[Notes on the geology of the Boundary Waters region, Minnesota and Ontario]: [specimens] 28979-28999, 40000-40001. No. 326 [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.

No 4

28979 - 28999
40000 - 40001

Nr. 326

28979 S. 775. E. 565. from M. C. on the lake shore. Continuing to the E. I go around the N. end of the prominent hill of greenstone and find at the above location at the foot of and just a short distance N. and E. of this greenstone a small ledge of sediments. On the S. W. side of this exposure there is found a conglomeratic rock represented by 28979, which grades up into the finer sediments to the E. The pebbles in this conglomerate look to me very much as though they were derived from the greenstone to the S. A little S. E. of this point I get a good connection of the sediments with the greenstone, but at this place I could not find any distinct conglomerate lying between them. The exposure shows schistose greenstone followed to the N. E. by graywackes and then by slate.

28980 S. 840. E. 650. from the M. C. on the lake shore. Here I find the greenstone with about 9 feet of a conglomeratic rock overlying it. The slide should show whether or not the matrix of this rock is distinctly fragmental ~~or~~ quartzose or whether the rock is a true breccia derived from the greenstone. Above this, that is, to the E. follow well banded slates and graywackes. The strike

on this exposure is N. 60 W. with a dip of 80 to the E. This is in all probability an unconformable contact of the greenstones with the sediments which have been derived from them.

S. 875. E. 700 from M.C. on lake shore. ..... At this point another contact between the greenstone and the sediments is found. This is clearly an unconformable contact. Immediately upon the greenstone there is a rock containing breccia or poorly rounded pebbles. This is like that
C
28980 represented by spec. 28980. This grades up by rapid alternation of conglomerate with the finer grained sediments into the normal Agamok slates. The bands of conglomerate vary from 3 feet in thickness down to those only a few inches in thickness. The entire gradation takes place within a distance of 10 paces from conglomerate on the one end and the slates on the other. The matrix of the conglomerate appears to be very quartzose and the conglomerate here is exactly like that represented
~~28979~~ in spec. 28979. The strike of the beddingas shown in the slates is N. 60° W. with a dip of 80° to the N. Having obtained the relations sought

we went N. crossing the river and returned by way of portage to the shore where we were met by the compassman with the canoe. We now began to coast around the lake for the purpose of studying the rocks there exposed. The afternoon's work was interrupted by a rain storm which forced us to return to camp. On the way in took a specimen, 28981 from a small island in Ogishke Muncie. See map opposite. The specimen is of feldspar porphyry similar to that found in greenstones N. of Fay lake. Compare the sections of the rocks.

F.P.
28981
Pebble

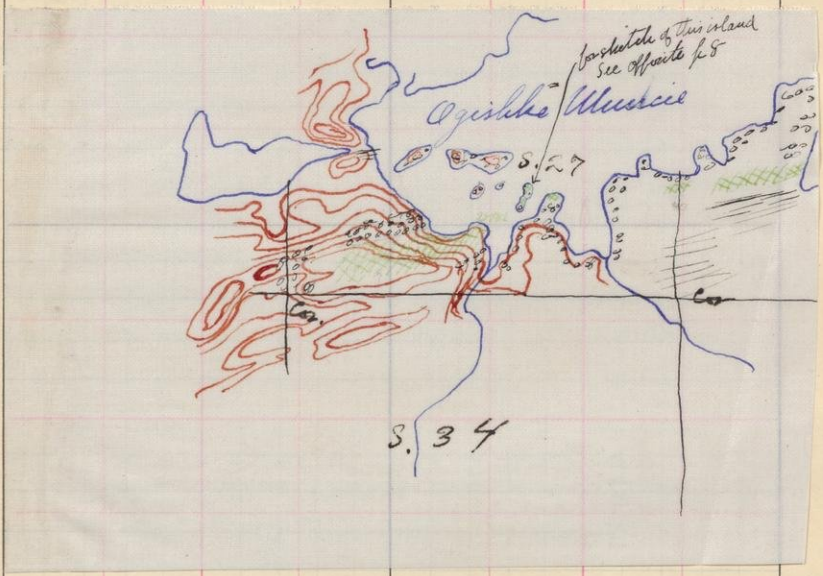
Went this morning in company with Professor Van Hise to the W. end of Ogishke Muncie trying to find out the relations between the Ogishke Muncie conglomerate and the slates at this point. The slates seem to run through the middle of Ogishke Muncie lake with the normal Ogishke Muncie conglomerate on the N. shore and the greenstone conglomerate on the S. shore. We ran in from the W. end of the lake to a point on the N. and S. section line crossing the small lake W. of Ogishke Muncie near where I located slates in 1898. The strike of these slates is N. 75° W. with a dip of 80° to the N. To the S. of them though not in contact with them comes an amygdaloidal basalt. S. of this farther up the hillside occurs conglomerate. This conglomerate is made up for the most part of pebbles of greenstone and has as a result a greenish color. It is in general very similar to the greenstone conglomerates occurring S. and E. However at this particular place large numbers of jasper and chert pebbles are associated with the greenstone fragments. From this I see that the division of the conglomerates on Ogishke Muncie into the Ogishke Muncie conglomerate proper on the N.

and the greenstone conglomerate on the S. is not justified. Lithologically they are different over that part of the area.occupied by Ogishke Muncie lake. However, W. of this lake it is evident that these two conglomerates must grade into each other as shown by the fact of the occurrence of these jasper and chert pebbles in the greenstone conglomerate at this place. I got no granite pebbles here but these would normally occur in the conglomerate to the E. near where the granite from which they are derived is exposed. If we now consider the conglomerate on the N. and S. sides of Ogishke Muncie to be the same then the slate which runs through the center of the lake must be above them. The lake, in other words, occupies a synclinal basin. Running E. from the conglomerate we came again into the amygdaloidal rock mentioned above. Spec. 28982 is a specimen taken from an exposure. This rock is here very decidedly porphyritic, the white weathering feldspar phenocrysts giving it a very characteristic appearance. Compare this porphyry with the Kakekabic porphyry. The width of this amygdaloid was not determined very accurately. It forms a ridge trending nearly E. and W. S. of this ridge comes a depression which I believe represents the contact between this

H.P.
28982
to Bault?

S. T. R.

D28991



6—747

eruptive and sediments still farther S.

