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[Lake Vermilion area, Minnesota]: [specimens] 28890-28924. No. 323 1899

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

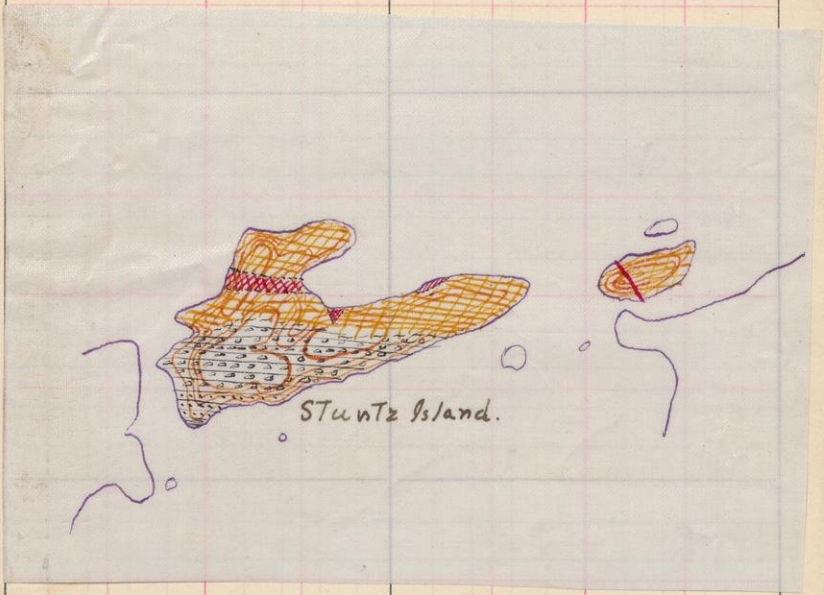
5. Forward this note book as soon as filled as registered mail matter to C. R. Van Hise, U. S. Geologist, Madison, Wis.

28890-28924

No 1.

Notebook No. 373

S. T. R.



Stuntz Sediments cgl.
sw.
sl.

Q. Porphyry (small eyed Q. Porphyry.

Micro-granite

28890-1-2-3-4

Stuntz Island.

July 2nd.

This, our first day in camp, was spent in examining Stuntz Island on which we are encamped. The S.W. end of the island is composed of a conglomerate, the typical Stuntz varying from a very coarse phase into finer phases and grading up in places into a graywacke. This conglomerate is cut by basic dikes varying from 1-1/2 inches up to 6 feet in width. At one place I counted 9 dikes essentially parallel within a distance of 60 feet. These dikes cut right across the fragments in the conglomerate giving sharp contacts. Jasper fragments cut by such dikes are apparently unaltered by them. These dikes are only very slightly schistose and then only on the edges. These dikes trend slightly S. of E. and cut across both the schistosity and the bedding of the conglomerate.

N. of the conglomerate but not in direct contact with it there is found a rock, specimen 28890, which is usually massive though in places, on examination, schistose, specimen 28891,. The contact line between

this rock and the conglomerate strikes a little S. of E. This rock forms the greater part of the island and is very probably a microgranite although its character cannot be determined absolutely in the field, but its uniform grain, lack of any indication of bedding, and the fact that it contains scattered through it here and there small yellowish green inclusions, points to its eruptive character. The nature of these inclusions could not be determined. They are for the most part small, rarely more than 2 inches in length by a half inch in breadth and seem to consist for the most part of a chloritic material.

This rock is separated from the conglomerate by a marked topographical depression. It forms the major portion of the E. half of the island. The same kind of rock forms also the greater portion of the northern point of the island.

On the N. shore of the eastern arm of the island we find an exposure of a rock with white quartz phenocrysts. This is very clearly a quartz porphyry The contact of the quartz porphyry with the supposed microgranite is irregular but trends approximately S.of E. On one place, as shown on the

plat, a tongue of this porphyry projects southward into the microgranite. On the N. arm of the island the same rock, specimen 28892, appears in contact on both sides with the microgranite. The contact is irregular and might be interpreted as an eruptive contact or a contact due to infolding. Looked at broadly the trend of the contact on both sides of the quartz porphyry is a little to the S. of E.

It is evident that the S. W. end of the island consists for the most part of conglomerates with which there are some very quartzose graywackes, specimen 28893. This graywacke has scattered through it either as stringers in it as a result of deposition, or as a result of infolding, areas of a rock, 28894, which looks strikingly like the quartz porphyry, 28892. It is believed, however, that this rock is not a quartz porphyry but is a rock derived from the porphyry, and that the angular character of the quartzes is due to the fact that they have not been very much worked over by the water.

S. T. R.

July 3rd.

Spent the day upon Tower and Lee hills. My chief object was to find, if possible, a basal conglomerate overlying the jasper. This conglomerate would naturally be found upon the flanks of Tower hill. The flanks of this hill were carefully examined and no such conglomerate was found. While working with the above object in view the following additional observations upon the geology of this hill were taken. It was noted in particular that the large dike of porphyry occurring upon the S.W. flank of Tower hill was split into 2 parts, the V formed by the splitting of the dike being occupied by jasper. This dike cuts across the jasper bands at an angle of 45°. The jasper on the W. end of Tower hill is very much crumpled, very much plicated, but on the whole has a strike of from N. 60°-65° W.

The ledges of jasper show alternating bands of white chert, brilliant red jasper and ore. These bands are cut by veins of quartz which fill small cracks and are evidently of secondary origin. Some cracks transverse to the above mentioned bands are filled with iron ore, the secondary nature of which is thereby shown At least two series of cracks have been formed in the jasper, the latest

having been filled by iron ore (hematite).

The W. end of Tower hill is divided into two points with an intervening depression. W. of the S. point across the wood road an out crop of jasper was observed. The large out-crop of Tower hill ends at the foot of Tower hill about 50 paces E. of the road. The small knoll of jasper above mentioned is about 25 paces in extent E. and W., and is about 75 paces W. of the foot of Tower hill.

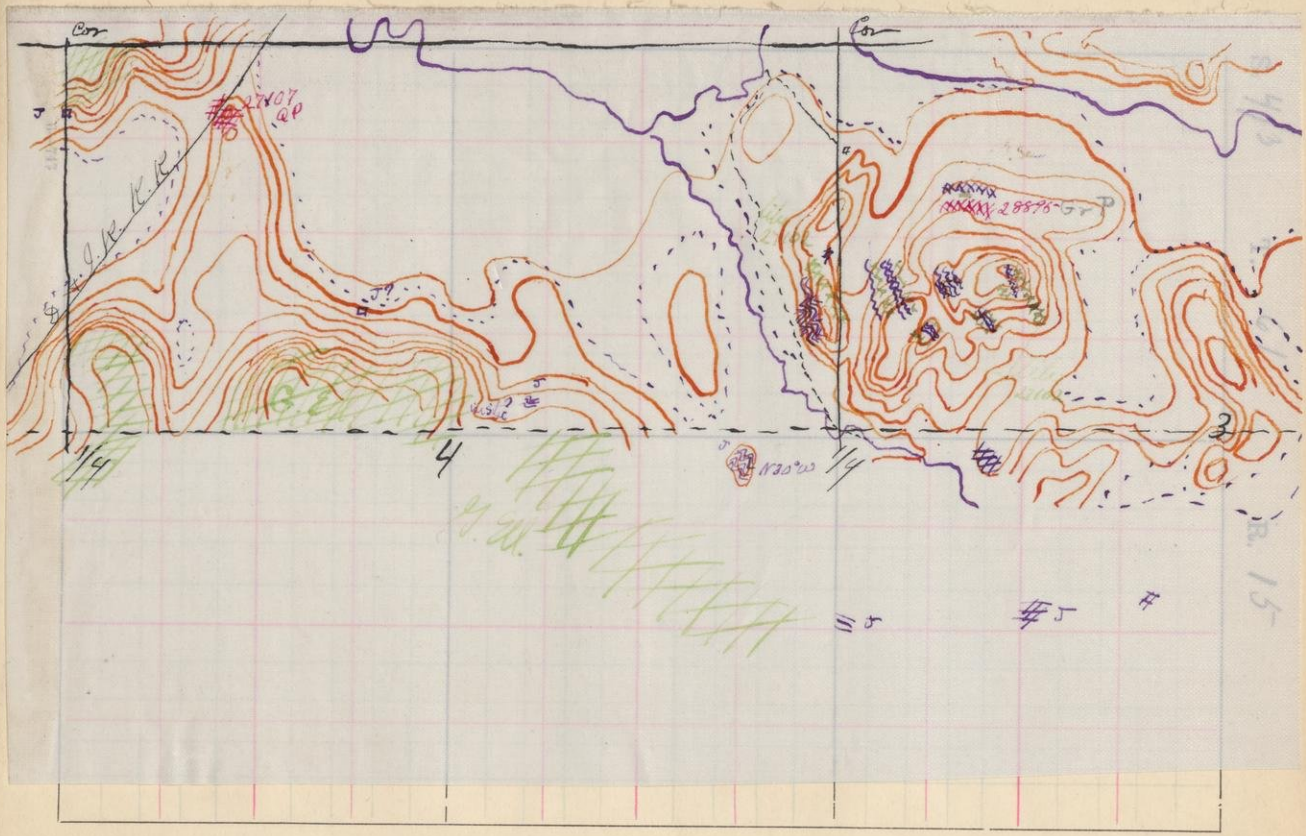
On the N. slope of Tower hill the plicated character of the jasper and green schists can be well seen. Here there are a number of small anticlines. The exposures in some cases show small V shaped areas of jasper about 35 paces long with a strike of the axis of the fold to the E. and W. The dip is nearly vertical, as is also the pitch of the folds. The point of the V is to the E. These jasper areas are surrounded by a schistose rock which in many cases, in fact in most cases, has distinct quartz eyes. Specimens of a rock similar to this have already been taken from the saddle between Lee and Tower hill. The rock appears to be a very large mashed amygdaloid. The green schists are very possibly basic in nature. The yellowish ones are more probably sericite schists derived from

