. 16. T. 64. R. 9. As I followed the sediments to the W. the distance separating the sedimentary exposures from the greenstone grows less and at the above location I find the two kinds of rock in practical contact. The greenstone possesses here a somewhat schistose or gneissoid structure. This

Cor.

1/4

S. 17 T. 63 R. 9

For description of map
see pp. 28-37.



Scale 8" = 1 mile

17

C. of Sec.

schistosity strikes N. E., S. W. Silicious infiltration bands follow along the lines of schistosity. This somewhat schistose greenstone is followed to the S. after a break of about 20 paces by an exposure, ~~of~~ about 10 paces in width, of a conglomeratic rock. The matrix is green and looks as t though it were derived from a greenstone, and in this there are pebbles of several kinds of coarse granite ~~+~~ and dolerite. Some of these are very feldspathic. Others appear almost non-feldspathic. The pebbles vary in degree of coarseness also; in fact, there are some pebbles of very fine grained greenstone. Other pebbles are of a hornblende-schist, with silicious areas, which resembles in a general way some forms of rock which occur to the S. of this and are hereafter to be described. South of this conglomeratic rock there is an area of no exposures of about 5 feet. Then we come to a rock like 28942 which is followed to the S. by the graywackes and slates. In some places the conglomeratic rock above described is followed directly by the sediments of which 28943 and 28944 are specs. 28943 represents a silicified graywacke and 28944 the hornstone like

Hb. Sch. ?
28942
Met. Sw ?
Sw
28943
met. Sw
Sl
28944
met. Sl.

slate. There is no question in my mind but that these rocks of which specimens were collected are the same as the sediments like 28941 except for the fact that these have been very much metamorphosed. To explain the cause of the metamorphism is another question. The occurrence here may be interpreted as follows: the great mass of hornblendic schist like 28942 is a large flow of greenstone which overflowed the sediments like 28941 and incorporated in the brecciated bottom portion fragments of this graywacke and slate, metamorphosing but slightly the main mass of the sediments although alterating very considerably those at the contact. The contact varieties seem to extend over an area of about 25 feet in width. The greenstone and the sediments were then intruded by the granite and the greenstone as a ~~pressure~~ result of the intrusion of that granite and of shearing was metamorphosed into the present schist. No ~~contacts~~ of the granite have thus far been found in these sediments so that the above explanation does not seem to ~~me sufficient~~. It would be curious to have the intrusion of the granite end just where the sediments began. This fact

tends to show that the present hornblende schist was formed prior to the sediments. Another explanation in agreement with these facts would be that the greenstone is the oldest rock, that it was metamorphosed and then cut by the granite. Upon these rocks there was then deposited these sediments. The conglomerate at the base being derived from the greenstone consists principally of course of greenstone fragments. Above these there was deposited the finer sediments. The difficulty with this theory is that the conglomeratic rock is of somewhat doubtful character. It does not show the most unmistakable conglomeratic features. It may be, in other words, a breccia although it is not believed to be such. Moreover how can we explain the silicified metamorphosed condition of the lower part of the sedimentary series? This is so strikingly connected with the sediments and the greenstone that it certainly seems to bear some relationship to the two. Can the fact that it lies along the line of contact, the plane of separation, in other words, between the two, warrant us in considering it as due to the action of infiltrating solutions? It looks

strikingly like the result of an eruptive contact. The difficulty with the consideration of the sediment as a series younger than and overlying the greenstone is the fact that the basic conglomerate is so quickly followed to the S. by such a very much more acid sediment as is the graywacke. The sediments near the contact with the schists are very much plicated but a dip of from 60°- 70° to the N., that is down under the schists, can be readily discerned.

There can be no question as to the sedimentary character of the rocks represented by specimens 28943 and 28944. I can follow in the field the gradations between the normal graywackes and slates and these rocks. Following the sediments to the W. They become more chloritic, that is, chloritic bands begin to appear among the sediments and alternate with them. These normal sediments have become very much less in quantity by the time we have reached N. 175. W. 750. S. E. corner Sec. 16. T. 64. R. 9. At this location I find an exposure of massive greenstone which is separated from the greenstones to the N. by a narrow belt of the sediments about 20 paces wide. These sediments are here crinkled into synclines which

28943
28944

plunge to the E. It looks to me as though there was here a syncline of the sediments plunging to the E. and wrapped around the greenstone which represents a small anticlinal core. See plat. At one place among these sediments I find a narrow band (sheet) of spherulitic greenstone infolded in a syncline of these slates and graywackes which is only 8 feet across from N. to S. The axis of this syncline strikes ~~to the~~ E. and W. and plunges E. at an angle of about 60°.

