Field notes of Van Hise and Leith taken during the meeting of the International Geological Committee in the Lake Superior and Lake Huron regions in August and September, 1904: 41853-41876. No. 407 Aug...

Van Hise, Charles Richard, 1857-1918; Leith, C. K. (Charles Kenneth), 1875-1956

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U. S. GEOLOGICAL SURVEY

FIELD SECTION BOOK

9-691

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.

Notebook #07.

41853-41876.

FIELD NOTES OF VAN HISE AND LEITH TAKEN DURING THE MEETING OF THE INTERNATIONAL GEOLOGICAL COMMITTEE IN THE LAKE SUPERIOR AND LAKE HURON REGIONS IN AUGUST AND SEPTEMBER, 1904.

MARQUETTE DISTRICT. VAN HISE.

Aug. 10, 1904.

In trip through Marquette and Gogebic districts the objections to the classification proposed; Archean and Huronian, and Archean divisible into Laurentian and Marinéniscan and Huronian are as follows:

Lane continually mentions the sedimentary features of the Mareniscan, and does not appear to fully recognize the difference in methods of work in the Mareniscan and Huronian.

The Canadian geologists, especially Bell and Adams, make the point that for economic purposes the chief break is between the Laurentian and all other series. Also the difficulty of mapping one from the other seems to them great, and finally Adams seems to think that such an eruptive contact as exists between the Laurentian and the Mareniscan is of greater structural significance than the unconformity at the bottom of the lowest Huronian.

The answers to the above objections are that the distinction between the Mareniscan and the Huronian is quite as important economically as the distinction between the Laurentian and other series. Second there is no difficulty in mapping the sedimentary ser-

ies of the Huronian from the pre-Huronian, although there may be great difficulty in separating the Huronian into its conformable series, and these series into members. As to the importance of the eruptive contact it was pointed out to Adams that the only way in which the Laurentian could have any age significance was to limit the Laurentian at some structural break, otherwise the Laurentian would include all granitic rocks which act as batholitic masses up to the Cretaceous, or even to the Tertiary, and if any structural break is selected to limit the age of the Laurentian the greatest of all breaks for this purpose is at the bottom of the Huronian.

The genesis of the hard ores of the Marquette district is supposed to be briefly in the following stages:

First a period of weathering of the iron carbonates of the Negaunee formation before the Goodrich quartzite was laid down, there being produced at this time in the belt of weathering ferruginous slates and cherts, the oxide of iron of which is hydrated hematite. Similar also was the detritus of the basal horizon of the Goodrich quartzite. After the entire upper Huronian series was laid down and doubtless also the Keweenawan there came the great period of intrusion and folding which is characteristic of the present struc-

ture of the district. At this time under the deep-seated conditions of the zone of anamorphism, and igneous rocks were abundant, the weathered materials and also the iron detritus in the Goodrich quartzite were dehydrated and transformed to hematite. Under these deep-seated conditions the heavy silicates formed, such as garnet, ottrelite, etc. The silica was dissolved out as evideced by the porous conglomerates, the pebbles of which are dissolved, and at the test put north of the Winthrop Mine the magnetite and hematite were dissolved, but especially the magnetite. Also the iron sulphides characteristically present with the hard ores were formed. This enrichment occurring under deep-seated conditions was doubtless largely accomplished by ascending waters, and the hard ores were practically finished during this epoch. The third stage began after denudation again rached the upper plane of the Negaunee formation. At this time the alteration of the silicates, such as garnet to chlorite, and the alteration of the ottrelite, the change from magnetite to martite occurred. At the same time further enrichment took place. These hard ores of this origin are controlled in their position mainly by the contact horizon, rather than by the presence of basal dikes and basins. Doubtless an important factor in the

solution of the silica was the alkalies furnished by the igneous intrusions. The specular hematite at Humboldt and at Champion represents the dehydrated and mashed oxide of iron antedating the Goodrich. The crystalline magnetite and hematite represent the second enrichment at depth. Soft materials, such as martite and infilitrated hydrated hematite represent t the third enrichment. The typical localities for the hard ores are Champion, Michigamme, and Republic. The ores in which the deep-seated process was not so important are those of the Ishpeming trough, in which the silicates did not abound. The deep-seated alteration for the western part of the region was so profound that the iron carbonate below the belt of weathering was silicated, and we have the grunerite magnetite schists. In the Ishpeming basin upon the other hand the deep-seated alteration did not take place to such an extent so but what there was present a large amount of siderite, and here the soft ores formed in basins at the same time the final enrichment of the hard ores occurred. In other words the great soft ore bodies were produced by a single enrichment after the rocks were exposed to the present belt of weathering, whereas the hard ores have had two anterior stages in their development. At the eastern end of the Marquette trough

the green schist, as well as the granite, occurs south of the syncline. This green schist is cut by granite, and the basal horizon of recomposed material having mcuh granitic detritus in places is directly above the green schist.

In the Gogebic district almost the only place at which red jaspers are found is at the Sunday Lake locality, where the Keweenawan comes against the iron-bearing formation. This is the only place where the iron carbonate was exposed to weathering before the Keweenawan was laid down. Here there would be developed a belt of weathering ferruginous slates and cherts, the iron being the hydrated hematite. When the Keweenawan was laid down and the conditions became those of the deep-seated zone, dehydration took place and the jaspers were formed. Immediately in contact with the Keweenawan and for a short distance downward the iron formation is here bright red banded jasper as beautiful as any in the Marquette district. The jasper in the Marquette district has been explained in a similar fashion. The finding of identical jasper at Sunday Lake in the upper horizon of the iron formation gives complete confirmation to the theory of the origin of the jasper, held for some time. At Sunday Lake, as in the Ishpeming area, the downward extensions of the iron formation give ferruginous slate and chert. From these the soft ores have developed.