rived by mashing from a quartz porphyry. In the one case the quartz eyes would be amygdules; in the other they would be quartz phenocrysts. The general appearance of the exposures on the N. slope of Tower hill is very much like that of the exposures on the saddle between Tower and Lee hills. The folding is so complicated that even with the most detailed mapping it would probably not be possible to trace out the respective green schists and jasper bands for long distances.

July 4th.

Spent the day in examining the N. slope of Soudan hill looking for the extension of the Stuntz conglomerate found in 1897. No more of this was found and there is apparently but this small patch on the slope of the hill. Across the valley from Soudan the slates outcrop forming hills of considerable height. Evidently the contact line between the slate and conglomerate would run approximately E. and W. through this valley.

Examined the rock on the S. slope of Soudan hill just below the mine stock piles. This rock was specimened in 1897, specimen , This is unquestionably a conglomerate although the section made from it does not show under the microscope very clearly its conglomeratic character. Pebbles of quartz and slate and some doubtfull quartz porphyry pebbles were observed.


Cor
Cor
1/4
4
1/4
3
R. 15

Went with T. Walsh to examine the outcrops of jasper in S. 3 and 4, ~~by~~ T. 61, R. 15, W. He has found jasper by means of a pit just at the foot of a greenstone ridge at about 150 paces S. of N.W. corner of S. 4. The greenstone bends around from this point to the S. W. and then up to the N. E., forming so far as its exposures are concerned a U opening to the N. E. On the railroad just a short distance S. of the pit, see plat, there is a cut through granite porphyry. This granite porphyry is also found cutting the greenstone W. of this point. It is also found cutting the greenstone to the E. It looks very much as though a jasper would be found in this U surrounded on three sides by greenstone and possibly with the opening of the U approximately closed by the granite porphyry dike. If this is the condition which exists here one can be almost certain that a large deposit of iron ore will be found within this area. Before beginning explorations, however, it is above all desirable to first find out by means of diamond drill holes or test pits whether or not jasper exists here. The part of this U lying between the section line of the E. and the greenstone on the W. belongs to the Minnesota Iron Co. and

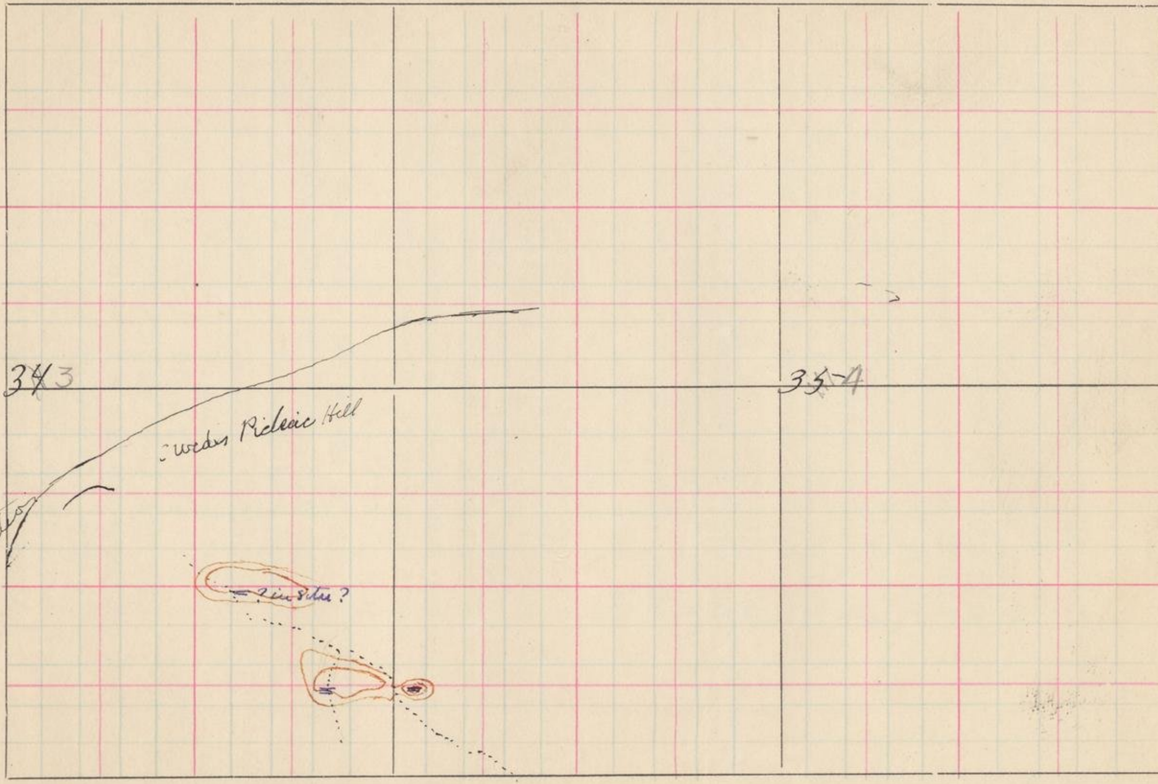
Walsh reported to me that, upon one occasion when the Duluth&Iron Range Railroad was making an excavation through here for the purpose of extending their track, the President and General Manager of the Minnesota Iron Co. were brought to this point to be shown ore which the workmen had found after cutting through the drift. Walsh carried me then to a test pit 41 feet in depth which he put down in 1897 and 1898. This pit is about 60 paces N. of the greenstone and is located on the accompanying plat. According to Walsh hard hematite ore was struck at the bottom of the pit 41 feet below the surface. A sample only was obtained as the pit was soon flooded and no further work was done. It is possible, as I told Mr. Walsh, that he had only found a boulder of ore although he is thoroughly convinced that he has obtained ore in situ.

I went over part of the ground covered in one of my runs in 1897. This year's observations confirmed those of that year that in this area the structure is anticlinal with the axis of the anticline trending to the N. 60°-70° E. Upon this hill the jasper and the greenstone are very closely associated and show apparent-

ly interlamination. This may be due to the infolding as the rocks are ver very much plicated although I am inclined to think that it is due to intrusive relationships. In some places a porphyritic greenstone, spec. 27102(?), occurs showing such a field relationship with the jasper outcrops that one is inclined to believe it to be intrusive. One can find an outcrop of jasper with its long direction trending, for example, S.E. N.W. and only for a short distance away from it, perhaps on both sides of the jasper, perhaps with jasper on both sides of it, occurs a porphyritic greenstone. Suce occurrences do notshow direct contacts. The greenstone areas vary from 5 to 50 feet in width. This greenstone seems to be somewhat different from the usual ellipsoidal greenstone in that it is porphyritic and appears to be uniform ly more massive, and as stated above I am inclined to consider this as an eruptive greenstone later than the jasper although absolute proof of this was not obtained.

Jm.P.
28895 At the place upon the plat indicated by the specimen number opposite there is an exposure of a rock which looks like a granite porphyry. It contains some few perfectly round areas possibly pebbles of greenstone. Some inclusions were seen which look

S. 34/35 T. 62 R. 15



6—747

like slate. This porphyry is differen
from the porphyry which occurs upon Vermilion lake but seems to be similar to that one outcropping in the railroad cut about one mile and a quarter due W. of this point and continuing on W. of the railroad. W. of the railroad the rock unquestionably cuts the greenstone although here its exact relationship to the greenstone cannot be determined. The character of the inclusions also indicates that it is later than the greenstone. I find in it three kinds of greenstone, one fine grained, another coarse grained, and a third with porphyritic feldspars. Upon the glaciated surface of the porphyry glacial striae were observed trending to the N. 25 E.

