Notes on the Keweenawan rocks of Lake Superior: [specimens] 40029-40082. No. 332 1900

Clements, J. Morgan (Julius Morgan), 1869-
[s.l.]: [s.n.], 1900

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. 1

Notebook No. 332.

40029 – 40082

Notes on the Keweenawan Rocks of Lake Superior

1900

J. Morgan Clements.

July 7th. Began my studies this field season on the gabbro at Duluth. I find that it varies from a medium grained rock, essentially a dolerite, to a very coarse grained rock which has usually been classed with the gabbro. Some of the feld spar individuals with rounded outlines, reach a size of 2 1/2 inches. The rock is rarely of a uniform character over large areas. More commonly it is a most intimate and irregular mixture of gabbro of various sizes of grain and of somewhat different composition. These varieties range from a rock of fairly acid character to one which is very basic; in places it is composed of almost pure anorthocite, and at other places it consists chiefly of titoniferous magnetite.

As a result of the mixture of gabbro of varying textural and chemical character, large exposures of the gabbro have widely different appearances upon weathered surfaces. For example, the weathered surface of the fine grained rock is usually fairly smooth, while the coarse grained gabbros, on the contrary, usually have very rough weathered surfaces.

Morover, where irregular areas of more basic gabbro occur, they usually weather more readily than the surrounding rock, and hence occupy depressions upon the weathered surfaces of the exposures. A very ~~fine~~ common variety of the gabbro is that in which small areas of irregular but in general rounded shape, and consisting of almost pure feld spar, are surrounded by other areas with a much higher proportion of basic minerals. The feldspar areas vary in size from that of a walnut to the size of the head. The interstitial basic portions weather much more readily than do the feldspathic portions, hence these rounded areas project upon the weathered surfaces as nodules (See Winchell, Vol. 4, Geological Survey of Minnesota, page 580, and Fig. 1, Plate p.) In some of the rocks, the basic areas have, in general, a rounded shape, and appear to predominate over the more acid portions. The basic areas weather out and give very rough pitted surfaces to the gabbro exposures. These pits vary in size up to several inches in diameter and 2 inches was about the maximum depth seen.

S. T. R.

Minnesota Point from Hills
Back of Duluth. View
Taken from Point East
of Pavilion

In general, the coarser grained gabbro seems to predominate and to enclose the finer grained varieties. At least about 125 yards northwest of the pavillion at the top of the inclined railway and just in front of the house, there is an exposure which shows a rounded mass of dolerite which is broken in two, the two pieces being separated by a stringer of coarse gabbro which is connected with the main mass of the gabbro which surrounds this dolerite inclusion.

100 yards northeast of the pavillion there is an exposure of coarse gabbro which is in contact with dolerite. This last is exposed for about four feet. Next to the gabbro, the dolerite shows a very distinct selvage. Clearly it is a dike in the gabbro. A little depression about 25 yards wide at this place may indicate the width of this dike, although no exposure was seen which would confirm this. Southeast of this exposure there is an escarpment where the gabbro has been quarried and here a fine grained basalt dike can be seen cutting the medium grained gabbro.

Just west of the entrance to the inclined railway, where 7th Ave. West

joins Superior Street, there is a cut which shows the "red rock" in dikes in the gabbro. Similar dikes may be seen also further west on Superior Street. Along here, as well as on the exposures along the side of First Street, nearly all of the varieties of gabbro may be seen.

At one place on First Street, very clear evidence of the action of water at that height was found in the presence of a number of imperfect pot holes. As is well known, conclusive evidence of the former lake level having been even higher than this is found in the presence of the lake terraces and beaches which occur still higher up the hill.

July 8th. Visited Lester Park to see the characters of the rocks exposed there. They were found to be lavas, porphyritic and non-porphyritic, coarse and fine grained, and amygdaloidal, and even scoriaceous in character. In general, they appeared to be typical flow rocks, and contrasted very strongly with the massive and generally coarse grained gabbros which occur in the more immediate vicinity of Duluth.

The limited time at my disposal did not suffice to enable me to separ-

ate the various rocks into individual flows. Presumably this could be done, however, if sufficient time were devoted to it. Likewise, there is a strong probability that, interbedded tuffs and perhaps distinct water deposited clastics might be found.

July 9th. Visited Short Line Park. Here, just north of the railroad are high hills of a medium to coarse-grained dolerite which, in places, is distinctly amygdaloidal. This rock is cut by dikes which are likewise amygdaloidal. These rocks have been classed by Winchell upon his maps, Vol.4, Geological Survey of Minnesota, Plate 88, with the gabbro. I do not believe the classification can hold, as the rock is so essentially different from the typical rock which makes up the main gabbroal mass of Northeast Minnesota. I walked back along the railway and at cut No.3, on the StP&D railroad, there are very good exposures of banded gabbro to be seen. Here thereare narrow to ~~heavy~~ broad bands of coarse and fine grained gabbro, anorthosite and gabbroal bands which are very rich in magnetite. These bands do not continue however over very great distances. They seem to split up and run out as one follows them, appearing to be more in

the shape of lenses than continuous bands. They seem to be portions of the main mass of the gabbro which differ from the homogenous portion of the mass chiefly as the result of movement and of differentiation processes.