East of the little Presque Isle river Seaman took me to a locality where the limestone was found in great volume. This limestone dips to the north as usual, and below it is a bed of quartzite fifty to sixty feet thick. This quartzite shows ripple marks and is perfectly characteristic sedimentary quartzite indurated by cementation. Below the quartzite is a bed of conglomerate, for the most part not more than two to four feet in thickness, bearing numerous boulders, mainly of green schist, but also having pebbles of greenstone and quartz. Directly below this, and in visible contact with it for two or three hundred feet, is the green schist, the foliation of which strikes parallel with the range, but the dip of which is almost exactly at right angles to the dip of the quartzite, the former being about 35 to 45 degrees to the north, and the latter 55 to 65 to the south. The discordance is as great as between the Animikie and the green schist of the north shore. This locality gave decisive evidence that the great metamorphism of the green schist, the great epoch of granite intrusion, and the metamorphism of the green schist all antedated the lowest of the Lower Huronian series, showing that this break is vastly greater than any other single break in the series, although where the Lower Huronian series are

absent, and the Upper Huronian rests upon the green schist the break is somewhat greater. But the difference in time represented by the unconformity between the Lower Huronian and the Upper Huronian is, I believe, but a small fraction of the time between the green schist granite series and the lowest Huronian.

The dolomite at the presque Isle and that at the eastern end of the Marquette district are very similar, and both are almost absolutely like the lower limestone of the original Huronian area. Illustrating this, Mr.George, who had recently been in the original Huronian area near Echo Lake, said upon seeing the limestone south of Marquette: "Why this limestone is exactly like the Echo Lake limestone."

South of Sunday Lake the ledges have been cleared and are well exposed. In all respects the green schist here is identical in its appearance with the great areas of greenstone schist south of Ely. It has the same hackly fracture and banding, and here and there contains bands of sedimentary looking material. Doubtless much of this is tuff, but also a part of this is probably sediment, indeed certain bands look as if the jasper was beginning to come in. This green schist immediately south of the railroad is cut by granite dikes. This schist is not nearly so much metamorphosed as much of the

green schist, and especially that near the granite. Near the latter contacts it is apt to be a hornblende schist formed largely through the influence of the granitic intrusion. This hornblende schist and gneiss is at the horizon which Lawson has locally called Couchiching. The Sunday Lake green schist is continuous with the green schist of Mareniscan township, and that west of the upper part of Gogebic Lake, which I have called Mareniscan.

In my first season's field work in this area I found bands of jaspery material in the green schist, and was doubtful on this account whether this green schist belonged to the Huronian. In places the iron material in the Mareniscan is in sufficient volume so that the formation has been prospected. The presence of this iron formation in the Mareniscan makes the analogy with the remainder of the green schist perfect and justifies the term Mareniscan as a general one.

Van Hise, Aug. 13, 1904.

Again revisited Vermilion district in company with part of United States and Canadian geologists. In reference to the iron ores the only new thing which occurs to me is the same as that in reference to the Marquette district, viz.; that the hard ores of Soudan and Lee Hills have undergone three periods of concentration exactly analogous to those in the Marquette district, while the soft ores at Ely have undergone onl a single concentration. Also the two horizons, a red jasper at the top where the Soudan formation is thcik, and a hard magnetite (black) jasper where the formation is in contact with the greenstone, suggest that the original siderite was weathered in this region before the deposition of the Lower Huronian, precisely as the Lower Huonian in the Marquette district was weathered before the deposition of the Upper Huronain, and as the Upper Huronian in the Sunday Lake area of the Gogebic district was weathered before the Keweenawan.

The hard ores of Soudan and Lee hills are intimately associated with brilliant red jasper. They intersect the jasper in veins, replacing the jasper beds precisely as with the hard ores of the Marquette district. In short there is here the same evidence of the solution of silica and the deposition of specular magnetite and hematite as in the hard ore of the

Marquette district. Doubtless this time of concentration was during the folding after the Lower Huronian was deposited, and correlative with the intrusions of that time. As in the Marquette district doubtless much of this work was done by ascending waters. The effect of the descending waters when the hard ores reached the belt of weathering is shown by hydrated hematite and various weathering products The hard ore is cut be veins of quartz apparently later than the ore enrichment. These veins were doubtless deposited after the Upper Huronian was laid down while undergoing denudation, and the ores were in the zone of fracture. As noted at many places, the ores are at places of maximum folding and brecciation. It is notable that the deposits of Lee Hill were very early worked out and that all of the rich ore of Soudan Hill has been exhausted. It is further notable that even the richest ores of Soudan Hill were not continuous deposits of pure iron ore, as in the case of the large soft iron ore deposits. Even the best of the ore was hand picked to a greater or less extent, it being impossible to get sufficient masses so that the rock and the ore could be altogether separated.

The soft ore at Ely was formed from the iron carbonate. The weathering was in a perfect pitching trough rest-

ing in an impervious basin. Thus the contrast between the hard and soft ores in the Vermilion district is identical with that between the two classes in the Marquette district.