I began on the S. side of this ridge at a point 450 paces S. 100 paces W. of a point on the shore of Ogishke Muncie lake just S. of the W. end of the island shown on the map. The locations which will hereafter be given on this run are all given from this same point. I ran N. across this ridge for 220 paces. This represents very closely the width of the eruptive rock at this place. See map. On the N. side of this eruptive at 220 paces, very nearly in contact with it, there was found fine grained conglomeratic sediments with jasper pebbles. The strike is E. and W. and the dip is 75° to the N. Although the conglomerate here is fine grained it is still noticeable that the coarsest part of it occurs near the eruptive and grows finer to the N., apparently grading upwards into the slates.

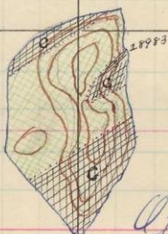
Going E. about 80 paces I find at S. 225 W. 20 a conglomeratic rock which is as it were plastered on the surface of the eruptive. There is here an actual contact between the conglomerate and this porphyry. Moreover large pebbles containing the lath shaped feldspars and the amygdaloids of the

underlying porphyritic rock are found in the conglomerate. Immediately upon the greenstone there lie some ~~feldspars~~ boulders derived from it which are 2 feet long by 8 inches through. The relations here clearly show that the porphyritic eruptive is older than the sediments.

From the portage into Ogishke Muncie S. W. the shore is occupied to a point just S. W. of the end of the island by slate. The conglomerate begins then on the next exposure and follows for a short distance around the headland. There follows then a small bay on the S. shore of which the porphyritic amygdaloid described above appears. Evidently this bay represents approximately the contact line between the conglomerate and this eruptive. The amygdaloid forms the main part of the shore of this bay with patches of conglomerate on the N. face of the cliff near the point. The amygdaloid also occurs on the island just off of the point. Around this point in the bay running into the S. we find conglomerates with a small amount of the eruptives as indicated on the map.

S. T. R.

For position of island in Ogishke Muncie Lake see map opposite P 6!



Ogishke Muncie L.

S ≡ slate
C # conglomerate

Contour interval 10' approximately

Scale

from blue line to blue line = 25 paces.

sl.?

28983 sl. or vole. ash? On the island marked on the map and of which a large scaled sketch is reproduced on the ~~accompanying map~~ private base I find conglomerates lying on the N. shore, followed to the S. by the porphyritic amygdaloid which on the E. side of the island is separated into two arms by a small infolding area occupied by slate, represented by spec. 28983, and conglomerate. This slate strikes N. 15 E. and stands vertically. In strike it corresponds with the trend of the contact between the eruptive and the sediment. The S. side of the island is made up of the normal conglomerate. In the conglomerate are pebbles which can be matched with the eruptive showing that the conglomerate is younger than, having been derived from, the eruptive. The shore of the lake to the E. and S. E. of this point was followed, an attempt being made to connect this belt of eruptive rock found to-day with the rock which is practically identical with it and was found yesterday on the S. side of the lake but farther E. These areas could not be connected, however. They could not be connected along the strike, the intervening area being occupied by the conglomerates which from this morning's

work it is clearly seen overlie this eruptive. It is to be presumed that the porphyritic amygdaloids of these two areas are connected underground, as they are identical in character and the areas exposed have essentially the same strike. From here went into the bay into which the drainage from Fox and Agamok lakes flows. I believe this creek has been known as Ogishke Muncie Creek. Beginning on the main land just W. of the mouth of this creek there is a small topographical depression at the bottom of which lies a small backbone of much sheared slate. To the N. of this slate and separated from it by a shallow depression there is found the eastern continuation of the same porphyritic amygdaloid which was studied yesterday on the section line W. of here, and today at the W. end of the lake. This rock hence is similar to that shown in spec. 28982. The exposure is from 75 to 100 paces wide from N. to S. N. of it and separated from it by a depression comes the normal greenstone conglomerate which continues on up to the lake shore. This ridge of eruptive rock was followed to the W. Professor Van Hise and I sought along the S. face for a contact with the slate in order to get the relations of the two.

b.A.p.
28982

We followed this depression to the W. until it ran down and joined the swamp through which we crossed yesterday after passing the amygdaloid. The amygdaloidal eruptive also ends at this swamp. At one place just before the exposures cease I found hanging on the S. face of the amygdaloid a patch of rock which both Professor Van Hise and I consider as a conglomerate. There is a very small area of the rock exposed. It is made up of oval areas of the porphyritic amygdaloid in a matrix which seems to be made up of fine grained detrital material of the same rock. This may possibly be the breccia phase which might be expected to immediately overlie the eruptive. Between this exposure and the slate on the S. there is a depression 10 paces in width, giving ample room for a transition from this brecciated phase of the eruptive through the conglomerate into the normal slates. Shearing has taken place along the plane of separation between the slates and the eruptive and this sheared material has been removed leaving the depression.

Left Ogishke Muncie lake to-day for Red Rock lake. On the way out followed the slate synclinal in which ~~the~~ Ogishke Muncie lies. For a considerable distance on the S. side near the base of this slate and above the conglomerate ~~there~~ there is a carbonateous horizon containing some iron, which on weathering gives an ocherous crust. This ferruginous limestone outcrops in bold cliffs and is the limestone referred to by Winchell in his reports and also in Bayley's notes. I am not so certain of its occurrence on the N. side of the lake although possibly, as supposed by Professor Van Hise, it does so occur. See Professor Van Hise's notes. On West Gull lake on the granite point about 10 paces S. of the M. C. I noticed 5 dikes of rock cutting the Saganaga granite. These dikes vary in width from 3 inches to 2 feet. They do not continue of a uniform width but can be seen to divide. Leith reports having taken a specimen in 1898 from a similar rock in this granite.

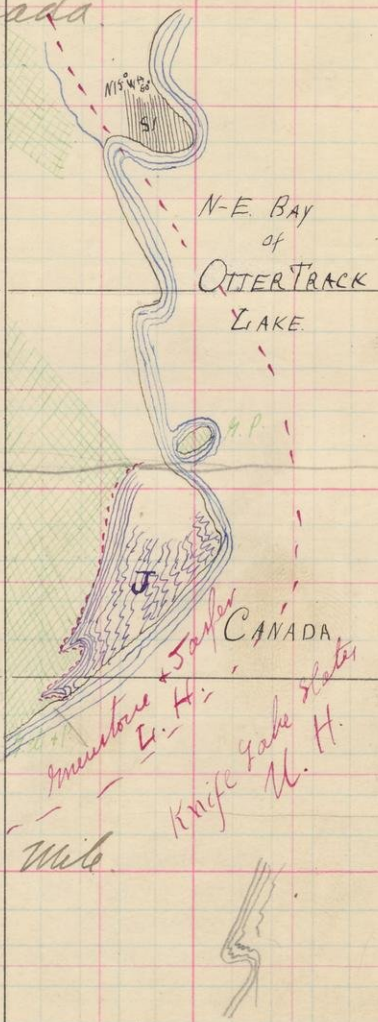
The granite on West Gull lake has quartz eyes in it and looks very much like the Saganaga except that it is finer grained.