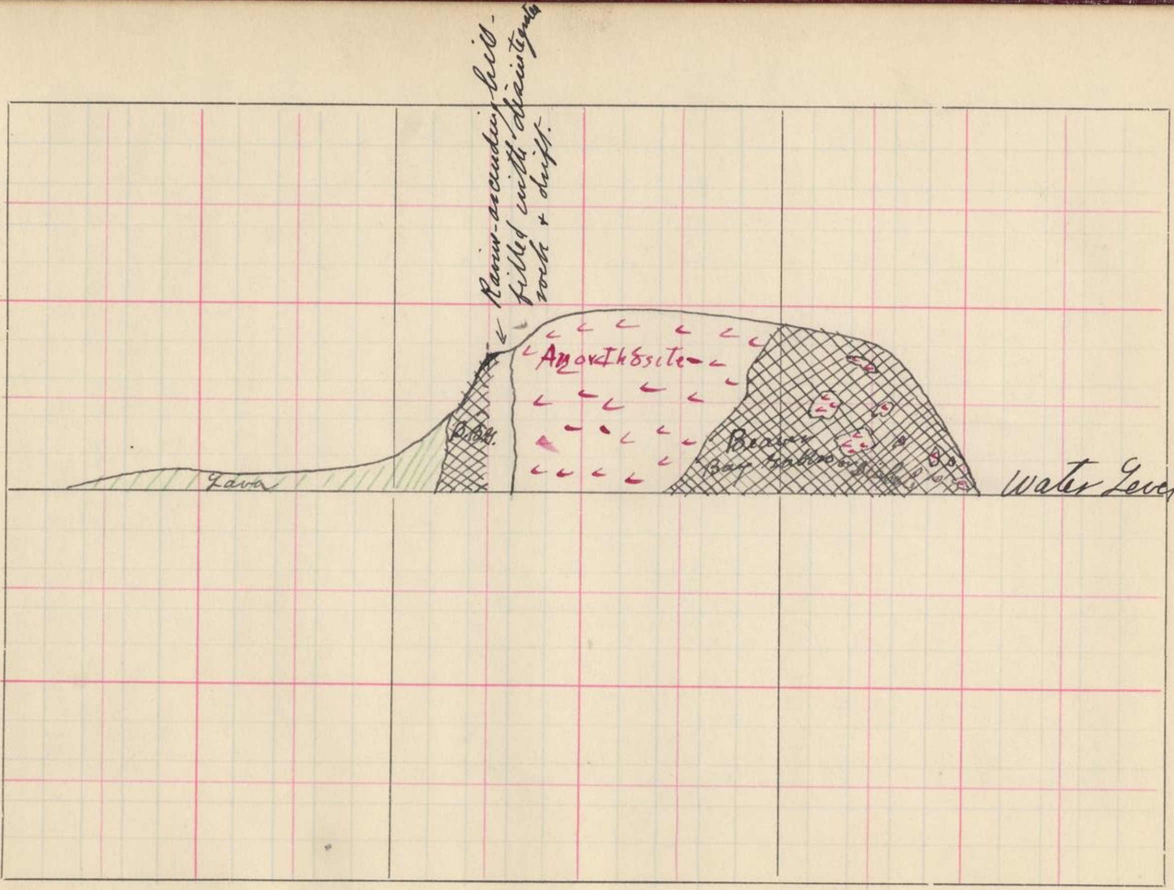
The boundary given by Winchell on the plate referred to above (Plate 88, Vol. 4, Geological Survey of Minn.) can be modified very essentially. For example, dolerite (gabbro) exposures were found as far south as the vicinity of Smithville. They are reported also as occurring not far from the shore near Rice's Point. It seems very probable that the gabbro should come down well to the water's edge. The amygdaloidal dolerite which occurs at Short Line Park probably was originally connected around this gabbro with the amygdaloidal lava flows which occur along the shore to the east of Duluth.*

July 10th. Was occupied to-day getting men and camp outfit (ready) preparatory to leaving in the morning.

July 11th. Left this morning via steamer for Beaver Bay, reaching Beaver Bay at 5.00 PM. where we made camp. Cook having failed to appear in time for sailing of steamer, we were consequently short one man.

* and which were probably intruded by the gabbro.

6—747


Ravine-ascending hill-
filled with disintegrated
rock + drift.
Anorthosite
Lava
Water Level

S.

T.

R.

July 12th. With Professor Van Hise, rowed to Split Rock (Castle Dangerous), there to begin our studies of the Keweenawan along the Lake Superior shore. We find here a rather coarse grained amygdaloid forming a low shore of the Bay and extending up to within about 50 feet of the bold cliff which is known as Castle Dangerous. The rock forming this cliff is anorthosite (Vol. 4, Minnesota Geological Survey, page 299). Between the amygdaloid and the anorthosite, there is a depression which appears to lie all the way in the Beaver Bay diabase, so called. The contact of this diabase with the anorthosite does not distinctly show on this side the weathered rock having covered the contact. This anorthosite mass already referred to forms a bold headland with nearly vertical face on the Northwest side next to the Beaver Bay diabase. On the Southeast side, the face has a Southwest dip, overhanging, therefore, the rock to the Southeast, as shown in accompanying sketch, which is coarse grained Beaver Bay diabase (See also photograph and sketch by Prof. Van Hise). On the Southeast side of the anorthosite, the contact with the Beaver Bay diabase is

S. T. R.

Banded Anorthosite

sharp. No fragments of anorthosite were found in the Beaver Bay diabase along the contact, such as would be the case if the Beaver Bay diabase were intrusive in the anorthosite. Away from this anorthosite mass, however, along the shore, the Beaver Bay diabase is very full of blocks of anorthosite of all sizes, varying from small ones up to those showing faces 50 x 20 feet across. In places the exposed faces looked almost as though we were viewing an eruptive breccia in which the fragments were the light colored to white anorthosite, and the matrix was the dark Beaver Bay diabase.*

A little bit farther east along the shore, the anorthosite was observed to be cut by and included in the Beaver Bay diabase (see photograph). Here also the anorthosite shows a very fair banding (see photograph). This banding appears to be due to seggregation and differential movements in the rock mass. Some of the bands appear to be a little more basic than the main mass of the anorthosite. They are presumably of the same origin as the bands observed in the rock cut of the St. P. & D. railroad west of Duluth, (Cf. S. Page 5.) The exposures here are much broken by a

* The mass of anorthosite forming [illegible] is considered to be, like these smaller pieces, but an inclusion in the Beaver Bay diabase. It is however of exceptionally large size.

S. T. R.

Anorthosite (light colored)
Cut by Dykes of "Beaver Bay"
Diabase (dark colored)

rectangular system of fractures which cut cross bands. The Beaver Bay diabase dikes follow both along the direction of the bands as shown in the photograph, and also follow the fracture planes.

The rock exposed in Two Harbor Bay is a reddish weathering amygdaloidal lava. On the east side of Two Harbor Bay, near the point, I find an amygdaloidal breccia which is clearly underneath the Beaver Bay diabase
40029 (40029) which here contains innumerable fragments of anorthosite. It cannot be told from this exposure whether the above relation is due to the intrusion of the Beaver Bay diabase along the contact between two lava flows, or whether it is itself a flow overlying the amygdaloid, although this last presumption is not warranted by its coarse grained non-amygdaloidal condition. The lava flow is here cut by a "red rock" (quartz porphyry). The lava shows considerable variation, being in places very dense and again very scoriaceous. Still farther around the point a number of places can be seen where the Beaver Bay diabase includes large quantities of anorthosite frag-

ments, and it is seen to be noticeably finer grained when near the larger boulders, for example, the boulder forming the tip of the point. Specimens 40029 to 40032 show variations from the fine grained Beaver Bay diabase taken near contact with the underlying amygdaloidal lava to the coarse grained phase. The coarsest phase was not specimened, as typical specimens are already in the collection at Madison. The diabase from where the specimens were taken is full of anorthosite fragments. Continuing on to the north, around this point, we find on the west side of the first cavern cut in the amygdaloid, the Beaver Bay diabase intruding the amygdaloid and containing fragments of it. Still farther north, along the shore, the same relations are clearly shown. The Beaver Bay diabase cuts the amygdaloidal lava (40033) which appears in a number of places. This amygdaloidal lava is also cut by the red rock, quartz porphyry, already referred to. The Beaver Bay diabase also includes fragments of the amygdaloidal lava and of the anorthosite. Thus far no relations have been observed between the red rock (quartz porphyry), and the Beaver Bay diabase

on the one hand, or of the anorthosite and the amygdaloid on the other.