28945 N. 200. W. 900. S. E. corner Sec. 16. T. 64. R. 9. Here the sedimentary character of these rocks are not so clear. If they are sediments, they are in very much metamorphosed condition ~~and character~~ with the greenstone lying both to the N. and S. with but a short distance, not more than 50 paces, separating them. I believe them to be sediments and interpret their relations to the greenstones here as due to close infolding of younger sediments with the older greenstones or else interbanding of sediments and flows or sills. The specimen is one which I think represents a ~~large~~ much metamorphosed graywacke.

W. of this place the exposures are fewer and when found are covered with moss so that on my former runs W. of here it was not possible for me to discriminate between the kinds of rocks with any degree of accuracy, hence I have not attempted to follow this belt out farther. W. section

Running S. along the railroad line I passed over hornblende-schists to the 1/4 post. This line had already been run in 1898 so that from here to the lake I did no mapping. The formation boundaries upon this hill can, I believe, ~~soon~~ be put in approximately only/ on account of the fact already stated that the exposures are so poor and the metamorphism is so great that it is difficult to make proper discriminations.

Left Moose lake this morning with a compassman and canoeman and traveled through Twin lakes ~~up~~ and thru E. through the Kawishiwi river. Crossing the portage just W. of Sec. 17. T. 63. R. 9. on the Kawishiwi river I see a dike of gabbro cutting the granite. The contact between the granite and gabbro must lie only a short distance to the S., as after leaving the E. end of the portage I find granite on the N. shore of the river and gabbro on the S. shore. These relations continue for some distance. The last seen of the granite is as it projects, as a point, E. into the river. The N. main shore of the river is found from here on for some distance to be made up of the much metamorphosed ellipsoidal greenstones. These are now in most cases micaceous and hornblendic rocks with ~~in~~ places ~~of~~ a distinctly schistose character. The ellipsoidal structures are, however, still present and enable one to recognize their original characters in the field. Just E. of the M. C. of the Sec. line between 19 and 20 T. 63. R. 9., and about 100 paces S. of the corner there is an exposure of a conglomeratic rock whose relations to the greenstones are not here recognizable. This conglomeratic rock bears a striking resemblance to that seen on the islands in

the Kawishiwi river about a mile W. of Deadman's portage. The character of the pebbles in the conglomerate cannot be readily determined for the conglomerate has suffered ~~from~~ very complete metamorphism. The pebbles appear for the most part to consist of greenstones and are most probably fragments derived from the greenstones lying to the N.

Starting at this M. C. I went N. to the corner and from there E. and then N. along a zigzag ~~line~~ as shown on the accompanying plat. My object in making this run to-day was to find out, if possible, the area covered by the sediments and greenstones ~~relatively~~, and to determine their relations to each other. Running E. along the Sec. line I was almost continuously on ellipsoidal greenstone. The conglomerate however outcrops about 150 paces S. of the section line near the river at the place shown on the map. After running E. 760 paces I ran N. still passing over the ellipsoidal greenstone.

Opposite Pl. 21-2

N. 370. W. 1210. Sec. 17. T. 63. R. 9. At this location I reached the contact of the ellipsoidal greenstone and the sediments. The contact

trends N. 80° W. and agrees with the banding of the sediments. The dip appears to be vertical. From the greenstone going N. the sequence is fine grained sediments grading to the N. into a fairly fine grained conglomerate and this is followed by a dark conglomerate apparently consisting essentially of greenstone pebbles, and this by ellipsoidal greenstone. In all the sediments are about ~~30 paces~~ in width ~~trending~~ N. to S. The area occupied by the sediments is about 30 paces wide from N. to S. Both of these kinds of rock have ~~now~~ been metamorphosed into mica-schists. Some of the pebbles in the conglomerate are recognizable as greenstone and veined quartz. The characters of the others, on account of the metamorphism, could not be determined. However the greenstone pebbles predominate. I followed these sediments to the W. and N. and in one place there is a mass of ellipsoidal greenstone, 12 feet wide, which seems to cut across the strike of the sediments. It trends N. W., S. E. This relationship, it is true, might be produced by infolding, though possibly we have here an intrusive dike. I followed these sediments to the W. as shown on the map. From here the ground slopes down rapidly into a low area in which apparently no exposures exist. Having

already made a N. and S. traverse to the W. of this without having found the sediments, I have drawn in the western end of this tongue only with approximate accuracy. It is a narrow belt however and the presumption is that it does not go very far W. After leaving these sediments, continued N. over the ellipsoidal greenstones again.