Camped last night on Red Rock lake and this morning started through Red Rock into Saganaga. I noticed that the Red Rock granite is somewhat coarser than the granite on West Gull lake. It would thus seem that Grant's statement that the Saganaga granite grows finer grained toward the porphyry is correct. On Red Rock lake I noticed at one place a partly rounded fragment of greenstone with large porphyritic crystals of feldspar and some few ~~crystals~~ of hornblende lying in the granite. Was this fragment derived from the greenstones through which the Saganaga granite is eruptive? Reached the Otter Track lake about noon and after lunch Professor Van Hise, Leith, and I reconnoitered the E. end and the N. E. bay of Otter Track. The normal slates and graywackes of the Knife lake series were found to occupy the E. and N. sides of the great N. E. bay of the lake. They are also exposed for a part of the way on the W. side of the ~~lake~~ bay. Near the mouth of this bay jasper was observed on the W. shore. It was so late that although we climbed the hill and saw that back of the jasper there was greenstone, we could not study the relations.

S. T. R.

Reconnoissance or sketch

Map of part of Shore of Otter Track Lake, Canada.



6—747

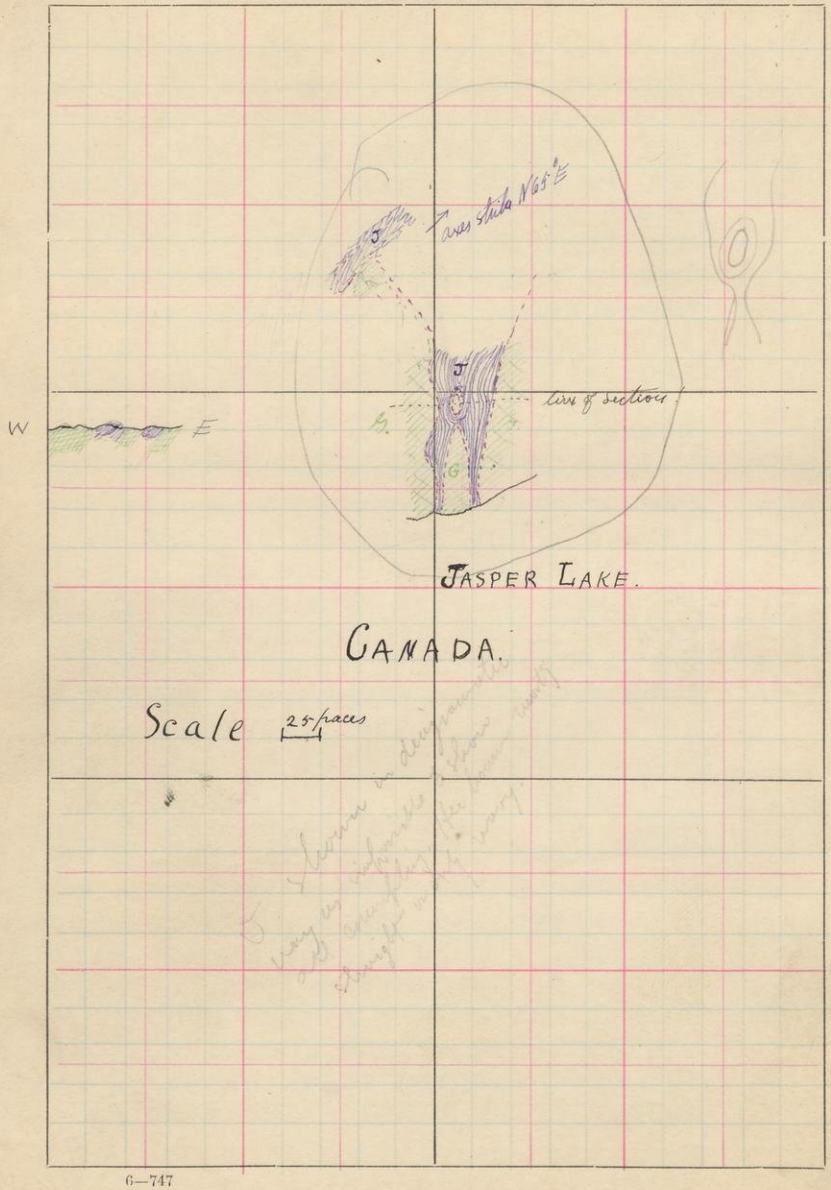
This morning, in company with Professor Van Hise, went to the jasper located last night upon Otter Track lake on the W. side of and near the mouth of the ~~B~~big North East bay extending into Canada. For supplementary notes of to-day's observations see Professor Van Hise's note books. The exposure ~~itself~~ is on the Canadian side of the lake. Going N. along the W. side of this bay beginning at its mouth, we passed alongside of cliffs of fine to medium grained ellipsoidal greenstone. In one place this greenstone has a very peculiar appearance. It looks conglomeratic. This is due to the presence of large individuals of a cream colored feldspar, which lie in the fine grained greenstone. These feldspar individuals are in almost all cases round and have a diameter up to 2 inches in length. In no case did they show crystal contours. Continuing alongside the cliff we finally reached a point where the jasper begins to appear. Ascending the cliff at this place we find the actual contact between the greenstone and the jasper. This was carefully studied with the following results. Between the jasper and the greenstone there is a very narrow green cherty ~~area~~ rock which is in places ~~separated~~, brecciated, and banded with hematite. This is only from an inch to about 3 or 4 inches in width.

ches in width. It gives no evidence of fragmental character. It may to some extent owe its origin to infiltration processes along the contact between the jasper and the greenstone, and shearing along this plane would readily account for the local breccia appearance. The strike of this contact is approximately N. E., S. W. with a dip of about 85° to the N. W. This strike of contact corresponds very closely to the strike of the axes of the numerous minor plications of the jasper. This jasper is followed to the W. where it comes out. It is surrounded on the S. W. and N. sides by the greenstone. It ~~is~~ appears that here the jasper lies in a syncline upon the greenstone and in sharp contact with it. The contact between the greenstone and the jasper was followed on this hillside and two separate tongues of jasper lying in the greenstone were traced out as shown on the accompanying map. The western contact between the jasper and the greenstone runs a little E. of N. The jasper is exposed between the greenstone and the lake shore in a number of exposures upon all of which the jasper shows extreme plications. The outcrops consist of red hematitic jasper interbanded with a

and hematite,
magnetic black jasper, and with these there is associated a greenish cherty rock which is especially noticeable as the phase occurring immediately along the contact of the greenstone and the jasper, although it is interbedded with the jasper throughout the exposures. Does not this rock contain some of the original iron carbonate? No specimen was taken here but the rock is similar to spec. 28984.