The Lower Huronian series of Ogishke conglomerates and Knife Lake slates is a great series. This is equally true of the upper slate which extends over a large area west of Vermilion Lake, switches south toward the Mesabi range, and is there intersected and metamorphosed by the Mesabi granite. Where thus metamorphosed it becomes a mica schist or mica gneiss identical with the schists and gneisses of Rainy Lake, which Lawson calls Couchiching. Since on the south side of the Mesabi granite this rock cuts the slates and conglomerates which are in a similar attitude with those north of the granite, and metamorphoses them in a like fashion, and since the Animikie unaltered rests on the edges of the slate and conglomerate series, and its metamorphosed varieties are a slate, there can be no question of the Lower Huronian character of the clastic series of the Vermilion district. Since this series is traced as a great series to the Canadian line there can be little question that Lawson's Couchiching which occupies a similar position with reference to the Keewatin is also Lower Huronian. Whether the Lower Huronian of the Vermilion district represents the Lower or Middle Huronian

of the Marquette district, or both, with intermediate unconformity, is undetermined. The most natural position with which to correlate it is with the Middle Huronian rather than the Lower for the reason that the Siamo slate is a considerable slate formation. In this case the Ogishke conglomerate and Knife Lake slates of the Vermilion district would be the equivalent of the Ajibik quartzite and Siamo slate of the Marquette district. The iron-bearing formation which comes into this series in Canada at the east end of the Vermilion district would be roughly correlative with the Negaunee formation, but occupies a somewhat different position in the series, being overlaid by slates as well as underlaid by them. If this correlation is correct, a more accurate statement would be that the Siamo slate is equivalent to the slate below the iron formation on the east side of the Vermilion district, and that the great slate formation above this ore horizon does not appear in the Marquette district. The correlation of these series is, however, very uncertain, and is suggested by the absence of anything which can be equated with the Kona dolomite.

In any case it appears that in the Lake Superior region there are two great slate formations, one in the Lower Huronian and the other in the Upper Huronian.

Leith. Aug. 17, 1904.

Party consisting of Robert Bell, F. D. Adams, W. G. Miller, C. W. Hayes, C. R. Van Hise, C. K. Leith, and A. C. Lane. Boat at Fort Frances, went up the river to Couchiching Point and examined the Couchiching series where na named by Lawson. The rock here is a mica schist showing clearly its sedimentary character. Bands of slaty and graywacke material were seen striking a little north of east and standing apparently vertical, although the folding, faulting, and metamorphism have been so intense that the strike and dip of the bedding cannot be relied upon. It was the general concensus of opinion that the beds were in a series of rolls perhaps varying widely in sharpness. Cutting the series are dikes of igneous material which can be distinguished wit with only the greatest difficulty from the graywacke bands. Specimens 41853, 41854, 41855, 41856, and 41857 were taken here.

41853-41857

Next stopped on little island about three miles east of Couchiching and saw the contact of the Couchiching and granite described by Lawson. In going along the island to the north along the contact the granite is observed to become more porphyritic, and loses the slightly foliated structure it has at the north end of the island. Near the contact there is no foliation whatever.

The contact is a perfectly knife edge contact and has the usual irregularities of an intrusive contact. Dikes of the granite may be seen ramifying through the schist in various direc-
41858 tions. The schist is a clear-cut mica schist, slightly, if any, more metamorphosed than the rocks seen at Couchiching. No porphyritic materials were observed. More or less banding may be seen parallel in general to the contact which may represent bedding, but the evidence is very obscure. Lane makes the point that the porphyritic texture near the contact, accompanied by the general diminution in the size of the mica flakes near the contact indicated the intrusion of the granite into a rock very different in temperature, i. e.; into a cold rock. This would not be in accord with the theory of subcrustal fusion. In general the granite has the fresh massive appearance of our Huronian granites rather than the gneissic appearance of the older granites. It contains a considerable amount of quartz.

Next went around Grindstone island into the mouth of Black Bay and went to the west end of the first western bay where Lawson has his Keewatin series mapped as emerging into the end of the bay. The Keewatin series here consists of very rough weathering chloritic schists, and in part horn-

blendic schists, very rotten on the surface. On the north side of this across a little arm of the bay appears the conglomerate which is itself very schistose, but on top of the hill shows its character clearly, containing fragments up to six inches in diameter. The matrix is a green chloritic and micaceous schist, the pebbles are (1) granite of three kinds, one of them very quartzose and another of the dense aplitic kind; (2) green schist fragments including both chloritic and hornblendic varieties; (3) dense gray chert or felsite; (4) a reddish novaculitic material looking like quartzite, which may be a chert or may be a dense porphyry similar to the one found by Adams across the next little bay to the north. Climbing up the hill onto the conglomerate it is found within thirty paces to pass into a feldspathic quartzite which is schistose and micaceous, in which the fragmental quartz shows very plainly. The quartzite appears on the shore a little farther west and from its relations in distribution to the conglomerate it is thought that it was standing nearly vertical and striking nearly parallel to the contact of the conglomerate and green schist. We paddled around the end of the point and saw a considerable amount of the quartzite indicating a thickness of at least four or five hundred feet, but perhaps

41859 less if the series is folded. Specimen
41860 41859 is a schistose quartzite. 41860
is a chert pebble in the conglomerate.
41861 41861 is a quartzitic chert or por-
phyry pebble in the conglomerate.

Leith. Aug. 18, 1904.

From camp on island on north end of Rat Root or Jack Fish bay went to south side of bay and saw the granite; worked west along the supposed green schist, mapped as Keewatin, to the conglomerate which appears on the shore. The principal pebbles of the conglomerate are granite. Some of them are greenstone. A few pebbles of a banded cherty rock (specimen
41862 41862) which were taken to be slate were found. The matrix is hornblendic, micaceous, and chloritic green schist. In following the conglomerate west it becomes very schistose in places, and also in going south up the hill it becomes schistose, but its characteristics are recognizable. We were unable to locate any rock which we were certain was the green schist, although the conglomerate becomes so schistose that the green schist may be intercalated with it and not be recognized.