The second salient north of Two Harbor Bay is a red rock, and back, that is to the Northwest, of it, comes the amygdaloidal lava with the red rock cutting through it in dikes. The Northeast side of this same salient is made up of the amygdaloidal lava like
40033 40033, which is cut by and included in a relatively coarse red rock, both of these being apparently cut at this place by the Beaver Bay diabase, although the relations are not absolutely clear here. The chief reason for believing that the Beaver Bay diabase cuts the red rock is that the diabase is fine grained at the contact and, as we go from the contact, that is to the Northeast, the diabase becomes coarser and coarser, until it becomes typical coarse rock. Just east of the small island off the small salient which divides the large flat bay into two bays, there is a flat lying dike (?) in the Beaver Bay diabase. Rock of this dike shows three different distinct phases occuring in
40034 parallel bands, of which 40034 forms
40035 the topmost band. Specimen 40035 shows the rocks forming the two lower bands. Of these two, the granular gabbro-like band is the lowest, and the very basic

rock consequently forms the middle band. I am inclined to consider this dike as a basic pegmatite vein similar to that dike seen on the point east of Split Rock Point, and figured by Winchell correctly as being faulted about ten feet.

Continuing north along the coast, the lustre mottled typical Beaver Bay diabase gradually changes to a coarse, even grained black gabbro. This continues along the lake shore up to a point in the N. W. 1/4 of S.13, T.55 N. R. 8 W., where the normal lustre mottled Beaver Bay diabase begins again. The bay immediately Northeast of this point has upon its shores exposures of amgdaloidal lava which is intricately cut by dikes of red rock. On the following salient, the Beaver Bay diabase again appears and continues on to the next bay where the anorthosite cut by dikes of red rock up to 8 inches across, is seen. Across the bay from this anorthosite there stand high cliffs which are composed essentially of red rock. This red rock is cut in a few places by dikes of dark green basic basalt. In Beaver Bay itself, especially upon the north shore east of the mouth of the creek, a very intricate mixture of the Beaver Bay diabase including anorthosite fragments

is found. This Beaver Bay diabase is here found to intrude an amygdaloidal lava* All of these rocks are then cut by the red rock. It is noticeable that the red rock is present in the largest quantity in the amygdaloidal lava. This is probably due to the fact that this lava is very much shattered and consequently permitted more ready ingress for the acid magma. The Beaver Bay diabase and anorthosite, on the other hand, are now, and have always been, very massive. The contact between the Beaver Bay diabase and the amygdaloidal lava is exceedingly intricate, but always sharp. One finds very small stringers of the Beaver Bay diabase, of coarse grain, however, running out into the amygdaloidal lava. As a general rule, the anorthosite and the Beaver Bay diabase occupy the reentrants in Beaver Bay, and the amygdaloidal lava is present upon the salients. Apparently although the lava was intruded by the Beaver Bay diabase, it was in general at this particular point overlying these masses, and consequently, as the lava ~~in~~ forming the reentrants was removed* the lower lying diabase and anorthosite were exposed. It was after having seen some of the exposures similar to these in which the round masses of

* with fairly characteristic columnar basaltic fracture.

intimately associated Beaver Bay diabase and anorthosite appeared partially surrounded and overlain by the lavas, that A C Lawson conceived the idea that such rounded masses represented the eroded surfaces of a pre-existant terraine which were covered up by flows of Keweenawan lava, an idea which, if future work shows the observations of to-day to be correct, cannot possibly hold good (Minn. Geological Survey, Bulletin No.8, 1. "The Anorthosites of the Minnesota Coast of Lake Superior.", Plate 4.).

As a result of to-day's study, we reached the following conclusion concerning the relations of the following units ~~of~~ Beaver Bay diabase, anorthosite, the basic amygdaloidal lavas, and the acid red rock which is normally a quartz porphyry: The anorthosite is included in the Beaver Bay diabase. The Beaver Bay diabasecuts and intrudes the amygdaloidal lava. All of these are intruded by the red rock. There still remains to be determined the source of the anorthosite and its relations to the amygdaloidal lava.

July 13th. Detained by bad weather.

July 14th. Left Beaver Bay and skirted the shore to the Northeast.

Found numerous instances of the Beaver Bay diabase containing large and small masses of anorthosite in it. Also saw numerous off-shoots of Beaver Bay diabase some of them forming narrow dikes 8 inches wide, cutting the anorthosite masses. Numerous other cases were seen also of the Beaver Bay diabase cutting the red weathering basic amygdaloidal lava. Dikes can be seen just to the west of the steps leading to the Club House at Baptism River, and also just east of Baptism River. About 3/4 of a mile up Baptism River, exposures of a red weathering conglomerate are seen (C. F. Minn. Geological Survey, Vol.4, Page 307). This rock lies with a very flat bedding, although with a slight dip to the south. In character, it is identical with the conglomerates seen later on during the day, farther east along the shore where they occur interbedded with the lavas. This rock presumably corresponds to some one of these conglomerate beds. About 1 3/4 miles Northeast, along the shore from Baptism River, conglomerate comes in and is here interbedded with amygdaloidal lavas, and with the red rock the two appearing as flows. From here on, along the shore, a number of beds of conglomerate of varying thickness

were seen associated with the lava flows. The lava predominates very considerably over the sediments. Along this portion of the Lake Superior shore, the red rock can be seen occuring in dikes in the Beaver Bay diabase. Moreover, the diabase is rendered somewhat reddish by the action of the acid intrusive. It seems highly probable that the resulting reddish diabase is the rock known by Irving as Orthoclase gabbro.

As we go farther Northeast, newer flows seem to appear. At least they are found to have a Northeastern dip, and presumably, as we go Northeast we are passing over later flows that is going higher in the Keweenawan. In all of these, the Beaver Bay diabase is found intrusive. I can see no valid reason for the division of these lava flows and interbedded conglomerates into the various groups as given by Irving, or into Winchell's divisions of the Manitou and Cabatian. It is found that the conglomerates are present in much larger quantity in association with the lavas along this portion of the shore, ~~or, at least, are better exposed than they are farther west.~~ The presents of these gives the

reason for the separation by Irving and Winchell under the name of Temperance group and Manitou group respectively of these rocks from the lower lying lavas. Since, now, we find that the rocks of this upper division of the Keweenawan, or The Temperance group, have been cut through by the Beaver Bay diabase, we have the relations of these two units, ~~of~~ the Beaver Bay diabase and the Temperance River group clearly established. Camped for the night about two miles west of Petit Marais.

July 15th. Continued on Northeast, passing over the same series of interbedded lavas with some associated conglomerates. The Beaver Bay diabase seems to be wanting up as far as Temperance River. At least no exposures were observed. I note now, interbedded with the normal very scoriaceous flows, some flows which in the interior are very massive indeed, and have a relatively thin, scoriaceous surface with very marked spiked vesicles. Both Temperance River and Cross River have cut fairly deep gorges in the Southeastward dipping interbanded lavas. On the east side of the small pool

just at the mount of Temperance River, there is a small deposit of shale with thin conglomerate at the bottom (C.F.Monograph 5, U.S.G.S., Page 325, Fig.27). Both the Temperance and the Cross rivers, especially the first, show good sections through the lavas, and have many very beautiful recent pot holes.