Just off shore ~~over~~ to the N. of the jasper just described there is an island which consists of fine greenstone containing large oval and rounded cream colored feldspares varying from 2 inches in diameter down to very small ones. The specimens which I took from this place were accidentally left behind. See Leith's specimens taken farther W. from an exactly similar occurrence. This apparently marks the northern extension of this ~~greenstone~~ jasper unless it is thought to represents merely the greenstone rising up through the jasper as a result of folding. This jasper is not exposed to the E. across the lake. There the normal Knife lake slates occur. We now continue around the N. W. side of the lake marking it as shown on the accompanying plat. The varying

S. T. R.


axes strike N 65° E
line of section
W
E
JASPER LAKE.
CANADA.
Scale 25 paces

strike of the contact between the greenstone and the slates is clearly indicative of the folding of these series. We now cross the portage from Otter Track into Jasper lake and begin to skirt the S. W. shore of this lake. The sediments are exposed along the S. shore. Specimen is of the typical graywacke.

28984

On the W. side of the lake there rises back from the shore a ridge upon which I find the greenstone outcropping. This causes me to draw the boundary line between the greenstone and the slates very nearly N. and S. through the southern end of this bay. The continued examination of the shore and islands to the N. E. enables us to map the boundary as shown on the map. On the N. shore of Jasper lake after passing greenstone outcropping on the shore we reached a point where a brilliant red jasper occurs. We examined this occurrence in detail and found here a N. plunging syncline of jasper lying in the greenstone. Within this syncline there is a small anticline which brings up a knob of greenstone through the jasper. The relations are shown in the large scaled sketch on the opposite page. The actual contact between the jasper and

the greenstone on this occurrence was observed for a number of yards but wherever seen the contact was always sharp. There was no transition from greenstone to jasper. There was no sedimentary deposit ~~upon~~ between them but in two cases we could find jasper on one side and clearly recognizable greenstone on the other. In most cases this greenstone was perfectly massive. In a few instances it showed a slight schistosity parallel to the contact and probably the result of the shearing caused by the close folding. The iron formation is made up of brilliant red jasper with hematite; in some cases with a white chert.

H. ?.

28985 The greenstone associated with this jasper is somewhat peculiar in that it contains very numerous grains of quartz. These can be readily recognized macroscopically. Are they the result of secondary infiltration or is this greenstone normally quartz bearing? This large jasper outcrop which may continue to a considerable distance N. of where we left it, as we did not have time to trace it out to its fullest extent, while doing this reconnaissance work, was not noted by Smith, Canadian G. S.

Greenstone is found upon the shore E. of this point. We crossed the portage from Jasper lake into the small lake to the N. of it. At the northern end of this portage a fragmental rock is exposed. S. of it we come to an exposure of greenstone. Still farther S. along the portage trail and about 50 paces to the E. there is an exposure of plicated jasper consisting chiefly of hematite bands interlaminated with a white weathering chert. There is no red jasper here. A depression exists ~~about~~ E. of this on the E. side of which the greenstone is exposed. There is considerable exposure of this greenstone which shows nothing unusual.

N. 25. E. 125 paces from the S. or Jasper lake end of this portage trail the contact between these greenstones and the sediments was found after close search. At this contact I find the greenstone overlaid to the E. by a band of finely fragmental material. The fragments are chiefly of greenstone but I find two pieces of jasper, one of them having bands of black and red jasper in it. Somewhat farther

E. on this same exposure the conglomerates and slates are again exposed. At this point the slates and the underlying conglomerate are infolded. There was no section exposed which would enable me to determine the thickness of the conglomerate. The folding and erosion have produced broad exposures of the conglomerate which appear approximately parallel with the bedding so that the thickness cannot be measured. The infolding explains what at first appear to be an intricate mixture of the greenstone, the conglomerate, and the slate. These sediments are the normal Knife lake sediments and we get here the relations of these clearly shown to the underlying greenstone and jasper. Running S. along the W. shore of the lake we find the greenstone outcropping on the E. side of the bay from which the portage going N. starts, and upon the point on the E. side of the mouth of this bay reach a large exposure of iron formation and greenstone. The iron formation here does not consist of the brilliant red jasper found on the exposure W. of here but is made up for the most part of a brownish to black hematite bands interlaminated with a greenish gray cherty rock.

1-e
28986

This cherty rock seems to contain a quantity of carbonate (siderite) upon the weathered surface. The greenish rock is nearly always bordered by a zone of yellow ocher and in some places the hematite is regularly banded with ocher. The result of this alteration is to give the outcrop a brownish color. Presumably the iron formation at this point has not been altered to the same extent as has the iron formation in which the red jasper occurs. That is supposing that this greenish rock is the original carbonate from which the iron has been derived. Lying as it does nearer the slates the presumption is that, as is the case with similar rocks in the Penokee region, it has been preserved by them to a great extent from the infiltrating waters. Erosion having now brought it to the surface gives to us the carbonate in its practically unchanged condition.

Started E. this morning from the camp in company with Professor Van Hise, each of us in our respective canoes. We purposed going E. through Cache bay of Saganaga lake, N. W. and S. through Jasper lake following the string of lakes shown on the Canadian map. Each of us taking one side of the route we should cover a considerable area.

28987 On the E. side of Oak lake there is exposed a banded rock which is an arkose from the Saganaga granite. This rock shows very clearly in places its sedimentary character in that we could see alternating bands of different degrees of coarseness. However, specimens from some of these bands bear the most striking resemblance macroscopically to a normal granite. In fact these are the rocks which have in previous years been described by Lawson and Grant as sediments cut by the Saganaga granite, they having recognized the sedimentary character of part of the rocks and having presumed that some of the bands were granite dikes, when in reality they were sediments which were strik-

ingly like the normal granite. This is also the area which Winchell describes as showing a gradation by increasing metamorphism from the true sediments down into the massive Saganaga granite. The specimen was taken from the portage between Oak (Swamp) lake and Saganaga lake. These sediments continued for some distance to the E. in Saganaga lake. The normal Saganaga granite then appears in a relatively narrow mass and is followed again on the E. by the sediments. This relationship has been produced by the infolding of the sediments in the granite from which they have been derived similar to the infolding noted in 1898 on the W. side of West Gull lake.