N. 620. W. 1200. Sec. 17. T. 63. R. 9. Here I came again upon exposures of unquestionable sedimentaries. The conglomerate at this place contains medium grained granite pebbles in it although the greenstone pebbles are the predominent ones. Associated with these conglomeratic rocks there are some finer grained phases of sediments. The strike and dip could not, however, be determined accurately. The schistosity in the sediments strikes N. 70 E. These sediments and the adjacent greenstonesare cut by a dike of greenstone trending N. E. S. W., which is of different character from that of the ellipsoidal greenstones and is evidently younger than both of the rocks cut. From the point located above I went W. following a zigzag line mapping the contact between the sediments and the greenstones. This contact is a very ir-

regular one when looked at broadly and shows that the sediments are infolded in the greenstones in a big syncline which opens out to the E. The W. end of this syncline shows plications. Slates and very fine graywackes are the sediments which predominate although in a few cases adjacent to the greenstones they are found as conglomerates, consisting of pebbles derived from the greenstone which grades up into finer grained sediments. The conglomerates lie for the most part upon the S. W. limb of the syncline, none having been observed upon the N. limb. This may be due, however, partly to the fact that the contact on the N. limb was followed for a very much shorter distance than was that of the S. limb. The following are the detailed notes taken at various places around the contact line.

N. 1400. W./465. S. E. corner Sec. 17. T. 63. R. 9. Here the greenstones and the sediments are very close together although the actual contact is covered. The sediments have a very marked schistosity striking N. 75° E. I cannot be sure of the bedding. Along the edge of the exposure nearest the greenstones bands

of green schist are interlaminated with the sediments and have the same strike as the schistosity of the sediments. The greenstone along the contact is fairly fine grained but becomes much more massive as it is followed to the N.

N. 500. W. 1490. Sec. 17. T. 63. R. 9. At this place there is a small area in the greenstone which has been discolored by the infiltration of iron. There is no jasper here and it is a clear case of infiltration. Upon Winchell's map Iron ore locations are given in this vicinity. I have thus far seen no jasper in the greenstone either at this place or to a run made W. of here in 1898.

Sl
28946 N. 1450. W. 1575. S. E. corner Sec. 17. T. 63. R. 9. Here I got an actual contact between the greenstone and the sediments. There is a gradual transition apparently from the ellipsoidal greenstones into the sediments. Starting at the N. where the characters of the ellipsoidal greenstones are clearly recognizable and following it to the S. I find it becoming more and more schistose and

with a few ~~sediments~~ bands weathering gray like the ~~schists~~ sediments appearing in it. These bands become more and more numerous until finally one is standing upon sediments in which there are occasionally schistose bands. These schistose bands seem to consist chiefly of chlorite and it is probable that those bands in the sediments are for the most part, if not altogether, the result of secondary infiltration. The specimen 28946 shows the contact between these rocks.

The contact line between the sediments and the schists is a more or less irregular one though trending in general N. 85° W. This zone intermediates between the mass of ellipsoidal greenstone and the clear cut sediments ~~are~~ are exposed here for a width of about 25 paces. The sediments vary from fine grained slates to beds which are finally conglomeratic. Their characters are clearly recognizable. The conglomerates here are fine grained, more properly speaking perhaps, are graywackes and no pebbles of greenstone could be recognized in them at this place. The occurrence is similar in respect to the contact of the sediments on the S. side of Ogishke Mungie lake with the ellipsoidal green-