Went up to a little island in middle of west end of bay and saw a very much more distinct conglomerate, with pebbles up to two or three inches in diameter, these pebbles being predominantly of mica schist, like the couchiching, and of a light yellow granular quartzitic rocks which may be in part vein quartz but which is cer-

tainly in considerable part fragmental quartzite, perhaps derived from the quartzitic phase of the Couchiching. 41863 Graywacke layers (specimen 41863) were seen in the conglomerate cutting the cleavage at an angle of about 20°. The dip of the bedding was thought to be approximately south at an angle, say of 45°. It was agreed that this conglomerate might represent a conglomerate later than the Couchiching and perhaps also one later than the conglomerate on the south shore.

Went on the north shore, saw the typical Couchiching again. Then paddled to an arm running south from Rat Root Bay (Grassy Narrows?) and saw the granite in contact with the green schist. Coming north visited small island in midst of main channel, consisting largely of diabase but having on the south side some banded slaty and micaceous material certainly sedimentary, containing fragments representing stretched pebbles, but thought to be for the most part the result of the autoclastic stretching of coarse bands in the sediment, and of vein quartz layers.

Attention should be called to the fact that the dip of the cleavage whereever observed near the contact of the Keewatin and Couchiching at Black Bay, Jack Fish Bay, and Seine River, is either vertical or toward the Couchiching. At Black Bay and on

the island in Jack Fish Bay the dip of the bedding also was apparently away from the Keewatin.

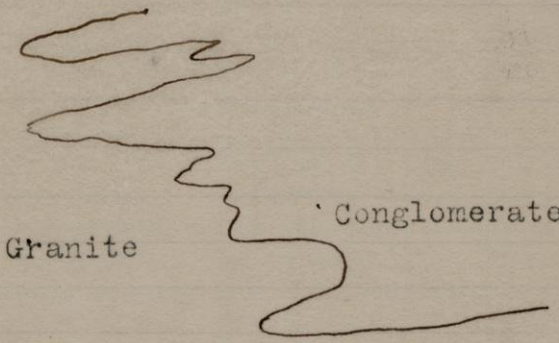
Then went up the Seine River and camped just west of Grassy Lake. Examined the north part of the river from camp to first small point to west about a mile and a half, where Lawson describes contact of Keewatin and Couchiching. The exposures on the south shore were found to be typical micaceous Couchiching, somewhat hornblendic in places. On the north side similar material was found at the shore but back a few steps massive andesite and hornblende schist appears undoubtedly belonging with the basement. Near the contact with the Couchiching it is so schistose that nothing decisive could be made out. I am not certain that I could even determine the contact within twenty-feet. Certainly hand specimens could not be distinguished. In this distance certain obscure lenses of granitic nature may represent pebbles in a mashed conglomerate.

Leith. Aug. 19, 1904.

Went from camp through Grassy Lake to east end of Shoal Lake and examined the main land for several hundred yards east of Mine Center. This was found to consist mainly of conglomerate with fragments of granite of at least two kinds, green schist, black chert, and banded chert specimens principally from iron-bearing formation. Interbedded with this conglomerate is a coarse graywacke. The two have been coarsely infolded, but in general strike about northeast-southwest, and dip to the southeast parallel to the trend of the belt. The cleavage almost uniformly cuts the bedding at a low angle. Just across the bay, east of the town, a coarse amygdaloidal diabase appears, but it is so separated from the graywacke that its relations cannot be determined.

Going west of the Foley Mine we landed on the shore about two hundred steps west of the mine and found the conglomerate within ten feet of the granite. The pebbles in the conglomerate are mainly of a light salmon pink felsitic rock, but in part also of coarse granite, of aplite, of green schist, and of iron formation fragments consisting of massive and banded chert. Working west along this belt its character may be seen to change widely by variation in relative abundance and size of the

fragments. One place was seen where the fragments were almost exclusively green schist. About a half mile west of the mine the actual contact of the conglomerate and the granite was observed. The granite is a very quartzose one with numerous quartz eyes, and pebbles of the same in great abundance are conspicuous in the conglomerate close at hand. The two rocks have here been so closely infolded, however, that the line of contact would make the relations of the two obscure were it not for the pebbles a few feet away from the contact.



Dr. Adams, who took a course somewhat farther inland in coming west reported a more distinct contact a little to the east of this one. Following along the shore to the west and south of the mouth of the Seine river the conglomerate may be seen to give way to a coarse clastic

41864 graywacke (specimen 41864) containing distinct beds of conglomerate, and showing a distinct bedding, then to a finer clastic and micaceous graywacke (speci-
41865 men 41865) still showing bedding, but more nearly resembling the Couchiching. The bedding uniformly strikes about parallel with the main belt of sediments as shown on the map, and dips to the south at an angle of perhaps 45°. On the south side of the river at the mouth the sediments become still finer, more micaceous and clastic. Three specimens collected by Van Hise
41866- show this gradation (specimens 41866,
41867 41867, and 41868). All were satisfied
41868 that the finer material about the mouth and on the south side of the river belong to the Couchiching series and that this series grades upward conformably from the conglomerate found on the granite on the north side of the Lake. However, this material on the south side of the river is mapped by Lawson as Keewatin. This is clearly a mistake in the mapping, for this material could not be distinguished from what he had mapped as Couchiching at the southwest corner of Grassy Lake. With this new interpretation the structure is that of a conformable southward dipping series extending from the granite to the north south through his main area of Couchiching, the slates probably being in a series of rolls, greatly increasing their apparent thickness.

The pebbles vary in coarseness from a fraction of an inch up to four or five inches, and near the contact of the granite great fragments four and five feet in diameter were noted.

Leith, Aug. 22, 1904.