Sev.?

28988 This specimen is from the broken rock which occurs just W. of the narrows between the main Saganaga lake and the arm which is next to Oak lake. This is the rock which I have considered to be a sedimentary and to represent a narrow N. E., S. W. trending trough of the arkose. Continued on into Cache bay. Professor Van Hise went around the W. shore and I around the E. shore. The ordinary

Saganaga granite is exposed on the point on the E. side of the mouth of Cache bay and in places is seen to be intruded by aplitic dikes and also by basic dikes similar to those which occur in the same granite on West Gull lake. No relationship could be obtained between the aplitic and the basic dikes. Granite continues to outcrop on the E. shore until we reach the small bay N. of a little granite island. The eastward continuation of this bay is in a topographical depression. On the N. side of this depression I find exposed on the ridges back from the shore a hornblende-mica-schist which is cut by red granite dikes. Does not this schist represent the metamorphosed ellipsoidal greenstone? Are not these dikes in it off-shoots from the main Saganaga granite? These facts could not be determined from the exposures here but I am confident that such is the case. On the first point N. W. of this bay I find exposed a rock which evidently contains a great deal of carbonate. Tracing this inland I noticed that it becomes blacker and contains less carbonate, until finally I can trace it back into a rock represented by specimens 28989 and 29890 which are nearly serpentine. The

28989 & 90 serpentine

facies
~~forms~~ which are more and more carbonateous are represented by specimens
28991 28991 and 28992. The lightest colored rock, the one apparently containing the largest amount of carbonate,
& 92 being farthest from the serpentine.
$CaCO_3$ This carbonate must be that dolomite to which Smith refers in his description of the map of this area when he states that dolomite occurs on the E. shore of Cache bay. This same rock is found exposed upon the point for some distance along the lake shore. It has been extensively sheared and the shearing has produced a schistosity which strikes N. 80° W. and dips vertically. This shearing has broken the serpentine into fragments which are now oval to rounded in shape. The weathering of the rock gives it an appearance strikingly similar to that of a conglomerate.

The relationship between this serpentine and the greenstones to the E. of it could not be determined. The exposures were not continuous. It is however very striking that, associated with greenstones which we here place with the Archean, there should be found a serpentine altering to a carbonate exactly similar to the occurrence of these rocks upon Presque Isle near Marquette, Michigan. Farther N. and

around the lake the Saganaga granite is found in close proximity to the serpentine lying to the S. W. of it. However, the relations between these were not shown here although presumably the serpentine belongs with the schists and like them is older than the granite. Continuing on N. around the lake shore I find that the Saganaga granite occupies the most of the points projecting ~~farther~~ W. Back of these, near the heads of the bays the hornblende-mica-schists are exposed. These schists are cut by off shoots from the granite mass and I am more than ever convinced that these schists were derived from the greenstones similar to those which occur upon Otter Track and Jasper lakes in association with the jaspers. After partially circumscribing the lake I met Professor Van Hise who had completed the other part and stated that he had found the granite cutting the ellipsoidal greenstone and metamorphosing it into a hornblende-mica-schist, and had observed also a basal conglomerate overlying the granite. A conglomerate containing pebbles of granite and of the green schist is exposed at the Falls where we stopped for lunch. This is where the water

runs out of Saganaga lake on its way N. and W. around Hunter's island. After lunch we continued on down the stream mapping the occurrence of the slates and greenstones. We were able to trace out and map a number of small infolded troughs of slates and greenstones. Contacts were observed between the slates and the greenstones with basal conglomerate derived from and lying upon the greenstone. These rocks, as a result of the folding, have been excessively sheared along the limbs of the folds. This has resulted in producing fine samples of schistose conglomerate. Viewed transversely to the bedding the conglomeratic nature can be readily recognized. Upon some of the cliffs, however, which run parallel with the bedding of the conglomerate and essentially with that of the schistosity the conglomeratic nature is not so clear. The rock is very schistose and but for the fact that this schistose surface seems to be made up of a mass of discs instead of being a homogeneous mass, one would scarcely recognize its conglomeratic nature. I crossed the portage into the lake leading S. W. towards Jasper lake while Professor Van Hise went around the point meeting me later on in this same lake. While

he was away I found several infolded areas of banded iron formation of only a few paces in width closely infolded in the greenstone. I say that they were closely infolded for I find a number of these belts lying parallel to each other of exactly similar characters and separated from each other only by narrow areas of the greenstone. The exposures were not such as to warrant the folds being traced out as was done in the case of the exposures on Jasper and Otter Track lakes, but I am confident that they are the result of infolding. The iron formation here consists of the hematite and grayish green chert. The red jasper is not present. The fact that this lies very close to the slates probably explains the preservation of the carbonate. Just S.E. of these exposures at the base of the sediments overlying them I find a conglomerate in which there are numbers of jasper pebbles. This conglomerate was presumably derived from the underlying iron formation. After meeting Professor Van Hise we continued S. W., he on the E. side of the lake and I on the W. side. We found that the sediments occupy the shore to the E. and that the islands in this lake and on the W. side are occupied

by the iron formation and by the greenstone. At several places on this lake we observed actual contacts between the iron formation and the greenstone. These contacts were absolutely sharp and in no case was there any indication of sediments between the jasper and the greenstone. Moreover the iron formation is on the whole straight, that is, is not nearly so plicated as is the case with the red jasper on Otter Track lake. Flutings along the contact of the greenstone and the iron formation ~~should~~ give conclusive evidence of infolding of these rocks.

We were successful in tracing out the connection of this belt of greenstone and sediments with the similar rocks found yesterday on Jasper lake. The reconnaissance map which has been prepared will show the outlines of the structure observed in this region. It is very clear from the small amount of reconnaissance work thus far done in Canada that the Canadian division of the rocks into the Kewatin will not hold. In the course of two days work we have been able to show conclusively that this division is readily separable into a greenstone which represents the basement, an iron formation lying upon and infolded in the greenstone, and a conglomerate, graywacke,

and slate series of considerable thickness lying upon the greenstone and jasper and separated from them by an enormous unconformity.

To-day we moved W. through Otter Track lake to Carp lake. Our route takes us through ~~the~~ Canadian territory and as is customary we studied the shores of the lakes, Professor Van Hise taking the N. side, I taking the S. The slates are found to continue upon the S. side of Otter Track to within a short distance of the portage from Otter Track into Big Rock lake. The greenstone has been upon the N. side of Otter Track but here crosses over to the point S. of the portage. Greenstone was found to occupy the greater part of the S. side of Big Rock lake. In a few places iron formation was observed but no attempt was made to trace this out for any distance inland and its relations to the greenstone was not observed, no contacts being seen.