with to the contact

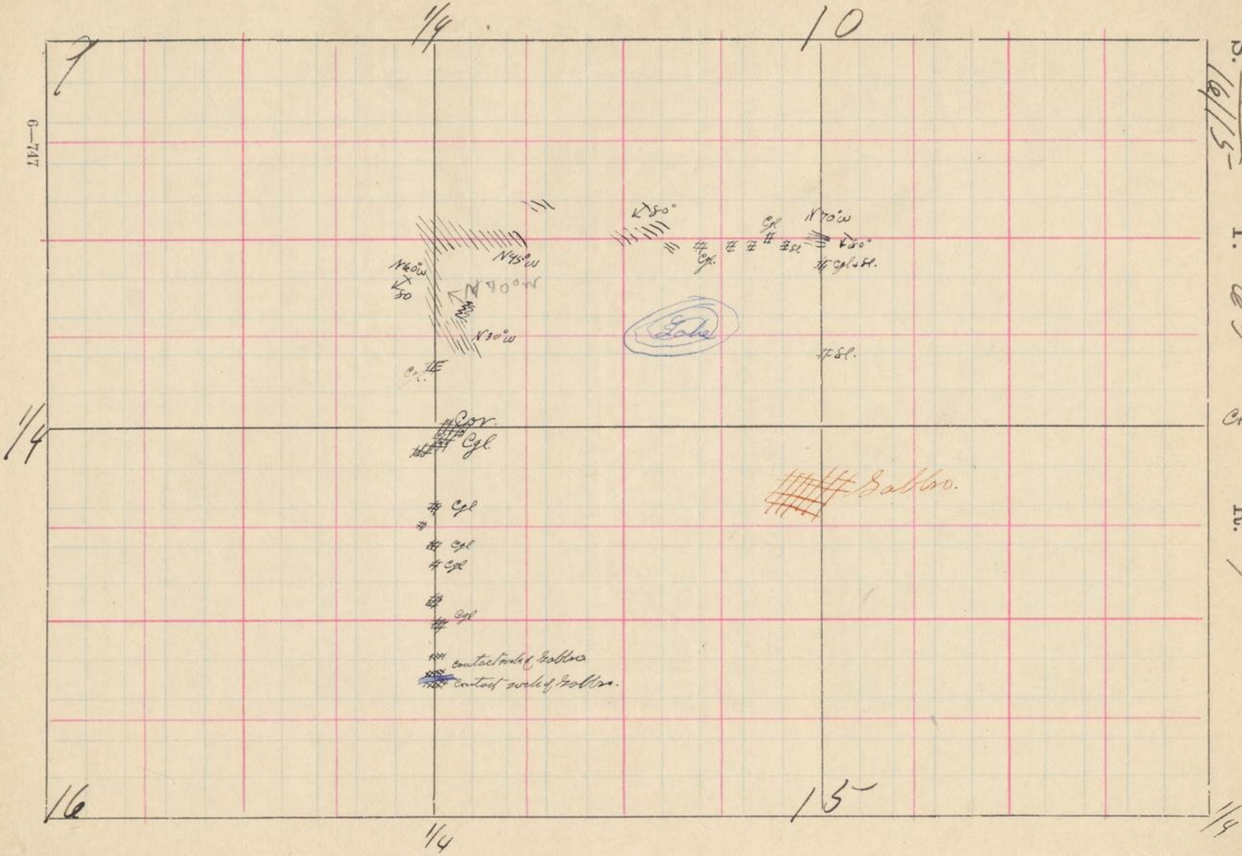
stones forming the Twin peaks. The sediments here N. of the Kawishiwi are full of quartz veins which agree in trend with the schistosity. S. of the contact small basic dikes are rather numerous and cut across the sediments in all directions. Similar dikes were specimened in 1898.

N. 1440. W. 1800. S. E. corner Sec. 17. T. 63. R. 9. This locates the W. end of the sediments and at this point their relations to the greenstones are well shown. There is here a small syncline of the sediments surrounded by schistose greenstone on three sides. To the N. W. and S. this schistose greenstone grades up into the massive greenstone. The syncline is about 10 feet across. On the N. limb of the syncline the strike of the sediments is S. W., N. E. On the S. limb the strike is N. 70° E. The strike of the sediments bends around at the W. end of the syncline joining these two and giving a small fold the strike of whose axis is N. 60° E. The pitch is very steep about 80° to the E.

N. 1580. W. 1775. S.E. Cor. Sec. 17-63-9
..... Here bands of greenstone

conglomerate striking N. 25° W. and dipping 70° E. lie on top of the ellipsoidal greenstones. The pebbles are practically all of them similar to the underlying greenstone. The S. side of the synclinal fold was followed back to the E. and ~~thus~~ similar greenstone conglomerates were found grading to the N. E. into the normal sediments.