July 16th. Ascended Carlton Peak from the Southwest. On the Southwest side came, at the base of the series of peaks which really form so-called "Carlton Peak", upon a small exposure of Beaver Bay diabase. Found a similar exposure upon the west side and at the base of the main peak (Carlton Peak). Anorthosite forms the main mass of the minor peaks, as well as the main peak itself. It is very uniform in character, and of coarse grain. Descended peak, traveling Southeast, intending to reach the Lake shore at the Post Office of Tofte. At the base of the small peak which is Northeast of the main one, came upon the Beaver Bay diabase within five paces of anorthosite. There is a considerable mass of diabase here. A little farther off again found a small mass of the

anorthosite with a great deal of the Beaver Bay diabase exposed. Near the base of the hill the vegetation is very dense. Consequently the exposures are not very good, but from the presence of these small anorthosite masses practically surrounded by the Beaver Bay diabase, and the fact that the main mass forming the peaks are likewise surrounded by Beaver Bay diabase, it seems evident that the same relations exist here between these two rocks as was found existing at Split Rock (Castle Dangerous), Beaver Bay, and elsewhere,* It is true that not enough work was done to enable me to say positively that the Beaver Bay diabase occurs all around Carlton Peak. However, on the side from which we ascended the peak, and on that upon which we descended, we, in each case, found upon a lower level than the anorthosite, the Beaver Bay diabase. This seems to warrant the conclusion that similar relations would be found at other places around the base of the peak. Between the peak and the lake shore occur the lava flows with a gentle lakeward dip. No exposures of them were seen, but the Saw Tooth

* namely the anorthosite of older age than and included in masses of varying size in "Beaver Bay" diabase.

mountain topography begins to develop here and shows clearly the presence of the lavas.

July 17th. Leaving our camp just west of Cross River in the morning, we coasted the shore to the east reaching Black Bay in the afternoon. We camped here. During the day have seen nothing of special interest and nothing new. The same series of amygdaloidal lava flows continue to be exposed along the shore.

At various places beautiful, raised beaches were noticed, especially in the vicinity of Poplar River.

July 18th. On this day we traveled from the east side of Black Bay where we camped last night, to Grand Marais. On the way up we passed numerous well exposed lava flows dipping Southeast toward the lake. With these very amygdaloidal lava flows there are some massive dolerites interbanded. These massive dolerites contain more or less numerous distinct amygdaloidal fragments which evidently have been taken from other lavas. They resemble to a slight extent some of the somewhat finer grained phases of the Beaver Bay diabase. I took a specimen,
40036 40036, from near the middle of the

massive flow which occurs at Lovers' Point. This should be analyzed and compared both chemically and mineralogically, with the Beaver Bay diabase.

Immediately below this massive flow at Lovers' Point, and also extending inland for a short distance, there is a mass of very fine conglomerate. This deposit does not show good bedding. It is possibly a river deposit. Could not get thickness of the sediments here.

The amygdaloidal lavas show up well between here and Terrace Point o on the west side of Good Harbor Bay. On the west side of this bay there is well exposed about 150 feet of red sand stone. This overlies an amyg-
40037 daloidal lava flow. Specimen 40037 was taken from the top of this lava flow from a locality about the middle of Good Harbor Bay.

Reddish weathering, dense to amygdaloidal basic lavas, and in some places showing very good columnar parting, are exposed on the East side of this bay, and for several miles along the shore. Specimen
40038 40038, taken from the shore about 1 1/2 miles west of Grand Marais, shows the general character of the ~~b~~black massive basic flow ~~of~~ rocks here exposed.

A short distance to the Southwest of Grand Marais, in the second little bay west in fact, there is exposed a red weathering fine grained acid amygdaloidal porphyry, represented by
40039. specimen 40039.* The east side of Grand Marais Harbor, from the light-house on east, consists of the red weathering basic lava. This rocky area here appears to have formerly existed as an island. It has been connected with the mainland, however, by a gravel spitupon which a portion of the town is built. Vegetation is scanty upon this spit, owing to lack of good soil, and various beaches can still be seen upon it. Between the lake end of the spit and the highland of the shore, there is even now an area of low ground which probably repre-sents an old lagoon. Various beach-es are well developed in the vicinity of Grand Marais.

July 19th. Left Grand Marais at 10.00 AM. , following the coast to the east. We passed, in the center of the first large bay, section 22, T. 61 N., R. 1 E., an exposure of
40040 acid rock, 40040, which here seemdd to cut the Beaver Bay diabase repre-
40041 sented by specimen 40041.

* The rocky west end of the fossil spit

At the second little point east of Grand Marais, I find a rock like
40041 40041, apparently a phase of the Beaver Bay diabase, which contains a great number of anorthosite fragments in it. These fragments vary from those which are very small up to others as large as one's head.

A little farther east, the red rock is noticed in contact with the Beaver Bay diabase again. Specimen
40042 40042 shows the contact of the two
40043 rocks. Specimen 40043 is a specimen of the fine grained black rock where it is very near the line of contact
40044 with the red rock. 40044 represents the coarse grained typical diabase, taken about 15 feet away from the last specimen. Between 40043 and 40044, there is a gradation. The above gradation seems to be comparable to the selvage of a normal dike. This gradation in the Beaver Bay diabase toward its contact with the red rock, leads to doubt as to the relation of the red rock and the diabase in all cases. Thus I find some red rock cutting some of the diabase. Here we find diabase which appears to have a selvage next to the red rocks. Are there two red rocks, or two diabases?

Made a section at Devil Track River for about a mile to a mile and a quarter up the river from the lake shore. All the way we passed through
40040 the red rock like 40040. About 3/4 of a mile up the river this red rock is cut by a dike five feet in width,
40045 of a basic rock 40045 (Peridotite?)

As we go farther east along the shore, exposures of acid red rocks appear occupying the reentrants, these ~~are~~ usually represented immediately on the shore by red pebble shingle beaches, while the flows of basic or
40046 intermediate rocks like 40046 form the salients. In a general way, the acid and basic rocks met with along the coast here resemble very strongly those seen east of Beaver Bay.

Specimen 40046 shows the general character of the intermediate to basic flows here present. This specimen represents the rock forming Cow Tongue point, and was taken from the shore just at Colville's (Hussy's) house. Camped for the night west of Fishhook Point.