I find this rock within about six inches of a crumpled jasper but cannot get its relations. It appears to cut across the strike of the jasper. There is no sun this afternoon and in the presence of this jasper I cannot use a compass so that I cannot be sure of the plating. At one place I find also a small patch of green schist lying between the jasper and the nearest patch of the porphyry.

On the way back to camp Mr. Walsh showed me several exposures of jasper in the low ground between this point and Soudan. These exposures are located on the accompanying plat. He

also tells me that jasper crosses in the bed of West Two Rivers about 300 paces E. and 50 paces S. of the water tank, S. of Tower Junction. The following location of a jasper exposure was given by Mr. Walsh, Oct. 4th, 1899. S. 400 W. 500 N. E. corner Sec. 4, T. 61, R. 15. He tells me that the jasper ledge rises to a heighth of about 20 feet above the swamp level. About 60 feet of the jasper is exposed. Walsh claims that he traced the jasper for 475 feet N. and S. and found greenstone lying on the N. flank of the jasper.

From the occurrence of the jasper in this swamp it seems highly probable that the jasper will be found to continue to the S. W. and occupy the U in the greenstone which has already been mentioned.

F. P.
28896

July 7th.

In company with Leith visited Ely Island for the purpose of studying the relations of the graywackes and slates to the porphyry which occur there. Started on the S. shore just at the foot of the high hill on the E. end of the island. As we go N. up the hill we pass over a rock which is clearly a quartz porphyry. A specimen of this was collected in 1897, c. f. No. 26855 This rock alternates with 28896, a rock whose character I cannot certainly determine in the field. It may be a micro-granite or possibly a fine grained graywacke. The contact between them is sharp and trends, as a rule, to the E. and W. Is the quartz porphyry intrusive in 28896? Are their relations due to interbedding or infolding? Either might result in giving the relationship found here.

28897
Basalt

The rocks mentioned above are cut across by a basalt dike from 12 to 24 inches in width. It trends N. and S. It is very slightly schistose and is evidently one of the youngest rocks in the region.

Q. P.
28898

On the N. slope of the highest hill on the E. end of Ely Island I find a fine grained gray rock like 28896 which contains a few pebble-like

areas of a green schistose rock. This gray rock is, I presume, a micro-granite. It is followed to the N. by a porphyry, 28898, in which we find a few round areas of veined quartz, slate and indeterminable greenish rock. If specimen 28898 is a porphyry then it looks as though we had on this hill an eruptive rock, 28896, cut by E. and W. parallel intrusions of porphyry quartz 28898. Or, if 28896 should prove to be a graywacke then the hill consists of a sedimentary series either cut by E. and W. intrusions of quartz porphyry, or possibly it is a case which has resulted from very close infolding of the porphyry and the sediments derived from the porphyry.

The contact between the fine grained rock, 28896, and the porphyry, 28898, is sharp and trends N. 30° - 40° E. A little farther down the N. slope of the hill I find an irregular contact between these same rocks. This contact is seen to run in all directions but a certain regularity can be traced out as is shown on accompanying sketch. Such relations might clearly be the result of very close infolding.

F.P

28899 This specimen was taken from the massive feldspathic rock occurring on the S. shore of Ely Island on the E. point just before the

point just before the unquestionable sedimentaries begin to appear. This is probably a micro-granite.

On the extreme E. end of Ely Island the rocks are well exposed. We find here a series of interbedded slate graywacke and typical fine conglomerates similar to the Stuntz extending across the entire breadth of the point of the island. The strike of the series varies from N. 60°E. to N. 80°E. and to E. and W. The dip is high to the N., about 80° on the average though dropping as low in exceptional cases as 70°. The conglomerate is made up of pebbles of veined quartz, jasper and slaty rock but chiefly of pebbles of quartz porphyry. The most prominent of these porphyry pebbles is one with large eyes of white quartz in a very dense felsitic matrix. This is the kind of pebble which is most striking. Another has the large quartz eyes in a granitic matrix. We have been accustomed to speak of these two porphyries as the big eyed quartz porphyry or the white eyed quartz porphyry on account of the size of the quartz phenocrysts and because, very frequently, these phenocrysts instead of being glassy are

white and porcelain-like.

In contradistinction to these porphyries we have used the term small eyed quartz porphyry for one in which the phenocrysts are more numerous and uniformly smaller than in those porphyries just mentioned. Pebbles of this porphyry are very common in the conglomerate.

At one place on the E. end of the island about 50 yards from the N. shore we find a quartz porphyry in contact with the above described conglomerate. The contact runs about N. 10° W. to S. 10° E. This porphyry mass is about 35 paces in width. The contact in detail is irregular though looked at broadly it trends as was given above. This porphyry is the small eyed quartz porphyry and is identical in character with the pebbles described above as occurring in the conglomerate. Although the relationship between the porphyry and sediments resembles an eruptive contact, it is clearly not an eruptive contact but must be due to infolding. Upon a former visit to this island it was, however, believed to be an eruptive contact.

On the first point W. of the extreme N. E. end of Ely Island a contact between this same quartz porphyry and the sediments was studied. The con-

tact here is extremely irregular. The eruptive and sedimentary rocks finger out into each other and in one place a small mass of the conglomerate lies within the area occupied by the porphyry. There can be no doubt as to the conglomeratic nature of this small mass which is only five or six inches in diameter as we can clearly recognize jasper and white quartz pebbles in it. In places along the line of contact between the porphyry and the sediment we find pebbles lying in the porphyry which appear to have been derived from the sediment. This contact seems to give conclusive evidence as to the relationship between the sediment and the porphyry. Mainly upon the strength of this it was concluded that the porphyry was intrusive into the sediment and included fragments derived from the sediment. When this conclusion was reached it had not been clearly recognized that pebbles of this same porphyry were contained in the conglomerates. However even this fact is not conclusive as to the age of this particular porphyry and the sediments. For, if one were so inclined, he might say that there were two porphyries of the same character in these regions, one, the older, having furnished materials

to the sediments; the other, the younger, being in this case the one which has just been described, cuts these sediments. Later studies, which will be described farther on in the notes, have convinced me that the relationship above given which simulates so remarkably an eruptive contact is really due to infolding.

July 8th.

When coming up from Duluth to Tower I kept a lookout from the train for the boundary between the granite of the Mesabi range and the sediments S. of Tower. I could follow the granite by means of good exposures a little beyond what is N., of Embarrass. To-day I went down to the farm S. of Norway and about half a mile N. of Embarrass and walked back to Tower studying the exposures, especially those in the proximity of the rail-road. The 86 mile post reckoned from Duluth is a short distance above Norway. The railroad cut near here through the drift exposes a large quantity of boulders of mica-schist cut by a medium grained white to gray granite. About 100 paces E. and one-half mile N. of mile post 86 I find large exposures on the E. edge of a hill just above the swamp of mica-schist or mica-gneiss. This rock is cut by dykes ramifying ~~phases~~ of a medium grained white to gray granite. From its general appearance I am strongly of the opinion that this rock was originally a sedimentary rock and that it has acquired its present character as the result of metamorphic action. This metamorphism may possibly have

been regional in character but more probably, in my opinion, the result of the intrusion of a granite. The small dikes seen here in these outcrops would not be of sufficient size ~~to metamorphose a sedimentary rock~~ to produce from a sedimentary rock the schist which we have before us; but these dikes are presumably but the off-shoots of a very much larger mass of granite and I judge that they are the off-shoots from the Mesabi granite. If this should prove to be true then we have the Mesabi granite younger than these metamorphosed sediments lying to the N. of it.

28900 About 200 paces S. of mile post 87 and 100 paces E. there is a large knoll of the same kind of rock, as described above, exposed in the open swamp.

28901 2 - 3 About 800 paces N. of mile post 88 there is a cut through rock. This rock is a banded fine, 28901, and coarse grained ~~mica-schist~~ hornblende. The banding strikes N. 80° W. and dips 70° to the N. I believe this rock to be like those lying to the S. ~~and~~ metamorphosed sediment. It is cut

by dikes of white granite varying in width from one inch to four and one-half feet. Specimen 28902 shows the width of a small granite dike and also shows an inclusion in it of mica-schist or mica-gneiss. On the exposures seen S. of this point the banding was so contorted that I could tell nothing about the strike. The above strike probably will answer only for a very small area as these rocks have been most probably extremely plicated.

The mica-schists are also cut by a dike about eight feet wide of rock 28903 which seems to be a pyroxenite. This is finer grained on the edge than near the center. The specimen was taken from near the edge.

Similar schists outcrop again at the switch at about 500 paces S. of mile post 90.