J.E

28993 Crossing the portage from Big Rock lake into Emerald lake, Ontario, we noted a large exposure of iron formation rocks on the S. side of the portage. These were examined and found to be the usual red jasper with hematite ~~+~~ gray chert. I noticed a ferruginous cherty rock which occurs in thin bands with this jasper. It has peculiar markings upon it somewhat

similar to those previously noted as occurring in the gray, black, and sometimes red cherts of the iron formation of the Vermilion district. Is not this a part of the original carbonate? I took a specimen of it hoping that the study of it might enable me to determine something about the origin of this banding and of the rock.

We now entered Emerald lake and coasted W. examining these shores. The iron formation mentioned as occurring on the portage continues W. and is exposed on the first point W. of the portage. Here it has lying to the N. of it a mass of diabase which is evidently intrusive, as it showed very distinct saalband features. This seems to have been intruded parallel to the bands, at least it runs so for the distance over which it is exposed. Leaving this I now find that the S. shore of this lake, as far W. as the bay which lies just S. of the long one continuing farther W. to the end of the lake, is made up of greenstone, outcropping usually in high cliffs. This greenstone varies from that which is fine grained to that which is coarse grained. One very common feature of the rocks is the ellipsoidal parting. The gashes caused by the shearing of

these rocks are very numerous and very prominent. Many of these cracks have been filled with quartz or a carbonate which is somewhat ferruginous. Was compelled to stop studying the rocks on the shore of the lake on account of the darkness just before I reached the long bay at the W. end of the lake. Reached camp on Carp lake after dark.

~~28994~~ This morning I portaged from Emerald lake into a small lake to the N. of it and then from that lake into That Man's lake. Immediately N. of the end of the portage in That Man's lake I find sediments, slates, and graywackes outcropping on the point. The point next N. of this is occupied by iron formation. The iron formation here consists of bands of hematite and red jasper with which there is in some places a carbonateous quartzite
Sl
28997 represented by spec. 28997. Associated with the iron formation and in fact interbanded with it there occur greenish gray slates. The strike of the beds at this place is about N. E., S. W. with a dip of 60° to the S. These rocks are exposed along the N. side of this point. To the S. of them on the E. side of the point occurs the normal sediments, slates, and quartzite again. Across this bay on the E. side there is a good exposure of the iron formation and slates again. At this point I got 3 areas of jasper which are interlaminated with the ferruginous schists and slates. Single brilliant red jasper bands are noticed interlaminated with the slates. The slates like the spec.
Sl
28994 28994 make up the greater part of the rock exposed in the face of the cliff.

The dip of these rocks is about 55° S. E. and the strike, as taken from the face of the cliff the beds not being exposed on the surface, appears to be to the N. E., S. W. This, I think is wrong as these are clearly the eastern continuation of the iron formation occurring to the W. To the S. of this ferruginous series of rocks there occur the normal slates, quartzites and graywackes of the Knife lake series. Following the S. shore of the lake to the E. the rocks were examined and it was found that the slates and graywackes with the iron formation occupy the bottom of the lake outcropping occasionally upon the islands, and for some distance running along the S. side. Just back, that is to the S. of these slates and separated from actual contact with them by a topographical depression occurs the greenstone forming a high ridge, trending approximately parallel with the long direction of this string of lakes, that is, N. E., S. W. A little farther E. this greenstone appears upon the shore of the lake as shown by the formation line upon the map.

The iron formation and slates outcrop again at the end of That Man's lake. Crossing the long portage I

reach No Man's lake and find that its S. shore is occupied by the sediments with greenstone forming the ridges still farther S. The iron formation and schist runs approximately through the center of the lake outcropping on the S. W. side and also on the E. side of the lake.

28994 & 95 & 96 40000

The best exposures seen in this area are those which occur on the range of hills crossed by the portage from No Man's lake into This Man's lake. Upon the hill immediately N. of the W. end of the portage I find a series of narrow interlaminated bands of jasper, hematite, and chert. These form broad bands of what I will speak of as iron formation up to a width of 10 paces. Between these and interlaminated with them there is a well banded gray slate similar to 28994 that represented by spec. 28994. Running through this slate and jasper, parallel to the banding of both for the most part there are seen bands of varying width from 2 inches down of a red weathering rock which looks strikingly like an eruptive. Spec. 28995 shows the banding of this hematite and red rock and their ~~subsequent~~ infolding. Spec. 28996 is of the red

rock alone. As we go W. along this ridge, this eruptive rock appears in larger and larger quantity. Topographically it underlies the jasper and seems to be an eruptive which has intruded ~~into~~ the slates and sent off shoots from it into them. In one place this eruptive rock is seen cutting off the bands of the slate very distinctly. It was clearly a case not of faulting but of igneous intrusion. These interbanded slates and iron bearing rocks continue to outcrop along the hill to the E. From this hill I, with Professor Van Hise, made a traverse to the S. with the following result. We convinced ourselves that there was here a synclinal ~~structure~~. The center, that is, the highest rock consists of gray sericitic slate of which at least 50 feet was exposed and which may have a width of about 75 feet. On each side of this, that is both to the N. and S., there is found a belt of jasper and slates. This belt is a complex made up of 3 belts of jasper with 2 intervening belts of slate. The approximate width of each complex is 50 feet. This iron complex is followed both to the N. and S. by a considerable width of slates which are in their turn succeeded by interbedded graywackes and slates. Finally to

the N. and S. of these sediments there comes the greenstone. This greenstone was not seen just at this part of the locality but its relations to the sediments was obtained on the strike farther W. of this place and but a short distance away.

From the repetition of these various rocks on the N. and S. it is clear that the structure at this place is synclinal, the greenstones on the S. and N. representing the oldest rocks with sediments which represent higher and higher formations as we go toward the center of the syncline which coincides essentially with the topography in this region. The lakes lie at the bottom of this syncline. Just at this place the relationship between the greenstones and the sediments were not observed but in other places in the area the sediments have been found lying upon the greenstone with a basal conglomerate derived from the greenstone, showing conclusively their relative ages. This That Man's and No Man's lakes evidently lie in this syncline of sediments.