July 20th. Continuing east along the shore this morning, we find essentially the same kinds of basic lavas continuing, that we have here-

40047 tofore seen. Specimen 40047 represents one of the more basic lavas that was seen between Cadance's Bay and the Big Brule River. Specimen
40048 40048 is a somewhat more acid variety of lava which occurs on the point just west of the Little Brule. Here the rock shows a very fair ellipsoidal parting. Examined closely, the matrix between these ellipsoids is found to contain round amygdules. The fact that these amygdules are round shows that the matrix has been essentially unsheared. The difference between it and between the ellipsoids which it surrounds is brought out by weathering. The difference between them appears to be due to original characters. Upon this occurence, as upon the numerous occurences previously studied in Michigan and Minnesota, the ellipsoidal parting appears to be an original structure. East of Big Brule there occur a number of exposures of dolerite with a peculiar
40049 black glassy material which appears to line small miarolitic cavities in
40049 the rock. Specimen 40049 was taken from the first exposure on the point just east of the Big Brule. This rock grades up into a somewhat more

massive rock represented by specimen
40050 40050, which was taken from the point on the east side of Big Brule Bay. Rocks similar to this continue to be exposed on east beyond Chicago Bay.
40051 Specimen 40051 was taken from the point west of Chicago Bay. It seems to be merely a fine grained phase of
40050 40050. Specimen 40052 represents a
40052 red weathering intermediate rock occuring on the east side of Chicago Bay. From here on for some distance this coarse rock has a decided tendency towards a reddish color.
40053 Specimen 40053 taken about two miles east of Chicago Bay is the reddest variety of this coarse basic rock that I saw.

These coarse basic rocks keep on up along shore to the first bay west of Red Rock Bay (Vol.IV. Minn. Geol. Surv. Plate gg.) Just after passing Cannonball Bay (l.c. plate gg.) the following specimens represent some of the coarse rocks occuring along this portion of the Lake
40054 Superior shore. Specimen 40054 is a coarse gabbro which was taken from the point opposite the westernmost island east of Cannonball Bay.
40055 Specimen 40055 shows the lustre

mottled gabbro which is present for a considerable distance along the coast. This specimen was taken from a point immediately east of the second island.

40056 Specimen 40056 represents ~~a rock~~ the shown in the last gabbro exposure before the red rock is reached. This exposure occurs on the west side of the Bay immediately west of Red Rock

40057 Bay. Specimen 40057. This is a red quartz porphyry taken from the exposure nearest to the gabbro, the one occuring in the center of the bay west of Red Rock Bay.

Red Rock is well exposed in Red Rock Bay. On the east side of this Bay quartz porphyry is cut by and included in a dike of basalt which shows ~~as~~ a well defined selvage and a very noticeable coarse center. Specimen

40058 40058 is taken from midway between the center and the margin of a dike which runs along the shore in the bay following an irregular course to the north of east. The dike is about ten feet wide and was traced by discontinuous exposures for 200 yards along the shore. At its east end it goes out to the water and there meets a 15 foot dike which has a nearly

north and south trend. They apparently join here, although the point of union cannot be seen. However, a large mass of basalt projecting out of the water in line with what would be their united continuation (see sketch), seems to represent the two dikes.

In the bay next east of Red Rock Bay, amygdaloidal flows both red and greenish weathering appear and are cut by a dike 8 feet wide of basalt
40059 represented by specimen 40059. This dike extends well out into the water forming a natural breakwater. It has a coarse center, and the usual fine selvage of dikes of this size. Upon this dike as well as upon the other dikes mentioned having been seen along here, the columnar parting perpendicular to the sides of the dikes is very distinct.

Camped back of Rocky Island just
E/ west of Deronda Bay (c.f. Minn. Surv., Vol.IV., Plate gg.).

July 21st. Unable to proceed on account of the strong wind.

July 22nd. After leaving camp on the east side of Deronda Bay, noted two large dikes along the shore.

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July 22nd. After leaving camp on the east side of Deronda Bay, noted two large dikes along the shore.

One was 40 feet wide and the other 15 feet wide. These trend about east and west and form the salients. They cut through the amygdaloidal lavas which occupy the bays. Both of these dikes possess a very marked cross columnar structure. The next point to the east was also formed by a dolerite dike with the amygdaloidal lavas behind it. On the second point west of Grand Portage Bay, there was observed a dolerite dike represented
40060 by specimen 40060 which cuts through the amygdaloidal lava. This dike has a very noticeable coarse grain, shown by the specimen, near its center, with fine selvage near the border. It has an approximately east and west trend.

Did not go far into Grand Portage Bay, as one can distinctly see that there are no exposures immediately along the shore. The bay is surrounded by a number of very high hills which rise from 3/4 of a mile to a mile and still farther back of the shore. The highest of these hills is Mt Josephine, appearing about Northeast of the village. These high hills are formed by a diabase, sills, and dikes. Mt Josephine being a very

noticeable example of this last. Very noticeable strand lines can be seen partially surrounding this Bay, the most noticeable ones occuring on the Southwest slope of Mt Josephine. These have been described and their approximate heights given in Lawson's paper "Sketch of the Coastal Topography of the North Side of Lake Superior". (A.S.Lawson 20th Annual Report Minn. Geol. Surv., pp 181- 289.

Conglomerate

Visited Grand Portage Island to see the ~~columnar~~ described by Grant in the "American Geologist", Vol.13, pages 437-9. This occurs on the shore near the water's edge, and about 200 yards east of the dock. This conglomerate contains a variety of pebbles, specimens of which were collected and are represented by specimens
40061 40061, 2, 3, and 4. Angular slate
40062 fragments up to 11 inches in length
40063 were seen, as well as smaller round
40064 pebbles of quartzite, gray and pinkish quartzite and pinkish acid porphyry(?). One small pebble of a granular red rock was seen, but I could not get it out. This may be the red granite re-
40061 ferred to by Grant. Specimen 40061 shows a coarse conglomerate with quartzite pebbles and slate fragments

40062 in it. 40062 is from a finer grained
40063 rock, a normal grit. 40063 shows
a number of fragments taken from the
different varieties of pebbles in the
40064 conglomerate, and 40064 is a specimen
of the sand stone which overlies the
conglomerate. Near the place where
the conglomerate is best exposed, we
find it as well as the overlying sand-
stone cut by a vertical dike five feet
wide, of fine basalt. Farther south
than this exposure, and therefore at
a higher horizon than the conglomer-
ate, as the beds have a gentle dip to
the south south east, there occurs at
the water's edge on the island, a
coarse sandstone which is represented
40065 by specimen 40065. About 4 feet high-
er above the sandstone a black fine
40066 slaty rock is exposed. 40066 shows
its character.

Overlying this slate there occurs
40067 a basalt represented by 40067. This
basalt has an edge which is only very
slightly amygdaloidal, and an under-
surface which is in general fairly
regular. This occurence of the basalt
does not resemble in my opinion a
flow so much as it does a sill. A
little farther southeast along the
shore a mass of basalt is noted im-

mediately overlying and in contact w with a sand stone. The sand stone immediately below the basalt is indurated and has an imperfect columnar parting. This last was probably produced by the baking of the sand stone by the basalt above. The induration is also probably to a certain extent due to this as well as to the second-
40068 ary action of water. Specimen 40068 represents this sand stone. Study sections and see if it shows any metamorphism. The specimen was taken about 2 feet from the actual contact. In general the sand stone is very light colored.

40069 40069 is a specimen taken from the basalt above the indurated sand stone just described.