28904-5 About 500 paces S. of mile post 92 there is exposed in the railroad cut and on the E. side of the railroad an extremely interesting series of sediments. On the first exposure to the S. on the right hand side of the road the interbanding of conglomerate and finer grained

sediments, specimen 28904, is very nicely shown. This conglomerate consists chiefly of pebbles of granite and of greenstone. It grades into a graywacke, 28905, which is now almost a mica-schist although macroscopically one can still see the original round eyes of blueish quartz. On this same exposure one can see small beds of a rather fine grained conglomerate, which consists almost exclusively of fragments of greenstone. It is a greenstone conglomerate or possibly greenstone tuff. The strike of the beds on this exposure is N. 40° W. with a dip of 45° to the N. The finer grained sediments display as beautiful a false bedding as I have anywhere seen.

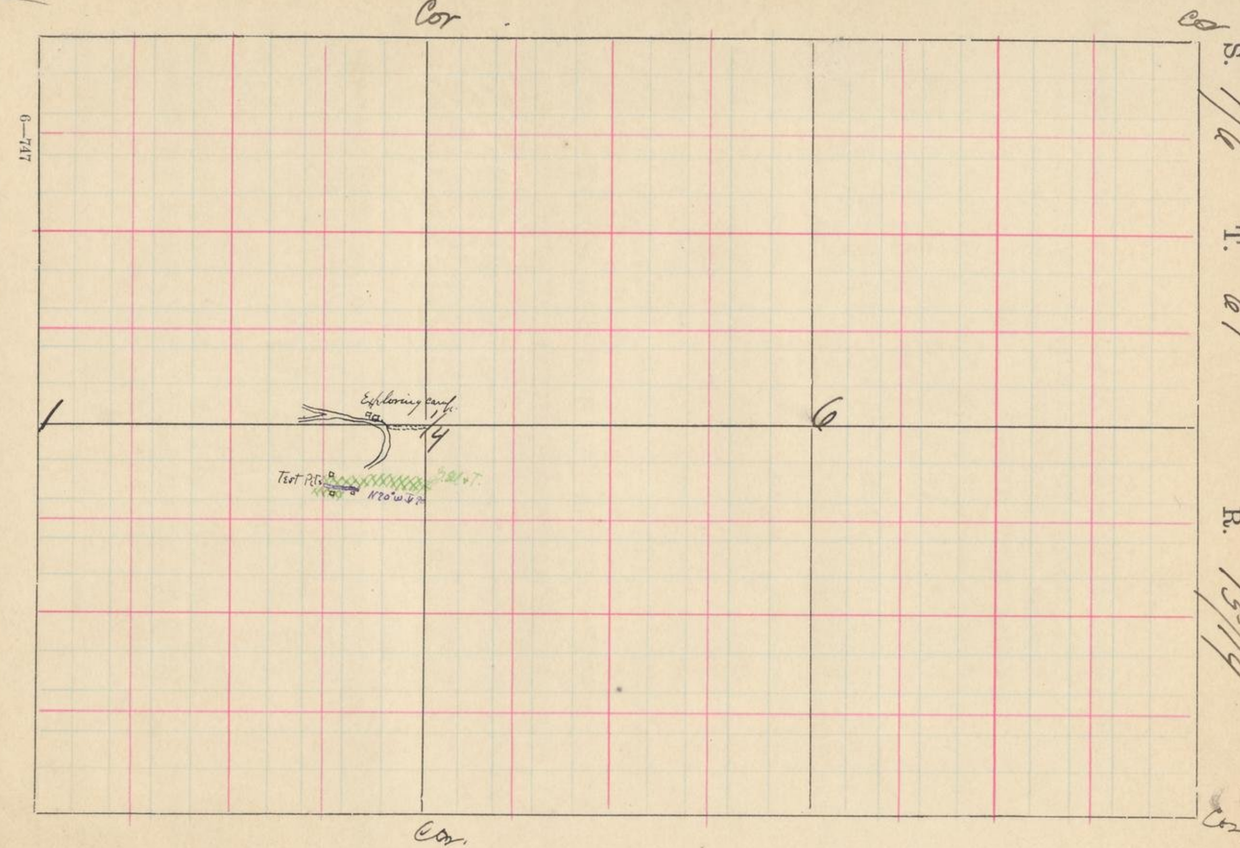
The fine grained sediments continue for some distance to the N. On the northernmost exposures, however, I find a coarse conglomerate. The pebbles forming this conglomerate are jasper, veined quartz, ferruginous quartz, greenstone of several varieties, slate or what appears to be slate, quartz-porphyry, and various kinds of granite and granite-porphyries. This conglomerate reminds me very strongly of the conglomerate which occurs in the vicinity of Snow-

bank and Disappointment lakes to the N. E. of this point. It is very different from the Stuntz conglomerate in that it contains large quantities of greenstone and in general a greater variety of other pebbles. It seems to me that this conglomerate is interbedded with the sediments which occur just to the S. and in contact with it, and in fact there appears to me to be a gradation from the finer sediments on the S. into a coarser sediment and into coarse conglomerate on the N. In other words, this conglomerate appears to me to be a basal conglomerate and one which is certainly older than the jasper, the greenstone, and the porphyry of the vicinity of Tower since it contains pebbles derived from them. It may be possibly of the same age as the Stuntz conglomerate though I am not inclined to believe that this is the case, but rather am I inclined to think that it is younger than the Stuntz conglomerate and that the sedimentary fragments (slates mentioned above) were derived from the sediments overlying the Stuntz conglomerate. Moreover up to this point it has been patent to my eyes that there has been an increase in the metamorphism of the sediments over those which I first saw N. of Embarrass

and which would readily pass for normal mica-schists and gneiss into these rocks whose sedimentary characters are clear. This of course is especially true for the conglomerates since it is difficult to destroy the pebbles. However, even the fine grained sediments although very much metamorphosed still retain sufficiently well the ear marks of sedimentary rocks, spec. 28906. The railroad cut through the conglomerates and graywackes offers an exceptionally good opportunity for getting ~~other~~ fresh specimens. This specimen is of a graywacke. The rocks dip from 50° - 60° to the N. and the strike appears to be, in general, to the N.W. These sediments are cut by a few narrow basic dikes. See notes upon this same occurrence taken at a later date and refer to specimens taken at that time. From here on up to West Two Rivers exposures are fairly ~~given~~ numerous. They consist of interbanded slates and graywackes which strike to the N. 80° W. and dip 65° N. These rocks are very similar in appearance to the sediments which have just been described although they seem to have been less metamorphosed.

sw. 28906 m.s.

S. 1/6 T. 61 R. 15/14



6—747

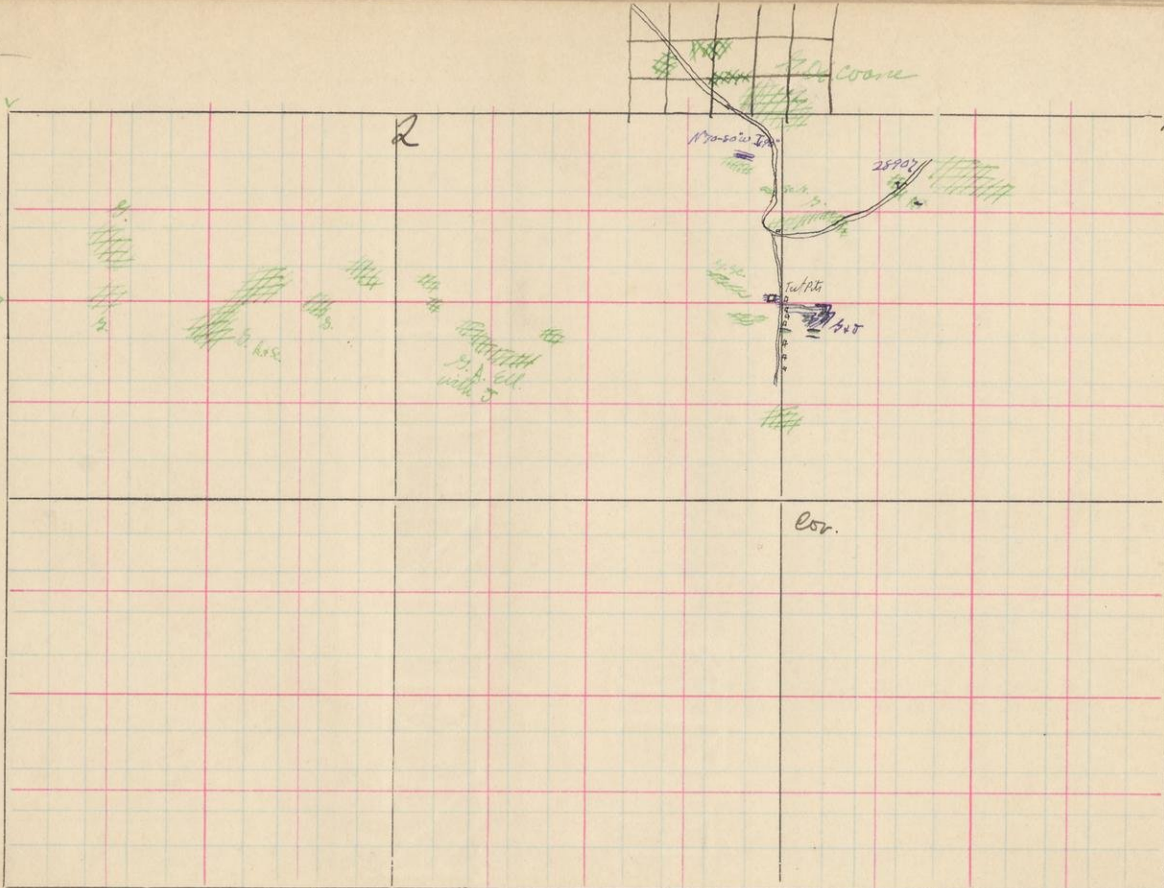
Went down to examine the exploration in the S. E. quarter of 1. S. of Jasper Peak on the railroad, at mile post 98, there is a cut through greenstone. 100 paces S. of this there occurs an exposure of greenstone cut by rather coarse granite porphyry like that S. of the tank at the junction. The next cut about 400 W. on the railroad shows greenstone cut by granite porphyry. Went on down along the Winter road into Sec. 1. Wasted nearly all of the forenoon in trying to find the land lines in order to get a location. This exploration was carried on by Mr. Underwood of Duluth and some one else. Very little stripping has been done and the surface exposures are very poor. The diamond drill cores which were found show nothing but jasper and greenstone. The exposure here shows jasper from 15 to 30 feet in width: strikes N. ~~e~~ 70° W. and dips 90°. It extends about 100 paces E. and W. To the S. of the jasper there is found a massive greenstone. On the N. side of the jasper there is a greenstone which is schistoidal and appears tuffaceous. It does not, however, show any good sedimentary banding. The greenstone both to the