The sediments seen in this synclinal tongue are for the most part very fine grained and weather with a light buff crust. When broken they are gray or blueish gray. They are very commonly spotted and resemble the so-called spilosite, the spotted contact rocks of the diabase. Bayley has collected a number of specimens of these rocks farther to the E. so that I took none. Are not these spotted rocks here the result of the contact action of the gabbro which now outcrops nearly three-quarters of a mile S.? Presumably this gabbro at one time extended much farther N. than it does now and probably overlay the area in which these rocks are now exposed. Hence it would not be necessary to consider that the contact action of the gabbro had affected rocks three-quarters of a mile away, for it might have been only a few ~~not~~ feet vertically above these at a much earlier period. These spotted rocks



S. 9/10 16/15 T. 63 Cov. R. 9

6—747

certainly could not have been produced by the intrusive action of the small dikes which cut through them. With a view to determining this, observations were made as to the relations of these spots to the dikes. No relationship was observable, the spots never appearing to increase in quantity as these small dikes were approached.

After having traced out the W. end of this syncline ran to the river and then went E. into the S. E. bay of the Kawishiwi in the N. W. 1/4 of Sec. 15. T. 63. R. 9. Coming up the Kawishiwi I find that the gabbro continues to occupy the S. shore with the metamorphosed sediments and occasionally some gabbro upon the N. shore. 9 Began at the narrows and ran N. along the section line between Secs. 16 and 15. For about the first 800 paces the exposures were for the most part conglomerates which had been extremely metamorphosed by the gabbro although still showing their sedimentary characters. Farther N. then the fine grained sediments began to outcrop in splendid exposures. These slates and associated graywackes are exactly like those observed the previous day to the W. of here. The spotted character noted yesterday is almost uniformly present and is very characteristic for these slates.

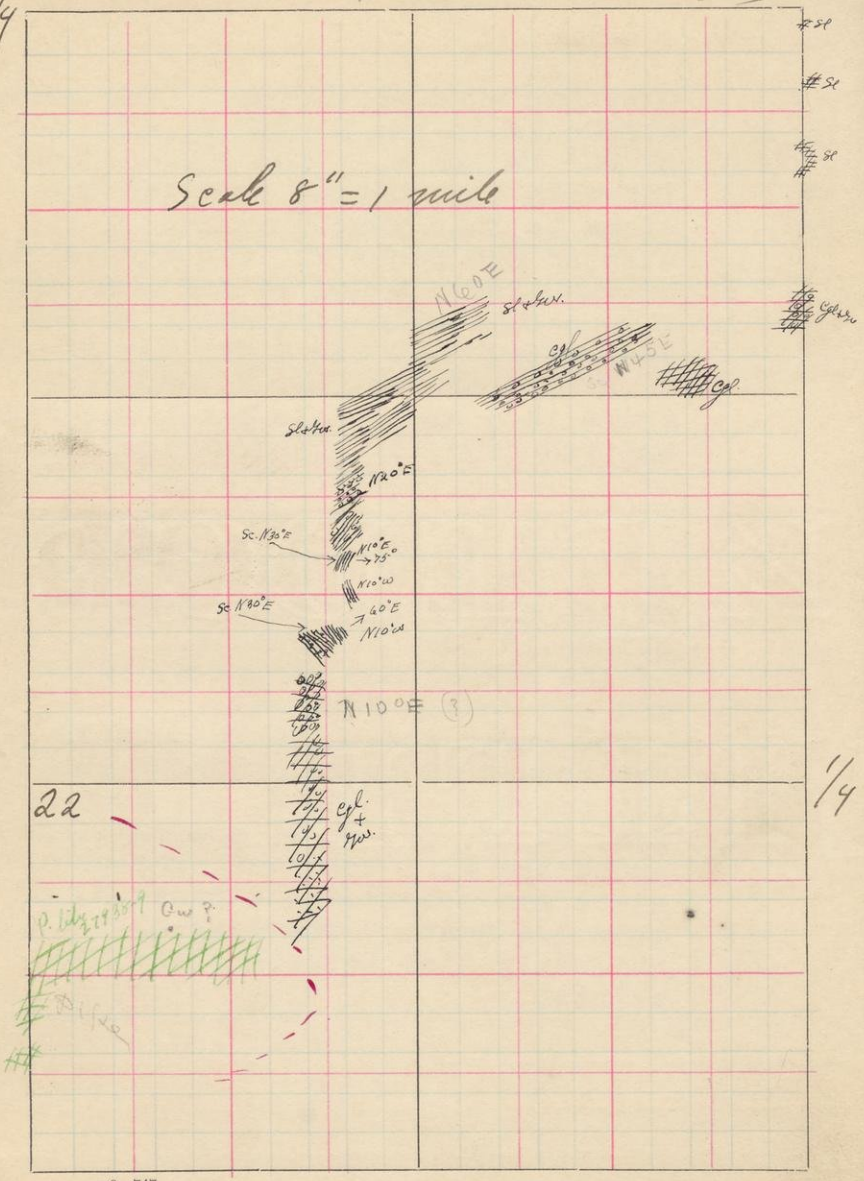
They are much contorted. The general strike is to the N. 45° W. with a dip of 80° to the S. The line connecting with this having been run previous to this year from the N. I stopped 500 paces N. from the corner between Secs. 9 and 10 and then ran E. one-half mile continuing in the sediments. In the S. E. 1/4 of the S. W. 1/4 of Sec. 10. T. 63. R. 9 there is a small lake which has been omitted from the topographical maps.