Visited Pigeon Point and saw the relations described by Bailey, that is according to him the animikie cut and metomorphosed by the gabbro; also animikie cut by basalt dikes. Do not these basalt dikes belong with the gabbro as off-shoots and are they not, that is both main gabbro mass and dikes, all of the same age as the sills and the dikes present elsewhere in the animikie? Prof. Van Hise

pointed out the red rock enclosing fragments of the animikie and apparently metamorphosing it to a spotted rock. There seemed to be in places a gradation from the red rock to the gabbro, but could not be absolutely sure of it from what I saw. It seemed to me that the occurences which I saw would lend themselves to the following interpretation: that is, that the animikie was cut by the gabbro, which metamorphosed it, and that then the red rock cut both the animikie and the gabbro. In some cases the red rock was injected along the contact plane between the gabbro and the animikie. The red rock in metamorphosing the gabbro changed it into a rock which weathers somewhat reddish, this color becoming more intense as the red rock itself is approached. This intermediate rock would probably be found t to be similar to Irving's orthoclase gabbro. Moreover the presence of such an intermediate contact zone would explain the apparent gradation from the gabbro into the red rock.

At one place a dike of coarse gabbro lies next to the animikie which occurs on its south side, and encloses pieces of this animikie. On

the north side of the gabbro animikie also occurs, but it is separated from the gabbro by the red rock which encloses pieces of the animikie. At this particular place there is a fairly sharp line between the red rock and the gabbro. Moreover there are veins of this red rock penetrating the gabbro and enclosing fragments of the gabbro. This occurence seems to show quite conclusively the relative relations of the three rocks. It seems to me th that the explanation offered by Bailey that the red rock is the result of the fusion of the animikie slates and quartzites is very far-fetched, and that, with a close examination in the field and in the laboratory, a number of facts could be found which would easily disprove this.

Camped for the night at Pine Bay.

July 23rd. Started from camp at Pine Bay, coasting the northeast. On the first point east of the Bay there is a dike of dolerite cutting the animikie slates. From here we left the shore going out to Victoria Island, passing on the way a small island upon the south side of which there is an intermediate dark gray to

nearly black basic rock with an acid red rock on the north side. This red rock included numerous fragments of the animikie quartzite. Moreover it occured in stringers in the dark basic rock and also seemed to pass rather gradually into this dark gray rock at places. The conditions here seemed very similar to those on Pigeon Point and I would judge that we had here the red rock enclosing the animikie sediments and cutting and metamorphosing the gabbro. On the southwest side of Victoria Island, there is a great dike of medium grained granular red
40070 rock represented by specimen 40070 which grades on its sides into a feldspar porphyry. This forms the selvage of the dike. The red rock cuts thro' the animikie sediments. The animikie sediments are also cut by a coarse gabbro which grades along its sides into a porphyritic dolerite and into a fine basalt upon its selvage. Was not able to find the relations described by Lawson in his article on "The Laccolithic Sills of the Northwest Coast of Lake Superior", Bull. 8, Minn. Geol. Surv.

On the Northeast end of the island named on the Lake Superior chart "Knob Island", although it is not

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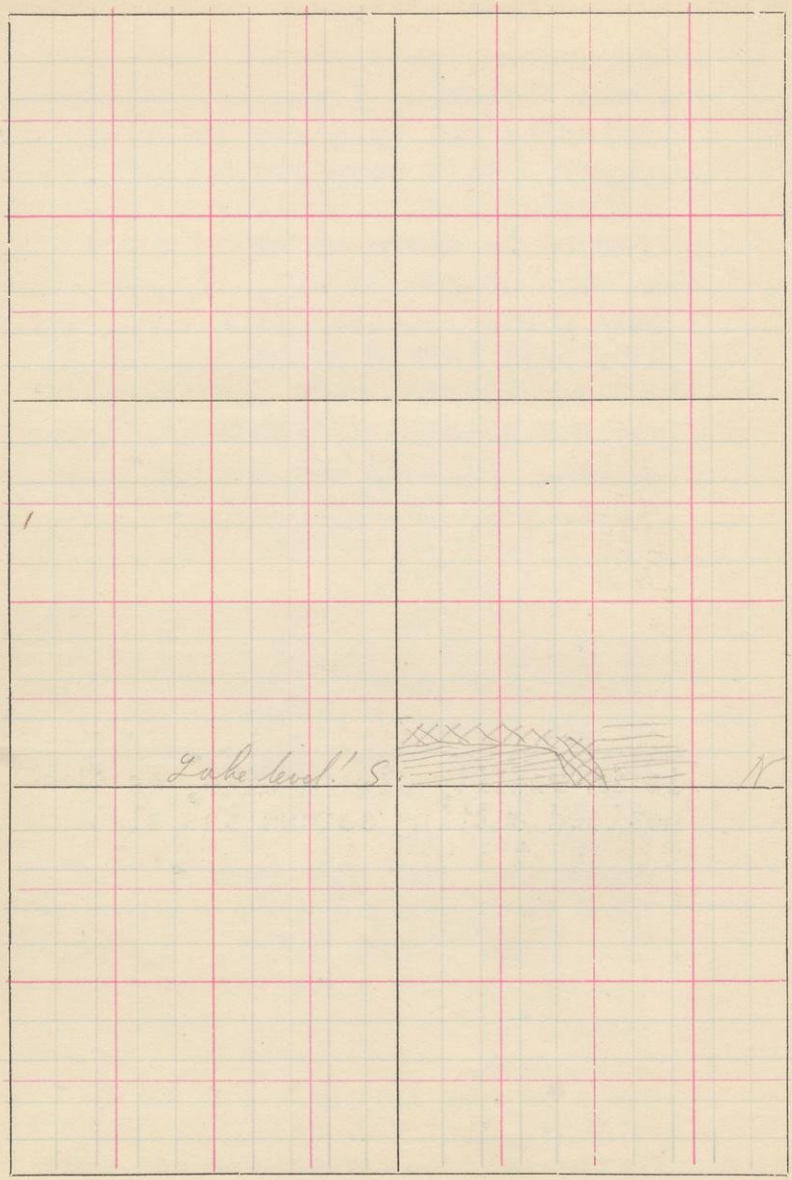
separated, so far as I could see, from Victoria, I saw the porphyritic dolerite cut by a red feldspar porphyry. This porphyritic dolerite is petographically similar to that referred to above as being but a phase of the coarse gabbro. I see no reason why these dolerite dikes seen here upon Victoria Island cannot be classed as of exactly the same character and age as the so-called gabbro on Pigeon Point. If they are essentially the same, then we have here clearly shown the relations between the red porphyry and the gabbro.

Victoria Island shows a number of cases of dolerite and gabbro dikes cutting the animikie. In none of the cases on Victoria Island where these dikes were seen is the animikie metamorphosed at all in the way in which that upon Pigeon Point is metamorphosed, and yet some of the gabbro here is just as coarse grained as is that upon Pigeon Point. In general, the dip of the animikie is very slight from 5 to 10 degrees towards the Southeast. Occasionally, however, this is not regular, for we can see plainly that the dolerite dikes have influenced the slates which near the

S. T. R.



dolerite dikes are wavy, although in general with the dip above given.