N. and S. is in contact with the iron formation which is the ordinary banded red jasper, white chert, and ore. After examining the exposures here and following them E. and W. as best we could, I traversed the swamp to the S. and W. looking for further exposures but unsuccessfully. I went on W. and my compassman, mistaking my instructions, failed after getting his location to meet me at the appointed place until late in the afternoon.

1

1/4

6—747



Cor.

S. 21 T. 61 R. 15

Started in this morning at the W. quarter post of Sec. 2. Went S. a quarter of a mile ~~following~~ E. and N. as shown on plat. The greater part of the run was over greenstone varying from the massive greenstone to that which was slightly schistose. This greenstone shows very commonly an ellipsoidal parting and an amygdaloidal structure. In one place, see plat, it was cut through by a granite porphyry similar to that found quite commonly in the greenstone between this point and the hill range S. of Tower. N. 500 W. 1400 S. E. Sec. 2 T. 61 R. 15. Here there occurs a schistose amygdaloidal greenstone which contains veined quartz and jasper in irregular areas from 3 to 4 inches wide and 18 inches long. There are in the rock a few areas of ferruginous chert with a small quantity of red jasper which are 3 feet wide and 4 feet long. These areas appear to lie right in the midst of the normal greenstone and are presumably either inclusions or the result of infiltration.

28907 N. 800 W. 1700 S.E. Sec. 1 T. 62 R. 15. This specimen shows the in-

filtrated gray quartz which is found in areas of varying size in the greenstone of this district. This quartz (or chert) is sometimes black and sometimes red and is then called black and red jasper respectively. The white, red, and black may occur together or ~~the~~ separately. Most commonly the white or grayish chert is associated with the other two. I could not find any regular order of occurrence of these varieties of chert.

About one-eighth of a mile N. of the S. E. corner of Sec. 2 there is a considerable area within which exposures of jasper are numerous and some of them large. This jasper is very much plicated but seems to form an anticline plunging to the E. The green schists are here interlaminated with the jasper as elsewhere in the district. ¶ About 100 paces S. W. of the quarter post between Secs. 1 and 2 and about 50 paces W. of the road there is a large exposure of jasper. The jasper strikes N. 70° to W. 80° with a vertical dip. To the S. of this there occurs a massive greenstone. S. E. of this point along the eastern continuation of this same road there may be found a number of small spots, they may almost be called , of jasper within greenstone.

It was from one of these that spec. 28907 was taken.

Carbonate

28908 Walked out this Sunday to Merriam's camp on the county road S. E. of Jasper Peak. Got all of his notes platted and visited with him the greenstone ridges N. of his camp. These are the normal ellipsoidal greenstones of the region cut by granite and porphyry dikes. These show fairly well the white granular matrix which is very commonly found between the ellipsoids in the ellipsoidal greenstones of this region and of the Crystal Falls district of Michigan. This rock now consists apparently of a carbonate and of quartz. As carbonation is the normal process which takes place near the surface, it is possible that the silicate is being gradually replaced by the carbonate.

Went over this morning to look over the mine records and the mine plats in the Minnesota Iron Company's office. Just as we got started to work Merriam came into the office and we all went out to map the jasper and greenstone W. of Jasper Peak.

B.S.
28909 N. 150 W. 250 S. E. Sec. 27 T. 62 R. 15. This is a specimen of greenstone which is usually associated with the jasper. This was taken from the area run out in company with Merriam of which he made a large scale map. This is just S. of the county road and N. W. of Jasper Peak on the outskirts of the village of Soudan. Here the greenstone is infolded ~~with~~ an anticline of jasper. The jasper is very much plicated into many minor synclines and anticlines. The pitch of the minor synclines is a little to the S. of E. and at an angle of about 80°.

Went to-day with Leith to the foot of the lake to see if the continuation of the Vermilion lake sediments could be traced out. We traced out the proximate boundary line between the granite on the N. and the mica and hornblende-schists to the S. The boundaries traced will be shown upon the plats in our respective note books.

W.S.

28910 This is a mica-schist which appears to me to be a metamorphosed sediment. It is distinctly banded and the bands strike N. 40° E. and dip S. 70°. This rock is cut and included by a fine grained granite.

28911 Canoed along the N. side of Frazer bay of Vermilion lake. Passed a number of points on which the mica-schists with crinkled banding occur. They seem to be metamorphosed sediments. I find them cut by and probably crumpled by the intrusion of a relatively coarse grained hornblende granite which has some reddish feldspathic ~~phase through~~ it. See Merriam's notes and the thin sections of his specimens taken in this area.

Continued on around the W. end of Frazer bay and found outcrops of metamorphosed slates similar to the ones already described. On the island, near the corner between Secs. 1, 2, 11 and 12 in the large bay E. of the old lumber camp I find greenstone with well marked ellipsoidal partings. On the S. E. side of the bay the greenstone is very schistose and may possibly be a green schist derived from a greenstone tuff or sand. This is cut by a basic dike.

G.S.
28912
(Sw)?

On the end of the point extending from the S.E. corner of Sec. 1 T. 62 R. 7 I find sediments which have a crinkled banding and seem to me to be very similar to the hornblendic graywackes which occur on the S. side of Pine Island. There are a number of exposures of these, some of which show a very schistose rock on the S. and N. sides of this point. On the S. side of the point the schists are cut by a granite porphyry with large feldspar phenocrysts. The banding on the fairly large surface gives a strike of N. 70° E. with a dip ranging from vertical to 80° S.

28913 hw -14 p. Spec. 28913 is from the quartzose rock almost a quartzite which occurs on the W. end of Stuntz Island and is there interbedded with and grades up into a conglomerate. The nearest conglomerate is to the S. of this rock. Immediately in contact with 28913 there occurs the rock 28914 which looks very much like a quartz porphyry. There is here only a very small tongue of this quartz porphyry, if such it is, and its relations to the other rock is not clear. It is possible that it is not a quartz porphyry but one of the sediments derived from a quartz porphyry, and not having been moved far from its source, has not materially changed its character. In other words it is that which may be called a "recomposed quartz-porphyry."

28915 hw. This is a specimen taken from the rock on the S. slope of Soudan hill just E. of the stock pile of the Alaska Shaft, just E. of No. 7 pocket and about 125 paces S. and W. of the foot of the stairs leading to the machine shops. This rock is now somewhat schistose and comes nearer being a quartzite or a quartz-schist than any other rock which I have thus far found on the Vermilion Iron Range.