N. 300. W. 1975. S. E. corner Sec. 10. T. 63. R. 9. Here the plications of the slates into minor ante and synclines is very noticeable. The axes of the plications strike N. 70° W. and are nearly vertical.

The easily recognizable massive gabbro occurs in large outcrops about 100 paces S. of the S. 1/4 post of Sec. 10. T. 63. R. 9. and continues on to the S. The last exposure of slate was observed 200 paces N. of this 1/4 post. The line of contact evidently lies between these two points.

S. 22 · T. 6 S · R. 9 E.

1/4



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Started in at the N. E. corner of Sec. 22. T. 63. R. 9. and ran S. The line goes through green timber consisting for the most part of balsam and spruce and the exposures, although fairly numerous, are covered with moss so that the character of the rocks cannot be very readily determined. Near the corner the slates are exposed. Going farther S. the conglomerates and graywackes begin to appear. After going 400 paces S. I ran W. and then zigzaged to the S.W. studying the sediments exposed along the line. The conglomerate is full of brilliant red jasper pebbles in addition to the black and white chert pebbles, and contains also granite with large quartz eyes and also long flat schistose greenstone pebbles. Some of these are 3 feet long and 4 inches wide tapering at the ends. Many of the jasper pebbles are banded and these bands run parallel to the length of the pebbles. Pebbles of veined quartz are common as are also a fine grained purplish weathering porphyritic rock of which specimens were taken in 1898. This conglomerate is schistose and the strike of the schistosity is N. 45° E. This corresponds to the strike of the long directions of the pebbles which is likewise that of the bedding. This conglomerate seems to grade up to the N. into fine grained slates, which are

S. 22 T. 6 B R. 9

Scale 8" = 1 mile

22
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1/4

now sericite and graywacke, which on the lake shore are very green and schistose. These have in some cases at least been called green schist although they are clearly normal sediments. The strike of these slates is N. 60° E. The graywacke of the series here shows very prettily false bedding. In some places the long direction of the pebbles was seen to agree with the schistosity which cuts across the bedding. Thus at one place the strike of bedding was N. 10° E. and of the schistosity N. 30° E. A very pretty case of a slate pebble folded around a pebble of jasper was seen. The slate had cut around the pebble and was cracked on the convex side by tension and compressed on the concave side. It was bent around so as to agree with the general strike of the bedding.

Going to the W. and S. the strike of the bedding is found to change to the N. 10° W. with a dip of 60° to the E. Moreover the typical conglomerate disappears and the graywackes and slates increase in quantity with an occasional band of pebbles in them. The graywacke is made up chiefly of round feldspars in a green matrix. The variation in strike of the sediments is shown on the accompanying map. Specimens of this conglomerate and of the sediments were taken in

1898.

N. 1200. W. 652. Sec. 22. T. 63. R. 9. After passing over the normal conglomerate, graywacke, and slate I reached at this place a schistose conglomeratic rock in which the pebbles appear to be of one kind, a medium grained porphyritic green rock. The phenocrysts are of feldspar, cf. Nos 27938-9. from note book for 1898. The long direction of the pebbles agrees with the trend of the schistosity which is N. 35° E. This rock grades to the S. into the normal conglomerate with granite pebbles although the granite pebbles are not very prominent and not so numerous here as in the rocks to the E. At N. 1100. W. 650. the strike of the banding is N. 10° E. The pebbles here are of green schist, white, gray, and black chert, and red jasper, with purplish porphyritic rocks which were specimened in 1898. No recognizable granite pebbles were here found.