From Victoria Island rowed Northwest to the mainland, and continued along the shore during the afternoon. Along this shore there are exposed a number of sills which overly the animikie slates. These sills have in places somewhat irregular bottoms. In some places, in fact, they are seen to cut across the animikie beds. At one place just on the point south of Sturgeon Bay, a good example of a dike with cross columnar parting was seen cutting across both the slates and the sills. At about this same place on the shore there was also seen a dike cutting across the slates and joining higher up the hill a sill. This sill is in reality also a dike, as it was noticed cutting across the slates, although at a very low angle. If followed far enough to the west in all probability it would be found to change into a normal sill lying parallel with the beds. This is thought to be the same occurence as that described by Lawson, page 35 Bull. No.8, Minn. Geol. Surv., from the south side of Prince's Bay. All along this coast

west of Pie Island, the terraces and raised beaches show up fairly well when one is some distance off shore. Camped for the night at Carp River. Walked up the valley following old road and saw here a beautiful high level shingled beach, which was crossed just before we reached the bridge a across the stream. This beach evidently had some time in the early history of Lake Superior, formed a dam behind which lay a small lagoon or lake. This dam has been cut through by a stream and the lake consequently drained. Two more small beaches and corresponding lagoon like depressions behind them were seen further up the valley, one at the saw mill and the other still farther up at the foot of the next lake. These lakes seem to belong to a type which so far as I know has not been described and might be termed "Beach"or "Lagoon" lakes.

July 24th. Leaving Carp River camp, we moved on Northeast along the coast, passing cliffs which show caps of basalt with undulating lower surfaces overlying the animikie slates which have a low dip to the Southeast. Both the basalt caps and the

underlying sedimentaries are cut by dikes of basalt. These dikes in all of the cases noticed possess a very well marked cross columnar parting. This structure enables one to follow quite clearly from a distance with the eye the basalt dikes as they cut through the sediments and igneus rocks. The low flat delta deposits of the Kaministiquia extend for several miles down the coast Southwest of Port Arthur. There are several small channels which connect with the lake, but only one of these is now kept open and is unnavigable for large steamers. The deposits extend for a considerable distance out into the lake and in fact the water is not more than 3 or 4 feet deep in places nearly as far as a mile away from the shore. Reached Port Arthur about noon and rowed east beyond the breakwater and elevator where we camped.

July 25th. Drove north of Port Arthur past Shumiah mine to the Huronian iron bearing formation in Gorham township.

The town of Port Arthur is built on the old lake beaches of sand and partially upon the Kaministiquia

delta. There is one especially well marked beach, and several others which are not so well developed. On the road the animikie slates with cap of basalt are exposed in places. Some time before reaching the Shuniah mine, and for a considerable distance on north, drift covers everything. Some time before reaching McKeller's location, there appear occasional exposures through the drift, of a light grayish sericitic schist which seems to be an altered porphyry. A little bit farther along, especially on the west side of the road, exposures of schistose, as well as massive green-stone appear.

At McKeller's location, on the west side of the Current River, the iron formation is exposed. At this place most of the rocks which are exposted are schistose green-stones which in places have apparently cutting them massive green-stones. Some of these imperfectly schistose green stones show a fairly well developed ellipsoidal parting. In these areas of schistose green stones, possibly infolded with them, as no distinct bedding planes or anything clearly indicative of bedding could be found, in the greenstones themselves,

S. T. R.

Taken out for publication with Allen's thesis.

McKay's Mountain from Indian Missions Settlement (Prof. C. R. Van Hise in foreground)

occur bands of white and black chert, red jaspar, and some bands of hematite ore. The entire aspect of the formation, green stones and the associated iron bearing bands, is strikingly like that of the lowest formation (Archean) of the Vermillion District of Minnesota. In fact, one can almost assert that it is the eastern continuation in Canada of the Vermillion District of Minnesota. This can probably be connected on the west with the Matawan iron formation, and through this formation with that occuring north of the Saganaga granite.

July 26th. Went to McKay's Mountain. Beautiful terraces and beaches here developed, especially upon the Northeast side. These have already been described by Lawson (l.c.) After leaving the delta deposits of the Kaministiquia, we crossed several well marked shingled beaches, and then ascended the slopes of the mountain. The terraces and beaches higher up upon the mountain are not so distinct as they are from a distance, although some of these are so well developed as to be unmistakeable.

Photo.

S. T. R.

McKays Mountain from
Trail Leading to it from
Indian Mission.

They form well marked graded terraces which extend around the face of the mountain. Such a terrace is that upon which the Catholic Retreat is situated. Here basalt forms the top of the terrace, and under it lie the slates. Continuing on up to the top of the mountain, we find that the mountain is capped by a heavy dolerite sill. In ascending the mountain a clean cut dike of dolerite was observed cutting through the slates. Observations were made both along this dike and at the contact of the sill with the slates, to see whether or not these igneus rocks had metamorphosed to any great extent the slates through which they cut. In most cases the actual contact could not be seen owing to the poor character of the exposures. However, in the case of the dolerite which caps the hill an actual contact was observed and one could note the dolerite, very coarse grained, grading down upon the edge of the sill into the fine grained basalt which formed the extreme outer side of the sill. The slates were observed in actual contact with the sill, and here no noticeable meta-

S. T. R.

Kaministiquia River Delta
From Top of McKays Mountain View
Looking Approximately North-
East. Abandoned Mouth of
River in Foreground
At the Left of Photo.

Woody

morphism could be seen. They break now with a somewhat ~~slew~~ developed columnar parting, and in all probability this is due to some extent to the baking which they must have undergone at the time of the intrusion of the sill. Moreover, particularly under the sill near their contact with it, the slates seem to be a trifle harder and consequently break off with sharp faces. This cannot, however, necessarily be attributed to the metamorphic action of the sill but may possibly be due to the character of the sediments themselves, they being here thicker bedded, more quartzose, and harder than the slates below which weather with a more gentle slope.

From the top of the mountain we get a beautiful view of the Kaministiquia delta upon which Fort William is built. The flat delta plain extends for a number of miles inland, and is also a number of miles in width. There are visible now three very well marked mouths to the river. The one which the stream at present uses chiefly, the largest one, is the farthest north. The second, still smaller, turns east towards the lake at a considerable distance back, that is west of where

Photo.

the northernmost mouth bends to take its course toward the ~~river~~lake. The Southwestmost, and oldest one of the mouths, turns off from the main stream about two miles back from where the present main stream empties into the lake. This old channel is now practically abandoned. Its course can be distinctly followed by the eye from the river to the lake, and is partially marked by several lagoons which lie in the old river channel. Possibly during extreme high water this channel may be used for a short period, although I am inclined to believe that only the more northerly mouths are ever used.