In company with the mining engineer went through the Minnesota Company's mines and obtained a good deal of interesting data concerning their methods of mining, etc. According to Mr. Ahbe, the method of mining pursued at Soudan can be briefly described as follows: it consists in filling and taking out the ore by back stopes. All shafts and raises are sunk in the country rock, not in the ore, and are worked in a soap rock footwall. The soap rock occurs both as the foot and as the hang wall. Sometimes jasper may be struck on either wall and then passing through this as a rule strike soap rock, sometimes first passing through the ore

The maximum depth of the mine is at present, July 1899, 825 feet vertical (850 feet on the incline). The shafts are inclined shafts. Four shafts are now working. The number of men employed was 750. The mines are fairly dry and seem to be kept in a very good condition.

The ore is first broken by drilling and blasting. It is then thrust into the ore ~~s~~chutes. These ~~s~~chutes are 25 feet apart so that the ore can be thrust into them by the men working between the ~~s~~chutes. This saves

handling. From these ~~s~~chutes the ore is loaded into cars and trammed by mules to the shaft. It is then raised to the surface, trammed to the crusher, crushed in a Blake crusher, and is then dropped into the stock cars and sent to the stock pile or the pockets. From the ~~boxes~~ it is loaded directly into cars for shipment to Two Harbors. From the stock pile it is loaded by means of steam-shovels into cars and shipped.

There is a great deal of timbering done in the mine. The drift timbers have nine ~~f~~oot legs, eleven ~~f~~oot caps. The ~~rocks~~ average fifteen inches minimum diameter, the caps sixteen inches minimum. In the ~~s~~chute sets ten foot legs sixteen inches minimum diameter and thirteen foot caps eighteen inches minimum diameter are used. The ~~s~~chutes are six feet square requiring timber seven feet long and averaging twelve inches in diameter with a minimum of about nine inches. In some of the minor drifts timber sets with eight ~~f~~oot legs and ten foot caps are used. Heavy l~~o~~gging is used throughout all of the drifts.

28916 While down in the mine the mine cap-

tain stated that they found graphite and upon my desiring it specimens of this rock were gotten for me. It occurs in No. 8 mine, Soudan, at the 12th level. Its occurrence is reported as follows: it occurs in soap rock in ~~two~~ areas ten feet long and from six to eight inches in thickness. It was cut in a third dimension for eleven feet representing the width of the drift. This graphite is reported as having been tested by Mr. John H. Eby who reported it as graphite. The presence of this graphite would seem to indicate that the rock in which it occurs is not an eruptive rock but possibly a sedimentary, or else the ~~conglomerate~~ is included in the ~~sedimentary~~ which would indicate the occurrence of a series of sediments, possibly below the jasper, containing graphite.

28917 G. This is a specimen of so-called black rock from the 10th level back of No. 8 mine and from the handing wall. Is it not a phase of the greenstone? The mining captain and miners were especially interested in this rock as in the dim light of the mine it is frequently mistaken for

ore and loaded into ore cars. If its presence is detected when the car reaches the surface the drift boss is docked.

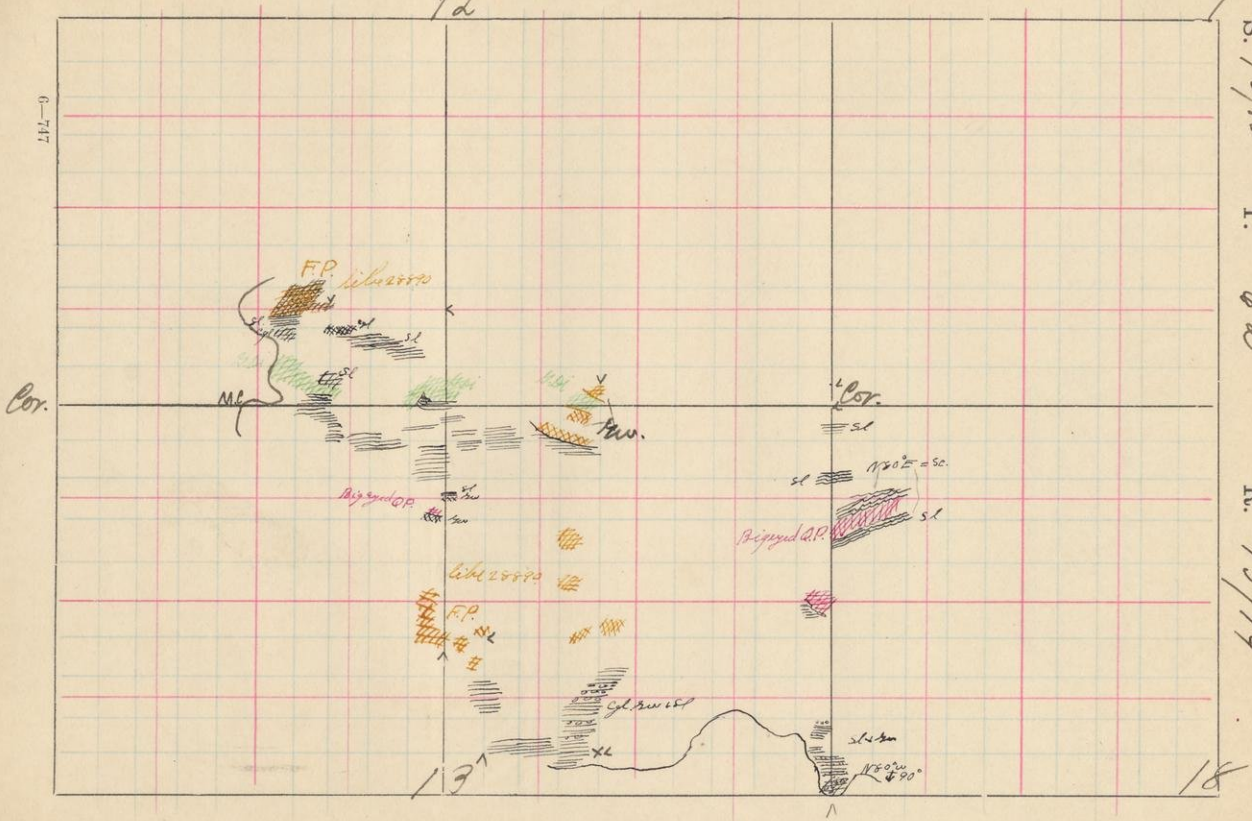
2

12

7

S. 18 T. 62 R. 15 W.

6—747



13

18

Studied to-day the point N. of Armstrong bay. Ran N. along the section line between 13 and 18, then W., S., and back N. again as indicated on the plat. The exposures near the shore are interbanded sedimentaries, fine gray conglomerates, graywackes, and blueish-gray slate. These strike N. about 80° W. and have a vertical dip. These are the normal sediemnts occurring on Vermilion lake. They show nothing beyond what has been previously noted many times. About 500 paces N. of the lake shore, approximately N. 1500 W. of S.E. cor. Sec. 13 T. 62 R. 15, an exposure was reached upon which was seen a big eyed quartz-porphyry in contact with the slate. The slate strikes approximately E. and W. abutting sharply against the porphyry. The contact between the two is somewhat irregular and trends in general S. E. and N. W. About 150 paces N. of this point I again reach an exposure of slate and graywacke about 30 feet in width to the N. of which occurs and in contact with it the quartz-porphyry with large quartz eyes. Still further N. across about 75 feet of this porphyry there is again exposed the slates. I could not get the bedding in these sediments. The schistosity strikes, however, N. 80° E.

The general trend of the exposures of these rocks is to the N. of E., approximately parallel with the direction of the schistosity. The relationship of the rocks here is probably one produced by infolding. As we continue N. we passed a few exposures of slate similar to those already mentioned in which no bedding could be obtained as the exposures are very much broken and too small to show the bands well. They all have a schistosity striking N. 80°E.

N. 1900, W. 635, Sec. 13 T. 62 R. 15. At the above location I find a graywacke in contact with slate to the S. The contact runs N. 80° W. and evidently gives the bedding of the rocks At N. 2000 about W. 600 - 700 there was observed a massive dolerite about 40 paces in width lying with graywacke both to the N. and the S. It was impossible to be certain of the relations.

N. 18, W. 10000 S. E. Sec. 12 T. 62 R. 15. Here the same dolerite mentioned above is found in contact with the slate. The contact is irregular

the slate bending around to the N. W. where the strike is apparently cut off by the dolerite. It looks very much as though here the contact was an intrusive one although the relations here are not sufficient to prove this conclusively. S. along the quarter line from the S. quarter post of 12 a number of exposures of slate and graywacke were observed. The slate occurs for the most part near the center of the point, that is, near the quarter post mentioned above. The graywackes are more common to the S. A microgranite similar to that of Stuntz Island containing green inclusions occurs in fairly numerous exposures about 500 paces S. of the N. quarter post of 13 and to the E. of this point. It looks as though there was either a boss of this rock, if it is an eruptive, which has penetrated the sediments, or these sediments if derived from the microgranite surround it. Was unable to finish this point to-day on account of the rain and was compelled to return. No observations were made on the second visit which would clear up the relationship between the sediments, the porphyries, and the dolerite. The plat shows the distribution of these various rocks.