Lake of the Woods.

Got off at the northeast corner of Falcon Island, and examined the north shore along Johnson Passage to the northwest point of the island. In coming up the east side of Falcon Island we had seen a considerable amount of hornblende gneiss of the usual gnarled and contorted variety. On the north side of the island the rock was found for the most part to be an acid and intermediate tuffaceous rock looking in some places like an acid porphyry, and in other places like an intermediate rock. Banded phases were seen resembling ash deposits and the tuffaceous deposits graded imperceptibly into massive phases of the same rock. On the northwest point especially it was impossible to draw the line between the feldspar porphyry and the tuffaceous banded porphyritic rock.

Going around the northwest point to the deep bay in the northwest corner of Falcon Island we found the same intimate mixture of tuffaceous and massive rocks collectively giving a close resemblance to the basement complex rocks. These may be seen on the south side of the point. Cutting these rocks at a number of places we observed quartz porphyry granites with large purple quartz eyes. On the south side

of the inlet to this bay, mapped as granite by Lawson, we found only a continuation of the same tuffaceous materials, acid and intermediate, cut by a quartz porphyry granite. The granite mapped as later granite here by Lawson is without question related to the dikes and irregular masses seen intrusive into the tuffaceous series. It was thought at some places that fragments of massive porphyry could be seen in the tuffaceous rocks, but this was very doubtful. The entire series, excluding the porphyries, showed a marked similarity to the Clarksburg volcanics of the Marquette district, but the similarity is almost equally as well marked with the basement complex rocks of the Vermilion and Mesabi districts and the Der Lake conglomerates of the Marquette district

Then went northeast to Tranquil Channel and went into camp in little cut leading into Turtle Bay.

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Leith. Aug. 23, 1904.

With canoe and boat went north into Turtle Bay, then into Quandrary Bay and thus around into Tranquil Channel. Part of the party also looked over Kennedy Island and the area adjacent. The granite mapped by Lawson is found to be the acid feldspar quartz porphyry seen on the previous day. The material mapped as slate was found to consist of the same tuffaceous series, mainly intermediate. The rocks were principally hornblendic chloritic schists, in places showing obscure fragments similar to those of the Deer Lake conglomerate. These rocks in some places had a very platy micaceous parting and near at hand graded into massive rocks which showed little deformation. Cutting these schists is the porphyritic granite mapped as later granite by Lawson. The granite itself shows a considerable variation in schistosity, grading from nearly massive, to mica schist. This granite with the green schist has in general a metamorphosed aspect such as is characteristic of the Archean Basement Complex.

It was concluded that all of the rocks seen during the preceding day, and about Tranquil Channel, were probably of Basement complex age, although many of them were recognized as volcanic fragmental, and possibly included

even some water deposited sediments. Certain of the very fine-grained schistose green rocks, while giving no clew to their origin, may well have been true slates.

In the afternoon examined the shore from Micrometer Island to Luella Point where alternations of the conglomerate and mica schist are mapped. The conglomerate was found to be the usual tuffaceous material of intermediate and acid character. This could be seen to pass by direct gradation with continuous exposures into very fissile mica schists. The tuffaceous character, even the most fissile forms, can frequently be seen on the planes normal to the cleavage, but on the cleavage planes are not to be seen. Passing around Luella Point in the bay the conglomerate series gives way to a narrow band of black graphitic slate containing iron pyrites which for the most part are weathered out leaving numerous rounded openings resembling blow holes. On the south side of this is a layer of what was taken to be coarse gray-
41869 wacke (specimen 41869). Judging from the contact the dip is very steep and strikes approximately east and west. This slate resembles the black slate of Soudan Hill to a remarkable extent, and with the other rocks already observed makes the resemblance to the Basement Complex of the Vermilion district a remarkable one, the essential

difference being that the clastic rocks in the Lake of the Woods district are relatively more abundant than in the Vermilion district.

Leith. Aug. 24, 1904.

Went into Ptarmigan Bay to Spruce Point, and then north past the northeast corner of Corkscrew Island, and examined the conglomerate and mica schist there mapped. The conglomerate of the north end of the inlet was found to be the usual acid tuff rather micaceous. The mica schist to the south was found to be a mashed ellipsoidal greenstone. Even where the mashing had developed a perfect mica schist the ellipsoidal parting could frequently be seen on the planes normal to the schistosity.

Then went to the northeast corner of Scotty Island and saw the limestone there. It is in narrow bands from a fraction of an inch to two or three feet in thickness in a schistose and banded greenstone. The layers for the most part pinch out lense fashion and show a considerable amount of contortion and faulting. The division between the limestone and the greenstone is for the most part sharp as it is in similar instances in the Hemlock volcanics of the Crystal Falls district. Then went south and examined Slate island. Here may be seen a banded mica slate which was concluded to be of sedimentary origin. In adjacent ridges banded slaty rocks with similar strike were taken to be interbedded calcareous slate, but this was not definitely shown. On the north side

of the island coarse gabbro was found intrusive into the slate.

Small limestone bands and calcareous discolorations were seen at other localities by Van Hise during the run of the steamer.

Went northeast to the Sultana mine, which is now in operation. The country rock here is a coarse porphyritic rhyolite with large phenocrysts of feldspar and numerous small round quartz eyes. The rock has the dark gray color of the Berlin rhyolite. It is for the most part schistose. Associated with this is dense, fine-grained, aplitic greenstone, probably in the form of dikes. The gold occurs as free milling gold associated with iron pyrites in quartz in a great shear zone in this rhyolitic rock. The maximum width of the vein as given by the superindendent is forty feet. From this width it varies to nothing. The superindendent describes a fault which offsets the vein for a considerable distance. The ore varies widely in richness, and makes statement of average value of little account. Over thirty thousand dollars have been taken out in a single day, but it is thought that on the average the mine has little more than held its own.