+ The other lakes

The jasper bands spoken of above as being interbedded with the slates and forming part of this complex are made up of jasper, hematite, and slate in which the jasper and hematite predominates. Spec. 40000 was taken from

I.S. 40000

such a band. From such a jasper, hematite, and slate complex there is then a gradation into the laid in which slate predominates and in which there is practically no jasper. The slate here shows upon its weathered surface pink and white and green bands, indicating a different composition of these bands

28998 This is a specimen from the exposure in the bay E. of that one into which the portage from the small lake S. enters into That Man's lake. It was taken from the same exposure from ~~28994~~ which 28994 was obtained. This spec. illustrates the carbonateous variety of the slates associated with the iron formation.

28999 Mention was made a few paragraphs above of the fact that an eruptive rock occupied somewhat lower ground to the W. of the slates and iron formation on the E. end of No Man's lake. This eruptive also cuts these sediments. This rock was represented by specs. 28995 and 28996. Just N. of the mouth of the ~~river~~ creek flowing from This Man's lake into No Man's lake there is an exposure of a green massive rock whose character I was un-

able to determine in the field. I judge that it is an eruptive rock and most probably is identical with that represented by specs. 28995 and 28996. Its relations to the sediments N. and E. of it are not shown. If it does prove ~~to be~~ the same as the other rock which cuts the sediments then we can place it with ~~either~~ lake.

After crossing the portage from No Man's lake into This Man's lake continued E. skirting the S. shore. The iron formation is beautifully exposed on the S. shore a short distance E. of the end of the portage, both on the point and in the bay. Sediments lie to the S. of it and then greenstone appears in the hills still farther S. and is exposed on the S. shore of ~~this~~ bay E. Continuing E. I find the jasper exposed on the island lying N. of the main shore. In one place a large exposure of the iron formation comes up to within 6 or 8 inches of the surface of the water. We could just go over it with a canoe and could follow it for something like 100 paces in continuation of the exposures on the shore. The strike is about N. E., S. W. with a dip about vertical Owing to the very small scale of the map it was practically impossible to map accurately the occurrence of the

various rocks. The islands are not correct and neither is the outline of the lake shores. In general, however, it may be said that the slates with the iron formation occur near the center of the lake on the islands. The graywacke is found to the S. on the islands and also upon the points of the main land projecting N. To the S. of this lies the greenstone. This relation holds throughout the extent of the lake. We reached the E. end of the portage into the Other Man's lake just before dark and camped here for the night.

This morning began work by examining the outcrop on the lake shore just at last night's camp. The iron formation is here exposed. It is much more broken and sheared than is that farther W. At one place there is, cutting it, a dike of red fine grained granite. Followed the S. shore of Other Man's lake this morning and found the iron formation continuing through the central part of the lake, as was the case in the lakes studied yesterday. The strike is to the N. E., S. W.

On the S. W. shore of the lake there was observed a large mass of feldspar porphyry apparently cutting through the greenstones which come in S. of the sediments. This porphyry is on

the main shore and also occurs upon an island N. E. of the exposures on the shore. Greenstone forms the major portion of the S. shore of this lake. The contact between the sediments and the greenstones on the W. side of the lake was not observed, low ground occurring ~~to~~ where the contact presumably runs. In crossing the contact near the E. side of the lake I find on one of the islands a conglomerate which lies to the N. of the greenstone and consists of pebbles of greenstone, jasper, and veined quartz. N. of this occurs the iron formation which I have been following from the W. Presumably this conglomerate represents a basal conglomerate of these sediments, the greenstone pebbles being derived from the lower greenstones and the jasper being derived from the jasper which E. and S. of here is found intimately associated with the greenstone, lying immediately upon it without any intermediate sediments. This conglomerate is exposed in a number of places farther E. along the shore. The contact between the sediments and the greenstone is supposed to run as indicated on the reconnaissance map prepared to illustrate this summer's work in Canada. At the extreme E. side of the easternmost bay of the

Other Man's lake there is a low small exposure of slates similar to that associated with the iron formation. Evidently this belt of sediments continues entirely across the lake. How far it extends E. of the lake is not known. I now turned back and followed the N. shore of the lakes, the S. shores of which I followed yesterday and to-day. The N. shore of Other Man's lake gives exposures of the sediments with the greenstone to the N. This same condition of affairs is found to exist on the E. side of This Man's lake. At one point on the N. side of This Man's lake I observed a mass of crumpled red jasper lying in the greenstone. In this case the contact was sharp, as in the case observed on Otter Track and Jasper lakes, and the jasper seems to be the same as that occurring on those lakes. That is, it is a crumpled red jasper not associated with sediments differing ~~from~~ in these respects ~~selves~~ from the iron formation associated with the slates and extending with very little crumpling throughout the series of lakes I am now studying. Shortly before reaching the W. end of This Man's lake the greenstones appear to swing back from the lake shore, their place being taken by the sediments. Just how far the contact should

be carried to the N. is not known; presumably not very far, for a short distance back from the shore can be seen a noticeable depression followed by a high range of hills. I believe that the formation line should run ~~return~~ through this topographical depression.

There can be no doubt as to the characters of the sediments. They are conglomeratic in places and show distinct lines of bedding. Leaving This Man's lake we crossed the portage into No Man's lake and find the sediments here likewise occupying the N. shore, forming high hills at this place upon which the characteristically weathering light colored grayish rocks can be seen. On the N. shore of That Man's lake similar sediments are also found. Just N. of the bay which trends N. W. from the N. shore and is about one mile W. of the E. end of That Man's lake, the greenstone begins to appear. In continuing, with Professor Van Hise on the day following the reconnaissance of these lakes we made a traverse to the N. into this greenstone and from one of the high hills could see a very marked typographical depression occupied in places by small lakes which extend N. W. for some 5

or 6 miles and can also be followed though it is less distinct to the S. E. This depression joins with the one to which reference was made above and in which the formation line between the sediments and the greenstones N. of the W. end of This Man's lake is presumed to run.

Continuing W. along the N. shore of That Man's lake I find in one place a slate which appears like that thus far found associated with the iron formation in this string of lakes. In this slate there are also a few bands of jasper although these bands are narrow in cross section and are exposed E-W for only a few feet. The idea of the geological structure along this string of lakes is that the lakes lie in the syncline of sediments, the slates occupying the center of this syncline. Now in yesterday's work I noted the slates and iron formation on the S. shore of this lake. Here it is apparently on the N. shore, at least a remnant of it. This would be the N. limb of the syncline the opposite limb of which was represented by the iron formation and the slates to the S.