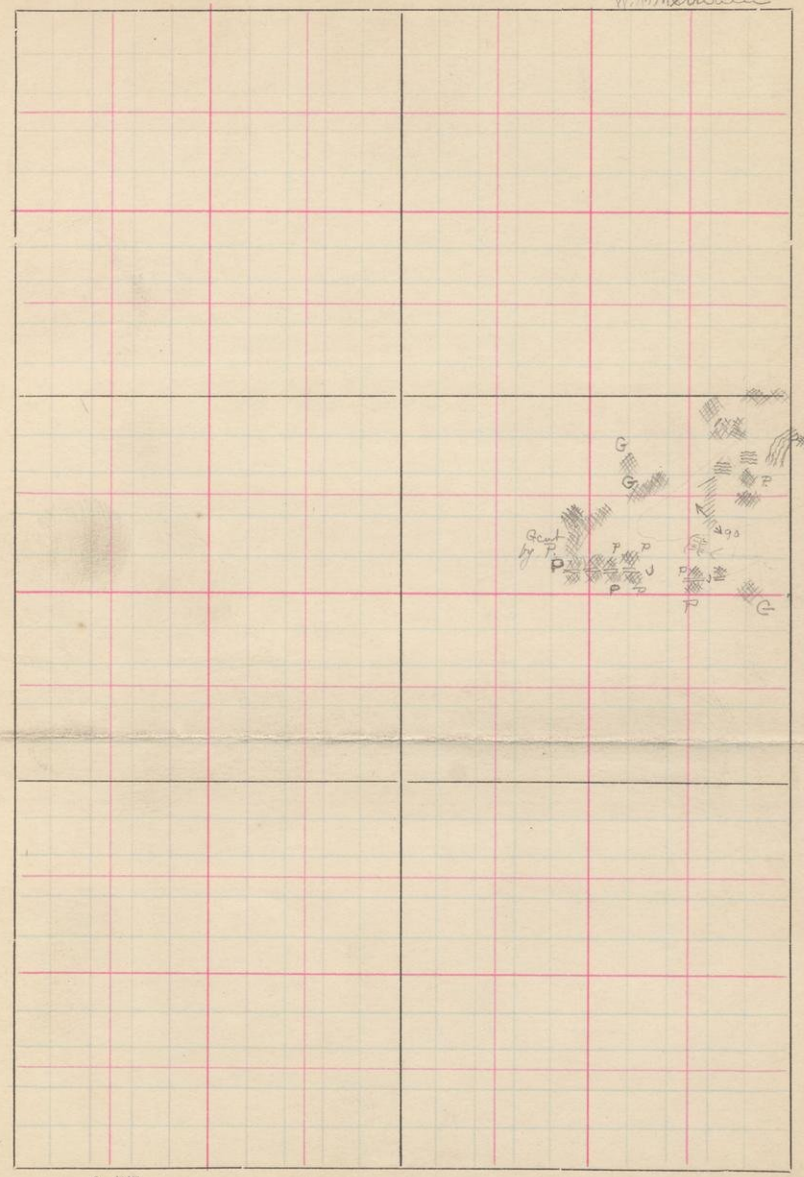
See.

S. 16 T. 62 R. 15/14

6—747

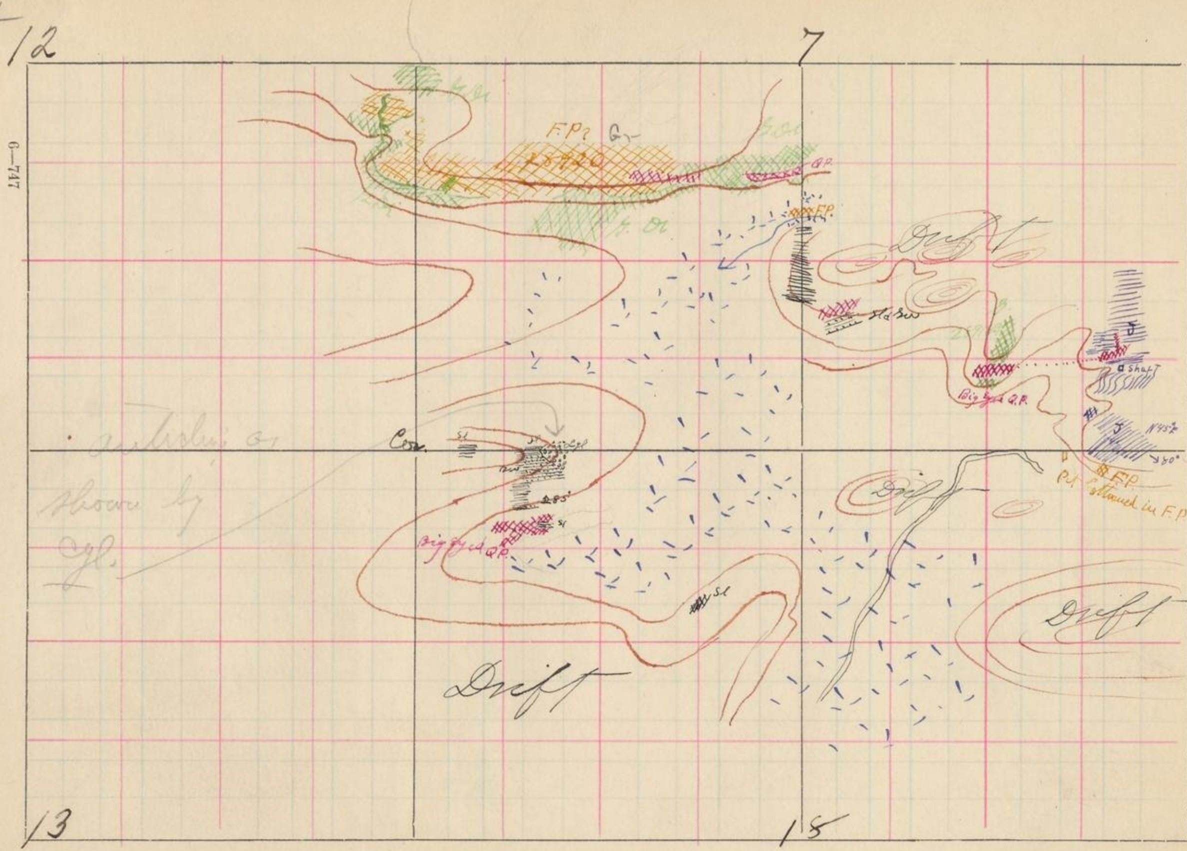
S. 1 T. 62 R. 15

W. M. Merriam



6—747

On account of the rain have been unable for several days to do more than partial days work. To-day started in to study the jasper which occurs about 750 paces N. of the S. E. corner of Sec. 1 T. 62 R. 15 Here the jasper, the greenstone and the porphyry show the most intricate relations. The greenstone is ellipsoidal but more schistose than is usually the case I think. It occurs as plated ~~or mapped~~ in juxtaposition with the porphyry but their relations could not be determined. Most interesting are the relations of the jasper and the porphyry. The jasper occurs in large exposures, the most of which lie to the N. of the porphyry. The jasper has evidently been included by the porphyry for, as shown on the map, the porphyry includes the jasper, both in small areas and others of considerable size, and likewise cuts the jasper in dikes. In one place it seemed to me that the porphyry also included the greenstone though this relationship might be explained by infolding. The jasper is for the most part black jasper with white chert. It occurs in the porphyry in large masses 15 paces in width N. and S. and 25 paces in length which are ragged at the edges and



S. 12/7 13/18 T. 62 R. 15/14

sides. The porphyry cuts directly across the banding of the jasper. There is also a slight schistosity in the porphyry parallel to the outline of the jasper fragments showing that folding and shearing has taken place since they acquired their present relationships. The banding of the jasper is not parallel to the outline of the areas, which seems to show clearly that the jasper is not the result of secondary infiltration. See Bayley's notes of 1897 for further details. Went into Secs. 7 and 18 to-day to attempt to trace the jasper on the Eaton property farther W. than it had been traced before and to study the relationships of the rocks occurring in these sections. Began at the N. W. corner of 18 and ran E. along the section line for 300 paces. Passed over slate striking approximately N. 85° W. and dipping 80° to the N. The strike of the schistosity is N. 70° W. Where I turned to go S. there is a large hill composed chiefly of slates, however with some conglomerates. This occurs on the E. slope of the hill and the contact between the conglomerate and the slate is rounded bending around

from

very nearly in a semicircle with the convex side to the ~~bends~~ W. From this it seems probable that there is an anticlinal ridge here. Going S. we passed over a succession of slates with the same strike as given above. Near the foot of the hill the dipwas observed to be 85° to the N.