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Leith. Aug. 25, 1904.

Examined the contact of the Keewatin and Laurentian granite just west of Rat Portage along the Winnipeg River. The Keewatin is a normal green schist here, varying somewhat in texture and structure, and on the lake a few hundred years south of the contact takes on a slaty phase. The granite contact was observed on the portage. The granite has intruded the schists parallel to the schistosity, and with the usual complex result. In approaching the granite the schist becomes more hornblendic and micaceous, bands of granite begin to appear, and also bands which it is hard to classify either as granite or schist. The zone of interleaved granite and schist is between twenty and thirty steps wide. Then the granite comes in in solid mass. The granite is a coarse, porphyritic one, the porphyritic feldspars being perhaps part the result of secondary pegmatitic action as shown by relation of veins, but being probably for the most part of intratelluric origin. The phenocrysts seem to show no variation in ~~size if thproaching these were found~~ size in approaching the contact, and some of the largest ones were found in narrow bands.

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In the afternoon went farther to the north along the Winnepeg River well into the granite and found same to include patches (stringers) of hornblende schist and gneiss as far as we went. In general the granite becomes more gneissic and contains more inclusions in leaving the contact but there is little question that the fresh looking granite at the contact and the gneiss away from it are one and the same for the most part, although a later and reddish granite was found
41881 intrusive into the gneiss.

Then skirted the west shore south of Rat Portage toward Devil's Gap. At Rat Portage itself the greenstone has a coarse agglomeratic phase with fragments six inches or more across. Going south these give away to the normal dark green hornblendic and micaceous schists and schistose basalt In the Devil's Gap itself a well marked ellipsoidal structure may be observed.

Van Hise. Aug. 27, 1904.

During the past two weeks we have visited Rainy Lake, Lake of the Woods, and the Loon Lake area immediately adjacent to Port Arthur.

At the north end of Vermilion Lake we found the hornblende schists cut by granite to have their usual metamorphic character. On the stage road from Vermilion Lake to Crane Lake the greater part of the distance was over coarse granite, oftentimes foliated, containing inclusions, and having the usual Archean aspects. Before Crane Lake was reached, however, a massive granite appeared which may be of later age. In passing from Crane Lake to Namakon Lake we came upon the mica schists of the Couchiching. It is here cut in a most intricate way by granite; indeed the relations are typical of a stage between a sedimentary series and a great intrusive mass of granite. After the main granite mass is passed large dikes and bosses appear. These become fewer in number as we pass into the schist area, until they are very subordinate. The first detailed examination of the schist was made at Kettle Falls. It is here a normal mica schist, not showing any bedding. The schist was observed at various points as we steamed to Fort Frances. From Fort Frances we went to

Couchiching where the mica schist was examined at the typical locality. It here shows coarser graywacke like phases and shows distinct bedding cutting the cleavage, although the rock has been completely recrystallized. At an island three miles east of Couchiching the mica schist was found cut by granite as described by Lawson. The granite is coarse-grained, perfectly massive, and has no foliation.

At various localities, notably at Rat Root Bay and at Shoal Lake the contacts were examined between the green schist and the conglomerate which Lawson marked as Keewatin. This conglomerate was found to contain both gray granite and greenstone fragments, the latter of many varieties. Where the conglomerate is on the green schist, as at Rat Root Bay, the fragments are dominantly green schist. Where it is on the granite, as at Shoal Lake, the fragments are largely of granite but not entirely so. The actual contact between the granite and green schist was found at Shoal Lake, the conglomerate bearing fragments of the coarse granite immediately adjacent. This coarse conglomerate was traced out through a fine conglomerate, this to a fine graywacke, and this to mica schist, on the east end of Shoal Lake and on the narrows at the east end of Shoal Lake. Here there is no question of the grada-

tion of the conglomerate through finer and fine grained phases into the typical mica schist of the Couchiching. Indeed the relations are so clear that all members of the party agreed that the Couchiching and the conglomerate belonged together, and that this entire series rests with a great unconformity upon the Keewatin green schists cut by granite.

In the Lake of the Woods area, contrary to expectation, no large sedimentary series was found. The agglomerates of Lawson are the tuff conglomerates of the green schist series, the slates are the mashed varieties of the ellipsoidal greenstones, or of the porphyries in large part. However, the there are subordinate amounts of sedimentary graywacke and slate in the series, including a small belt of undoubted black slate. These subordinate masses of sediments are exactly analogous to those which occur in the green schist series south of Ely. East of Corkscrew Island the transition between the ellipsoidal greenstones and the slaty varieties of the rocks is particularly well shown. As the name Keewatin was first proposed in reference to the Lake of the Woods series and since apparently none of these are equivalent with the Huronian, this name seems justified for the old series of rocks. The contact between the Keewatin and the Laurentian was studied north of Rat

Portage and a trip made into the Laurentian area. Here the relations are those typical of the green schist series when cut by great masses of intrusive granite. The contact at the Falls is somewhat sudden there being only a few alternations of green schist and granite, but a little farther to the north there are innumerable alternations of the two, lit par lit injection, and great blocks and masses of the green schist series included in the granite. In other places the granite is comparatively free from the greenstone. The green schist series where having the parallel arrangement with the granite and in large blocks within it, has changed to the black glistening hornblende gneiss so typical for the green schist series when intruded by and metamorphosed by the granite. There is undoubted exomorphic and endomorphic effects, the green schist series gaining material from the granite and the granite from the green schist series. Doubtless the schist series has also been locally fused. The relations north of Rat Portage and the character of the Laurentian are identical with those found in the Marquette district. The Laurentian Basement Complex is precisely the same as west of Michigamme.