N. 775. W. 975. S. E. corner Sec. 22. T. 63. R. 9. Here a ~~jasper~~ basic dike is found cutting the sediments. After leaving the conglomerate whose character is clearly recognizable, I go W.

and S. over a rock which has a fairly uniform grain, greenish in color with occasionally a pebble like area through it. It has somewhat the appearance of some of the graywackes which one finds in this area especially those graywackes which are made up for the most part of fairly large feldspars. These resemble very strongly certain of the porphyritic rocks which occur W. of here and not very far from the portage from Moose lake into Flask lake. Moreover pebbles similar in general appearance to this rock have been observed in the conglomerates. In fact the pebbles occurring in the conglomerate mentioned above as consisting of pebbles for the most part of one kind resemble these very strongly. Is not this a rock identical with the porphyry which occurs occupying large areas W. of here and which is probably older than the sediments instead of younger and cutting them as was supposed to be the case? Specimens of this rock were taken in 1898. 27938-9 The area occupied by this rock whose characters I am unable to determine in the field is approximately as outlined on the map.

H6. F. P.
28947

N. 500. W. 1500. Sec. 22. T. 63. R. 9. Here I come to an exposure of

the purplish porphyritic rock which occurs in numerous pebbles in the conglomerate to the E. This conglomerate consists for the most part of the pebbles derived from this rock. The matrix from these pebbles seems to be made up chiefly from feldspars which are probably also derived from this rock. It is possible that this rock which I have taken to be a conglomerate is really a sheared porphyry. Shearing along fracture planes at 45° to each other give oval to round areas which on the weathered surface give a conglomeratic appearance to the rock. This porphyry contains some irregular fragments of fine to coarse grained greenstone. It must evidently be younger than some if not the majority of the ellipsoidal greenstones of this area and possibly with them forms the complex from which the sediments were derived. N. of this feldspar porphyry there lies a greenstone which varies from fine to coarse grained. Although in contact with the porphyry relations could not be determined. The contact is presumably eruptive, and probably with the porphyry intrusive in the greenstone. The top of the hill to the N. of this is occupied by a greenstone probably a variety of that occurring to the S. The N.

slope of this hill down to the lake is very steep. Along it there is exposed a very rotten slatey rock which I presume is a true slate.

While I had been doing work on the Kawishiwi, at other places Leith has been tracing out the boundaries between the sediments and the greenstones just S. of Moose lake. Visited this area with him to-day in order to try and straighten out the relationship between the sediments and the greenstones. We revisited together the area mapped by him as slates which show a synclinal structure with conglomerates upon the N. grading to the S. into slates and with the conglomerate coming up on the S. limb. Similar conglomeratic rocks apparently lie in the western continuation of this syncline. The syncline opens to the E. and has a trend of approximately E. and W. See Leith's notes for details.

Was also shown the feldspar porphyry which here had what appeared to me to be an eruptive relationship to the sediments. This does not agree with my own experience to the E. where I found fragments of it lying in the sediments. I could find no proof here of the fact that it was, however, older than these slates. Now visited the contact between the conglomerates and the greenstone. There can be no question here as to the relationship of these rocks. The conglomerate has been derived from the greenstone containing fragments of

the underlying greenstone. One can match numbers of these pebbles with the greenstones. The conglomerate is made up for the most part of fragments of greenstone with numerous pebbles of black and red jasper and some veined quartz. The jasper pebbles show almost uniformly a concentric structure, ~~weathering~~ black jasper upon the outside and red in the center. The black color of the jasper is caused by the iron existing as magnetite while in t the red jasper it is present as hematite. Were the pebbles originally red jasper and is the exterior zone due to a process of reduction in the zone of deep burial, or was it originally black jasper and is the red center due to oxidation in the surface zone of weathering? The first seems to be the easiest method of explaining the zonal structure although it is the reverse of the process with which we are accustomed to deal.

C. Geo + Sl

28948 W. 150 N 1850 S. E. corner Sec. 32. T. 64. R. 9. Here are sediments, the conglomerates, graywackes, and slates, which consist essentially of pebbles of greenstone, some showing amygdaloidal characters, others being without these; some being fine grained and others massive. No granite pebbles

were observed in this conglomerate, although veined quartz is present with some pebbles apparently of slate or of schist whose source is unknown.