N. 1800 W. 1700 S. E. corner of Sec. 18 T. 62 R. 14. Here an exposure of ~~peculiar~~-eyed quartz-porphyry was seen. The slate occurs near the E. end, is surrounded on three sides, N., W., and S. by this porphyry. They are not in direct contact however. The strike of the slate is ~~th~~ that normal for the area to the E. and W. Does the porphyry cut through the sediments? Continued on to the S. to the point indicated on the map, then ran E. in a zigzag line finding a slate outcrop at one place. The high hill along whose N flank I ran E. is composed of drift. Across a swamp to old road; followed this to the N. until we reached high ground, which upon examination proved to be drift. A number of test pits have been sunk in this but they were not apparently bottomed in rock.

big white of the exposure

I examined ~~this country of~~ the N. E. 1/4 of 18; got a good starting point at the 1/8 stake 500 paces W. of the N. E. corner of 18; ran E. 300 paces to the jasper. On the S. flank of this jasper hill there is a relatively coarse feldspathic porphyry which occurs for the most part in massive angular blocks. There was one ~~dip~~ pit which seemed to have been bottomed in a similar rock. I presume it is ~~in~~ in situ although I cannot be absolutely sure. The jasper at the top of the hill where I reached it on the line has a dip of 80° to the S. and strikes to the N. 60° E. Ran N. along the line 200 paces W. of the corner passing over an almost continuous exposure of crumpled jasper. Passed the shaft upon the dump of which there is some ore though apparently not of high grade.

N. 270 W. 200 S. E. corner of Sec. 7 T. 62 R. 15. Here a large dike 20 paces in width of the big white eyed quartz-porphyry cuts the jasper. The dike trends ~~to the~~ N. E., S. W. In places it cuts directly across the strike of the bands. At other points it runs in stringers

in/ out to the jasper and in such case it becomes finer grained along the contact and also includes masses of jasper. The porphyry is slightly ferruginous along the contact. The jasper does not appear to have been modified by the porphyry. The contact is an intrusive one as is shown especially by the selvage of the small porphyry stringers. The jasper continues on up to the N. for some distance as shown.

28918 -19 W. of this exposure of jasper and porphyry at 450 W. and continuing to N. 350, there is on the S. side of a high drift hill overlooking the valley, large/ there is a ~~peculiar~~ bare knob of green-28918 stone, 28918. This is very massive (Sph. G.) and looks much like the greenstone which occurs in such large quantity to the N. E. of this locality. In places this greenstone contains small banded areas. It also shows in places unmistakable rounded pebble-like areas of an acid rock with small quartz eyes. This is not like the quartz porphyry which we have spoken of as the small eyed quartz porphyry but has a smooth weathering surface instead of a rough weathering surface. Is this a greenstone which has cut through the Stuntz sediments and includes fragments de-

rived from the conglomerate? Is it to be compared with the greenstone on the N. slope of the point S. of Mud Creek bay which contains fragments of jasper? Nothing here seen enables me to answer these questions. I found no jasper pebbles or fragments in this greenstone. Spec. 28919 shows the fine conglomeratic material found in this greenstone. This may possibly be a greenstone tuff.

On the S. flank of this hill, near the southern end of the exposure of greenstone, there is a large dike about 20 paces in width from N. to S. which cuts through the greenstone. It trends to the N. 80° E. and if extended to the E. would join to the dike there found cutting the jasper, and it is believed to have originally been continuous with this one. Ran W. after locating the porphyry dike following the line shown on the map. The first hill consists of drift which overlooks the large swamp to the S. There is sufficient space for the jasper of the Eaton property to pass between the outcrops of sediments thus far found, and it may underlie the drift. It is believed, however, that it is overlaid by the sediments and that the jasper does not continue near the surface much farther W. than the westernmost point at which the ex-

posures occur.

Ran N. along the 1/4 line of Sec. 7 passing over a succession of slates and graywackes with some of the big eyed quartz porphyry associated with them. At 750 N. on the 1/4 line passed over massive greenstone with a dike of quartz porphyry cutting through it. Ran W. along the southern slope of a hill consisting for the most part of the massive greenstone with dikes of the big eyed quartz porphyry in it.

28920 Gr. N. 700 W. 1388 S. E. corner Sec. 7 T. 62 R. 14. Here begins the exposures of the rock represented by spec. 28920. These are rotten and very badly broken up, it being practically impossible to get a fresh specimen and to trim out one of good shape. It apparently contains considerable iron carbonate or else iron pyrite. Through it there are scattered numerous more or less rectangular areas now filled with limonite. This rock is ~~small~~ similar/ to that which occurs upon the top of the hill farther W. and of whose character I am not sure. Is it a graywacke or is it one of the porphyries belonging in the porphyry complex from which the Stuntz sediments were derived? Comparing the section made

from this specimen with the section from spec. 40019. This rock is cut by the big eyed quartz porphyry as is the greenstone.

The greenstone on the S. slope of this hill varies in character from that of relatively fine grained to one which is very coarse. It appeared to cut the rock 28920 though the relations were not such as to be conclusive.

Grn ?
28921
sed

Moved camp to-day from Vermilion lake to Long lake by way of Mud Creek and Burnside lake. On the way I took specimens from an outcrop near the S. W. 1/4 of the S. W. 1/4 of Sec. 4 T. 62 R. 14 on the N. side of Mud Creek. This is a schistose rock which looks as though it might be sedimentary in character. The hills to the N. and S. are greenstone. If this is sedimentary it may be the eastern continuation of a long narrow tongue of the Stuntz sediments lying in a greenstone syncline.

Gr. ?

28922. N. 1550 W. 2000 S. E. corner Sec. 5 T. 62 R. 14. This is a specimen of porphyry or graywackes in which there are fragments ~~around it~~ of what may be porphyry or greenstone. This was collected by Merriam and given to me. If it should turn out to be a sediment it would indicate that the sedimentary series goes up at least as far to the N. E. as this occurrence. If this is a part of a sedimentary tongue then it is cut off from connection with the sediments to the W. and S. by the greenstone. I do not believe it to be a sediment. It is about 500 paces in extent N.E.

S.W.

1.0

28923 -5 These are duplicate specimens of typical hard hematite ore which comes from the Alaska and the Montana ~~shelves~~ shafts of the Minnesota Iron Company of Soudan. This is classed in the Vermilion grade.

1.0

28924 I took two other specimens of the above grade of ore showing the small vuggs which are filled with crystals of hematite and chlorite. Many of these vuggs have in addition considerable quantities of quartz both in crystals and in irregular granular masses in them.

If I understood Mr. Ahbe correctly the Red lake grade of the Minnesota Iron Company's ore is essentially the same so far as content of iron and phosphorus is concerned as the Vermilion but is made up from the screenings of the lump ore. All of the Minnesota Iron Company's ore at present is ~~known as~~ Bessemer. It is reported that it would be possible to ship Bessemer ore if very great care were taken but the present prices do not warrant the attempt.

I went up to examine the old North Lee pit. The schistose greenstone is exposed in a practically solid mass for about 125 paces to the S. There is almost this same distance exposed to the N. of the pit also. Then to the N. of the solid greenstone there begins the alternation of jasper, greenstone, and green schists, followed still farther N. by a large mass of greenstone similar to spec. 28933. Greenstone very schistose outcrops for a considerable distance both to the N. and S. of the pit. The schistosity strikes E. and W. This greenstone contains near the main jasper mass small lenses and stringers of jasper and white chert which have clearly been introduced since the greenstone was rendered schistose. The exposures on the surface show that it very nearly cuts out the jasper to the E., and I learn from Mr. Ball that underground it does cut off the jasper to the E. Just E. of the pit across the road the jasper shows a small V of greenstone in it pitching to the E.

The jasper of the North Lee pit is very badly broken up and the ore has been introduced, healing the cracks and filling the cavities. This ore runs in veins across the bands of jasper and all through them. The

red jasper is interlaminated with bands of white chert, purple jasper, and ore. Just along the contact between the greenstone and the jasper the rock has the appearance of veined material. There is here a larger quantity of white chert. Moreover in places along the contact brecciation has occurred and the chert and jasper are broken and lie in the greenstone which has been ground down by the shearing and forms the matrix of the breccia. This does not look to me at all like a sedimentary rock. The jasper and schists are cut by little white quartz veins varying in size from mere threads up to those of considerable size.

To the N. of the North Lee pit the greenstone continues for about 125 paces in almost solid exposures showing very few stringers of jasper. Then the jasper bodies become larger until they reach the width of 50 paces. It looks somewhat here as though the greenstone cuts the jasper for the jasper bands do not run parallel with the edge of the contact but seem to cut across it.