Van Hise. Aug. 29, 1904.

Drove from Sault Ste. Marie on Garden River road until great conglomerate ledge visited at several times before was reached. Here again examined the relations of the conglomerate to granite and to limestone. Where the ledge is first seen near the road it contains very numerous green schist pebbles with granite. The conglomerate is of only moderate coarseness. In passing north toward the granite, the granite fragments become more and more prominent and larger and larger until, as before stated, they constitute a granite stucco.

Again visited the limestone making the north crest of the conglomerate hill. As the conglomerate occurs upon both sides of the limestone it is natural to suggest that there is here an anticline, rather than that the conglomerate north of the limestone is the lower slate conglomerate. Since the limestone dips to the north this would make the anticline overturned toward the south. If the succession were regarded as a normal one it would be equally necessary for this limestone to be overturned. Where the limestone is first met with it is rather thick and has conglomerate on

each side of it. Toward the east, next to the limestone, the rock is a red quartzite having only a little coarser material. This also bears in favor of the limestone being an anticline and the conglomerate on each side of it being the upper slate conglomerate.

Van Hise. Aug. 30, 1904.

Again visited the limestone quarry north of Garden River. Made no new observations of importance at the quarry. However, examined the conglomerate close to the limestone on the north side along the south side of the valley separating the two. Here found numerous fragments of the limestone in the conglomerate. Also found the conglomerate to become coarser and coarser as it approaches the limestone. The two were not found in contact. The dip of the entire series seemed to be monoclinal to the south. The presence of numerous limestone fragments in the conglomerate north of the limestone and the fact of the coarsening of the conglomerate toward the limestone gives strong confirmation to the idea that the limestone is brought up on an anticline, and that we have upper slate conglomerate on each side of it. This suggestion also accords with the observations of the previous year. The quartzite between the conglomerate adjacent to the limestone and the north ridge of conglomerate would be the red quartzite above the upper slate conglomerate.

Van Hise. Aug . 31, 1904.

Again visited Echo Lake. Here no new new observations were made but was again impressed with the dominating importance of the quartzite of this area, and the subordinate character of the slate conglomerate. The succession of limestone point, east of the Lake, is quartzite, slate conglomerate (thin, not more than fifteen or twenty feet), limestone (thick), and over this great slate conglomerate (very thick) containing very numerous limestone fragments adjacent to the limestone. These are beautifully shown where the conglomerate nearest the limestone comes to the shore of the lake, the limestone fragments being shown by numerous depressions. Many of the limestone pebbles are wholly dissolved, but many still show remnants of the limestone.

The limestone point on the west shore of the lake shows beautifully its eastward plunging synclinal character. Going west of the point the dips are south on the north side and north on the south side. On the south side, as was observed in the previous year, below the limestone there come in the lower slate conglomerate, and below this the quartzite.

The west shore of the lake, as before described, consists of a series of great synclinal bluffs between which

are subordinate ridges. Each of these bluffs has quartzite at its base. The lower slate conglomerate is shown with variable thickness on at least three of the cliffs. The limestone is the capping formation. The limestone is prominent on the first cliff, i. e.; the one west of limestone point. It makes a more thin layer capping the bluff on the next point to the north. It has not been observed on the third bluff, the one showing prominent cliff, but has been observed on the northern bluff, the one at the north end of the lake, cut by diorite. The southern bluff, that upon which limestone is prominent, has the synclinal pitching to the south. The next ones show the synclinal pitching to the north. The third one is almost flat, and the northern one again shows bedding to the north, carrying the lower series down under the layers of quartzite and red jasper conglomerate, visited by Leith on a previous year. The lowest horizon shown at the lake would probably be at the base of the subordinate anticline making the secondary ridges between the prominent bluffs. As the cliffs are between six and seven hundred feet high, and as the quartzite goes up to about six hundred feet it is certain that the quartzite has at least this thickness. The limestone may be two hundred feet thic

on the southern bluff. The conglomerate is of inconsiderable thickness, not more than thirty feet. Thus we know for a certainty that there are probably eight or nine hundred feet of sediment shown in the lake, and the thickness may be more than this, but a very large estimate woudl be twelve or fifteen hundred feet instead of several thousands as might be concluded from the structure given by Logan and Murray.

Van Hise, Sept. 1, 1904.

At Desbarats.

Went inland at a point west of the hotel on the point, and saw belt of slate as shown by Ingall. He is doubtful as to the strike and dip, and the relations of the two. We ascertained that the slate grades into the quartzite by interstratification, that the two dip to the south at an angle of 60 to 70° and that the conglomerate is an undoubted anticline. This anticline extends across the Desbarats river and runs out into the island; the quartzite to the south making another row of islands between the mainland and Camp Ment Dour. In fact the structure corresponds with what one would expect from Logan's map, but the slate conglomerate is far less extensive in the area than given by him, and the red quartzite extends out into the lake between Camp Ment Dour and the mainland. The structure worked out makes this the upper slate conglomerate as mapped by Logan, i. E.; the conglomerate below the red quartzite.

Van Hise, Sept. 3, 1904.