Going to the S. from the contact we passed over numerous exposures of greenstone. The gradation from the ellipsoidal fine grained greenstone into medium grained greenstone and this into the very coarse grained greenstone can be observed in a number of cases. It appears as though these ellipsoidal forms of the greenstone occupy the N. and S. sides of either large flows or sills, presumably flows, the centers of these flows being naturally of a very much coarser grain. Lying to the S. of this great greenstone mass over which one passes for a long distance, there is a narrow belt of sediments similar in general appearance to the sediments which we find to the N. of this greenstone. Have we not here an anticline of the greenstone with the sediments derived from it lying to the N. and S.? In fact a double anticline has the greenstone continued to the S. of this small sedimentary belt and has in its turnings followed by sediments.

28948 S. 2050. E. 950. from the M. C. on Moose lake between Secs. 28 and 29.

S. T. R.

Fig. 1

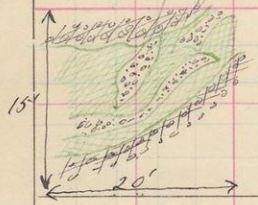
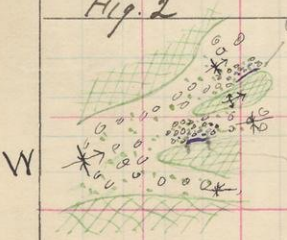


Fig. 2



This locates the narrow belt of sediments from 50 to 75 paces in width, which is bounded on the N. and S. by the greenstone. This belt connects on the W. with similar sediments thus giving a strike somewhat N. of W. to the belt. The width of the exposures of sediments varies very slightly. At the above location I find in the conglomerate a narrow tongue of greenstone. In the conglomerates these appear to come from below as I cannot connect them laterally with the greenstone. Some of these show a coarse center with finer sides apparently, judging from this alone, having intrusive relations with the conglomerate. The following Fig. 1 is a rough sketch to illustrate the association of the greenstone and the sediments at this place. Going E. farther along the belt we find a place where lying upon the greenstone to the S. there is a small mass of jasper about 2 feet in width, and immediately upon this overlying it to the N. there is found the conglomerate with pebbles of greenstone and of jasper in it. At this place the relations of the rocks as mapped Fig. 2 appear to result from infolding and I am strongly inclined to think that the intricate relations mentioned above are the result of in-

folding. A large scale sketch showing the succession from the greenstone and jasper into the conglomerate has been made by Leith, and in his note book will be found the details carefully noted.

28949 S. 2700. E. 1500 paces from M. C. on Moose lake between Secs. 28 and 29. This is a specimen of the conglomerate or of fine tuff which lies next to the greenstone and is infolded with it. The result of this infolding, which can be seen well at this point and just W. of here along the belt, is that the greenstone and sediments occur intimately associated with each other in irregular patches, and just at this point alone it would be practically impossible to determine the relations between them. However, having traced the belt one is certain of the relationship. A little bit farther W. of this point the conglomerate contains numbers of pebbles of a purplish black felsitic rock. This appears to be to me the same as found just W. of here in 1898. cf. spec. No. 27848. This belt of conglomerate was traced out to the E. for some distance further but owing to the lateness we had to give up the tracing of the belt for this day. Then we waited two days

on account of the rain hoping for a chance to trace the belt further. On the third day moved in the rain farther E. not considering it worth while to remain longer at this point for the purpose of tracing out this belt which, although desirable I did not consider necessary. The work of this and previous years has shown sediments in practically continuous masses to the E. of the point where we stopped tracing this narrow belt. I am certain that this belt will join the main mass of sediments lying to the E. The areal ~~w~~ may will ~~then~~ show in this vicinity at least two large anticlines of greenstone trending to the S. of E. separated by a narrow belt of sediments, and with sediments wrapping around their E. ends and N. and S. sides. Just how the greenstones and sediments connect with the greenstones and sediments to the W., that is, with those around the Twin lakes and Pine lake and especially how the boundaries would run in the area still farther W., must remain unknown. There is no doubt in my mind but what, if the exposures were sufficient, a great number of anticlines of greenstone with intervening synclines of sediments could be traced out between Moose lake and Ely; and the same thing could be done farther W. of Ely. However, as the expo-

sures are not sufficiently good it has been possible to trace out only a very few of the folds.