40001 There is a green rock possessing

peculiar characteristics exposed on the point somewhat farther W. which is on the N. side of the lake and almost due N. of the N. end of the portage into this lake from the small lake to the S. This rock upon fresh fracture is very noticeably spotted, the spots being white to gray with some green, and of irregular shape though in general oval. They lie in a matrix of a rich green. On the weathered exposures, the rock has a mammillated surface which is very striking. This rock I consider a metamorphosed sedimentary, drawing the conclusion chiefly from certain banded areas which I observed in it. It may be an eruptive including ~~x~~ areas of sediments. Just on the S. shore of this exposure there is a small outcrop of iron formation similar to that occurring in the iron formation belt on This, That, and the Other Man's lakes. Where it lies against this greenish rock, 40001, the contact is sharp and the bands of hematite are cut off obliquely instead of running parallel to the contact edge. This seems to indicate that the rock, 40001 is an eruptive and that the contact is an igneous one.

40001

This spotted rock reminds me very strongly of similar rocks seen in

previous years on the Vermilion Range. I could not at the moment recall exactly the place where they occur. Upon a visit at a later date to Moose lake a rock very similar to this was observed occurring at the highest point of the portage between Moose and Wind lakes. Here it can be seen to belong with the conglomeratic sediments which are overlaid by jaspers and slates. Here is a rather striking lithological resemblance between very widely separated portions of an iron formation upon Moose lake and upon That Man's lake, both presumably belonging together in the upper Huronian series.

The day after having examined the lakes above described I revisited parts of them with Professor Van Hise in order to show him this new iron formation which was found here. He agreed with me in thinking that it differs from that very much plicated jasper which we have heretofore found in the area E. of here lying immediately upon the greenstone and infolded with it. The jasper in this formation here although showing some plications possesses in general a very nearly uniform strike. Moreover this is unquestionably interbedded with true sediments forming a part of a sedimentary series

lying unconformably upon the old ellipsoidal greenstones and separated from it by a basal conglomerate. The sediments with which this iron formation is associated are similar to those which we have been speaking of as the Knife lake slates. Moreover between the slates occurring on This, That, and the Other Man's lakes and those known as the Knife lake slates which lie to the S. there are practically continuous connecting exposures. Moreover structurally they occupy the same relative positions, immediately overlying and unconformably upon ellipsoidal greenstones with the associated plicated jaspers. Hence the belief that they are of essentially the same age. This being so, we have in the Canadian portion of the Vermilion Range two distinct iron bearing formations; the one lying upon the greenstone with a sharp contact between them and unassociated with the sediments; the second containing more carbonate than the first and associated with sediments which are unconformably above the greenstone and older jasper. The observations made today were merely confirmatory of those which have already been noted. The additional points have been incorporated in yesterday's notes.

Moved the camp to-day through Carp lake and Birch lake into Moose lake. I followed the S. shore, Professor Van Hise noting the rocks upon the N. shore. The Knife lake slates and graywackes are exposed throughout the length of Carp lake and over the greater portion of the S. shore of Birch lake. Just on the point N. of the portage from Birch lake across the point into Sucker lake there is exposed a conglomerate. This conglomerate has been very much metamorphosed, apparently, as the result of shearing. The pebbles have been like the matrix much sheared, and while the conglomeratic structure can be readily recognized it is difficult to recognize the characters of the pebbles. It seemed to me that the pebbles were uniformly of greenstone.

On the point across the bay to the N. E. of this and about one mile distant, there is exposed a yellowish weathering schist or slate which contains very evidently a considerable quantity of ferruginous carbonate. Near the E. end of the narrows connecting Birch lake with Sucker lake greenstone is exposed upon small islands and also upon the N. shore. Going farther W. I find the greenstone swinging down to the S. side of the

narrows. The contact between the sediments and the greenstones would cut across this point running to the S. W., N. E. We had lunch in the narrows and then while Professor Van Hise visited the contact of the Basswood granite with the green schists, which I had already seen, I went on into the camp. On the way in passed upon the N. E. projecting point of Sucker lake a brown weathering carbonateous rock which is apparently in direct continuation to the S. W. of the strike of a carbonateous rock essentially similar to this observed on Birch lake. Were one so inclined one might say that this respresents a ferruginous carbonate horizon lying a short distance above the contact of the sediments with the green schists and corresponding to the iron formation in This That and the Other Man's lakes and to that known as the Animikie, all of these occupying relatively the same position.

The day after we reached the Moose lake camped at the S. end of the portage into Wind lake, We were prevented from working in the afternoon by rain but spent the afternoon studying the iron formation upon the ridge crossed by the portage trail. There is evidently here an infolding of the interbedded slates and iron formation. It seems to me that some of this iron formation especially some of the stringers and irregular masses found at some distance away from the main masses in the sediments owe their origin to the process of infiltration, although I would by no means insist upon this method of explaining the occurrence of all of the jasper here.

We visited to-day the area S. of Moose lake studying the various rocks occurring here. I took very few notes on this trip, most of them being made by Professor Van Hise. He agrees with my main conclusions as to the structure of this area, that is, that we have here several S. E. trending anticlines of greenstone with overlying younger sediments derived from them and wrapping around them. The origin of certain jasper areas found to the S. and lying in massive greenstone showing sharp contacts which I had considered as included by the greenstone, he considers as doubtful being unable to offer any suggestion which is thoroughly satisfactory. Some of the indications point to infiltration processes and others toward inclusion. However, as we go E. we find upon a point separating two small lakes near the township line a number of exposures of jasper which appear to be included in the greenstone. The presumption is that we have here a jasper similar in its origin to that found associated with the greenstone throughout this district. At one place this jasper as well as the underlying greenstone is cut by a dike of diabase, a specimen of which was taken by Leith. To the N. of these bands of S. E., N. W.

trending jasper there was noted an occurrence of jasper which has to the N. of it andapparently underlying it a banded rock, consisting of alternating fine and coarse bands, which seems to be a sedimentary. To the N. of this there occurs an ellipsoidal greenstone. It would seem here that possibly we have under the jasper a small band ~~edge~~ of sediments separating the jasper from the greenstone. This occurrence has been described in detail in Professor Van Hise's notes. Going N. from this place we pass over numerous exposures of ellipsoidal basalt showing in many cases a structure which strikingly simulates a greenstone conglomerate but which in a number of instances is clearly due to brecciation. I noticed a number of places, calling Professor Van Hise's attention to them, where the material bore a striking resemblance to fragments of a greenstone conglomerate (?) so-called which we have already seen in the conglomerates N. of here on the portage from Moose lake into Flask lake. We have had some difficulty in explaining this, the conglomerate pebble within the conglomerate. If we admit its identity with these brecciated areas then its source is readily accounted for since the conglomerates above mentioned are derived from these greenstones.