With Adams again visited the locality on Bruce Mine road running west from Little Rapids. Here saw the quartzite striking diagonally toward the road about E. 30° S. and dipping to the northwest so that in traveling toward the west we passed to higher and higher beds. The thickness of quartzite here exposed must be very considerable, possibly as much as two or three thousand feet. The limestone at the bridge of Thessalon River and perhaps a half mile to the east were again visited. No new observations were made but the old ones confirmed as to the relations of the limestone and quartzite series. Certainly there must be here between the quartzite and the limestone either an unconformity or a fault or both. The intraformational conglomerate in the lime-ledge in the field was again examined and in accordance with previous statements is regarded as only intraformational, but may possibly be autoclastic. We now turned back toward Thessalon and drove east on the first road turning in this direction south of Little Rapids. The first outcrops found on this road perhaps somewhat les less than a mile from the former were found to be quartzite. After a short

interval we came into the same green schist series which is so well exposed at Thessalon. This green schist belt extends east for some distance, probably between two and three miles. We then came at once upon ridges of granite, many of which contained block of green schist. We had little doubt that this granite is intrusive in the green schist series. We continued east for perhaps a half a mile in the green schist series, then turned north for a short distance until we could overlook Pakowagaming Lake. Here we saw great granite ledges. We then turned back to the west and after a short distance turned south. We had not gone far before we passed from the granite into the green schist series. Here the granites and greenstones are near each other. The granite ledges were examined and numerous ledges of greenstone schist were found intruded by the granite in such a fashion that Adams and I had no doubt of the intrusive relations of the granite in the greenstone. However, no dikes of granite were found in the greenstone.

We then followed a road which went west, southerly, southwest, then west, then southwest to Thessalon, the greenstone series being seen all of the way and no other rock being noted. The observations of the day make it extremely probable that the greenstone schist series belongs with the pre-Huronian.

Van Hise, Sept. 4, 1904.

With party visited the well known locality of basal conglomerate on the coast five or six miles east of Thessalon. So far as this conglomerate and its relations are concerned no new observations were made. All of the party were completely convinced that the conglomerate rests unconformably upon the granite which includes many fragments of green schist. Various points were visited where the pseudo-conglomeratic fragments of greenstone are contained in the granite, many of them well-rounded. The only contact which was seen at the present high water was on the island where the granite containing greenstone inclusions graded into a brecciated ledge on each side, and this into unmistakable conglomerate. The change from the broken ledge to the clear cut conglomerate on the west side of the ledge is rather sharp. On the little conglomerate island to the southeast of the big conglomerate island the same greenstone dike was seen to cut through the rocks that intersect the big island. At the south side of this island the rick is a fine grained slate containing big fragments of granite, the general appearance of the slate is very much like that of the greenstones. We now went toward Thessalon, the first island beyond the big island being conglomerate and the

next one being quartzite. We now went to the next point, which, according to observations of previous years, shows quartzite. This was found upon the shore, but going a little way into the interior, and toward the mainland, we found greenstone cut by a granite dike. This greenstone has the distinct ellipsoidal weathering character. The granite dike varies from eight to twenty feet in width and its last stretch toward the quartzite runs N. 30° E. This dike, before reaching the quartzite, disappears under shingle, but the depression continues quite to the quartzite, just as if the granite had weathered away, but no granite dike intruded the quartzite.

The contact with the greenstone and quartzite strikes N. 20-25° W. and has a nearly vertical dip. Immediately adjacent to the greenstones is a narrow belt which is regarded as slate and was specimened. Over this belt of slate about two feet thick is a coarse belt of arkose which follows the contact line and grades up within a few feet into fine-grained quartzite, which was specimened. It seemed to me that the slate, the arkose, and the higher quartzite above showed the bedding very distinct as corresponding to the contact with the granite, with a nearly vertical dip. This observation of dip does not agree with

the flat dip of six degrees recorded at a previous visit. A closer examination convinces me that this supposed flat dip is merely jointing. In the next little bay from the quartzite which lies against the greenstone nuthing but greenstone was found. This greenstone shows a beautiful ellipsoidal structure. At various places we observed the greenstone series on our way to Thessalon. In places it is amygdaloidal, the amygdaloid bands corresponding in position with previous observations. At two places volcanic tuff or agglomerates like those described by Lawson in the Lake of the Woods was noted. About half way between the conglomerate and Thessalon red felsite, in places becoming rather coarse so as to be granite and very closely resembling in texture the granite upon which the conglomerate rests, was found. This granite is in very considerable masses, making a number of islands. The contact with the greenstones was found at various places. At one island especially the felsite in clear-cut dikes cut through both the massive varieties of greenstone and the agglomeratic variety. Taking all of the facts observed yesterday and today I have myself no doubt that the entire greenstone series of Thessalon, mapped by Logan as Huronian, belongs unconformably below the Huron-

ian series, represented by the quartzites, conglomerates, limestones, etc.

41870 Rock between coarse arkose and fine-grained greenstone, believed to be slate. (Cut section).

41871 Granite dike, striking N. 30° E., about 20 feet wide cutting through greenstone, strikes toward edges of the quartzite series. Following along the strike of the granite dike an arkose layer (cut section) is found. It is the normal fine-grained quartzite. The strike of the contact between the vein greenstone, cut by granite, and a thick arkose layer is N. 20-25 W. The arkose layer varies in breadth along the strike from four to six or eight feet, and on the southwest of it is fine-grained quartzite. The contact of the arkose layer and the greenstone is almost vertical.

41872 Cutting the quartzite is greenstone represented by 41872.

41873 Another apparent dike in the quartzite.

41874 Greenstone cut by granite northeast of the contact.

41875 Next to the greenstone cut by the granite the sedimentary rock is a coarse arkose almost a conglomerate.

41876 This grades within a few feet into fine-grained impure gray quartzite.

The arkose is not directly in contact with the greenstone, but grades into fine-grained slate or quartzite.

Note taken on train.

Excellent exposure of red jasper conglomerate just east of bridge which is continually going down between Desbarats and Isbester.