July 27th. Took the tug "Georgina" from Port Arthur to Thunder Cape, as there is almost too large a stretch of water between Port Arthur and the Cape to risk crossing in small boats, and otherwise we would have been compelled to row all around the Northeast side of Thunder Bay which would have required nearly a couple of days. Beautiful terraces and beaches can be seen on Thunder Cape as we approach it. After reaching the Cape, left two of the men to make camp

while we rowed Northwest along the shore to Sawyer's Bay. Before reaching this bay we have been passing along the shore back of which high cliffs of animikie slates with capping and intruded sills of basalt appear. This can be readily be followed around to the Southeast side of Sawyer's Bay, although here they do not come down to the shore, but are well inland. These slates dip flat to the Northeast. Got out at the extreme Northeast end of the Sawyer's Bay, and went to the cliffs which appear to the North. Forming these cliffs there is found a bedded series of conglomerates about 30 feet thick at the base. At least so much is exposed, with overlying carbonateous gray quartzite represented by
40071 specimen No.40071. Near the top of the cliffs, beds of red sand stone begin to appear, alternating with the lighter colored sand stone. Farther to the North these become more prominent and come in and cap the hills. This series of clastic rocks dips to the Northeast at about 10 degrees. This dip, if carried to the South, would carry the rocks well over the animikie which now exists on the

Southeast side of Sawyer's Bay, and would leave room for a considerable thickness of animikie to have formerly existed between the present top of the hills and the base of the conglomerate. This series of sediments here is that which, by Irving, was placed at the base of his Keweenawan. The conglomerate at the base contains a number of varieties of
40072 pebbles. For example, granite 40072, mica schist, white vein quartz, animikie sediments, graywhackie, and
40073 slate 40073. Chiefly, however, the fragments appear to consist of the more resistant cherty iron bearing formation which occurs near the base
40074 of the animikie. Under 40074 there are a number of the varieties of these cherts, some spotted and some not, which occur in pebbles in the conglomerate. One of these pebbles especially looks as though it might be a pebble of conglomerate, that is, animikie conglomerate. These fragments showing the round spots should under the microscope show true clastic characters, that is, they appear to be altered green sands, and there is no reason why some of these green sands

Page Numbers

Out of Order

Until Page 50

which I cannot interpret with certainty. They seem to me to belong either to the hyolithes-like form, consequently to be of organic origin, or else they are well developed cases of the cone in cone structure. Should this, upon more careful examination, be determined to be organic, we will then have been able to carry the existence of organized beings whose characters can be recognized very much deeper down in the sedimentary series than they have ever been carried before. Study
40075 of the specimens of green sand 40075 may also give conclusive proof of the existence of foraminiferae. Although this has been suggested before, upon theoretical considerations, the proof of their existence and a statement as to the kind of foraminiferae has not been made.

40078 40078 is a piece of the argentiferous ore from Silver Islet.

July 28th. Were wind bound and compelled to remain at the cape. Went up to the top of the cape in the afternoon. Going up we pass at first over a rather gentle slope which shows several well marked abandoned beaches. The first most noticeable beach is at

should not have ~~similar~~ small pebbles in them as well as the fine sand grains which constitute them in great part.

Especially interesting were specimens
40075 of green sand 40075 which were found. These green sands show their characters clearly now, and are conclusive evidence of the existence of the greensand in the animikie. One specimen in fact shows indications of organic (foraminiferal) structure on the weathered surface. These specimens should be sectioned and studied with care, especially with reference to Spurr's suggestion, Bull. 10 Minn. Geol. Surv., that the source of the ores of the Mesaba ridge was an original green sand and not a cherty
40076 iron carbonate. Specimen 40076 is a piece of this conglomerate from the base of the Keweenawan.

Northwest one can see a dike of basalt which extends across the low land which cuts through and joins the cliff of sediments just described. It is very important to note that no pebbles of basalt or of quartz porphyry were found in this conglomerate.

As the result of the study of these sediments, the following important points are noted:

First. The sediments are normal, unmetamorphosed or but slightly altered.

Second. They do not contain pebbles of basalt or of quartz porphyry. The absence of these kinds of pebbles shows clearly that the quartz porphyry and the sills of the animikie are younger than the lowest Keweenawan, and certainly younger than some of the dolerite dikes, as is shown by the dike which was seen cutting the sand stone as noted above.

Third. Of especial importance are the green sand pebbles which show clearly that this green sand existed as one of the clastic deposits of the animikie. It remains to be seen whether Spurr has overrated the role which this animikie green sand has played as the source of the Minnesota iron ores.

I found upon the beach of this
40077 bay some pebbles, specimen 40077, which were very clearly derived from the surrounding animikie cliffs. These pebbles show markings upon them

100 feet aneroid measurement above the lake. A second can be seen at 275 feet and a third was passed at 475 feet. A very imperfect beach was noted between 700 and 800 feet, but it was not at all well developed, and its existence is really very doubtful. All of these beaches can be best seen from some distance out in the lake, and to the west of the cape. From such a position also several beaches at a lower height than those mentioned are visible.

July 29th. Left Thunder Cape this morning with a rather high dead sea running. Coasted Northeast along the shore. At the first point east of Thunder Cape, there is a thick dike of dolerite which shows imperfect cross columnar parting. This dike shows on its south side patches of conglomerate and slate. The dike can be followed cross country to the east for about five miles to a point where it goes out to Black Bay. For a part of the way a second dike is parallel to it, and so close to it that one can step from one to the other. The dikes cut through the animikie slates. Numerous dikes of

S. T. R.

Basalt Dike Cutting
Animikie Slates on shore of Bay
West of Silver Islet Village.

various sizes, some of them being very small, run off from the main dike, and cut across the slates. The photograph shows one small one about four feet
Photo wide on the east side of the Bay just west of Silver Islet village. The rock of these dikes is very massive and varies from a very fine grained basalt at the edges of the dikes to a coarse grained dolerite near the centers of the dikes, and especially in the larger dikes. Theselarge masses of dolerite show very large porphyritic individuals of feldspar, and some of them even contained rounded masses of anorthosite up to 18 inches in diameter. In this respect, and in coarseness of grain, it resembles the Beaver Bay diabase. In its porphyritic character and in occurrence in the animikie slates, it is much like the so-called Pigeon Point gabbro. The contact action of these dikes upon the adjacent animikie is very
40079 slight indeed/ Specimen 40079 was taken at the edge of a contact which was very sharp, between the animikie slates and the gabbro. This should be sectioned and studied to see if it has been much affected. It certainly does not show

microscopically, that it has been much metamorphosed.

Reference has already been made to the thick dike of dolerite which was noticed on the first point east of Thunder Cape. It was also said that we found here patches of conglomerate and slate lying on its southern face. Patches of conglomerate were also found overlying this dike and were seen to have been strongly metamorphosed by it.

40080 Specimen 40080 shows the dolerite with some of the sediment in contact with it.

40081 Specimen 40081 shows a granite pebble in what appears to be an unmistakable

40082 sedimentary matrix. Specimen 40082 shows conglomerate with the metamorphosed sedimentary matrix. This conglomerate lies well up on top of the dolerite and is above the animikie slates and quartzite which are found occurring in places upon the flanks of the dike. Moreover this conglomerate contains pebbles of slate and of Quartzite as well as several varieties of granite and pebbles of vein quartz. It is not possible at this place to state absolutely the relations which exist between the conglomerate and the animikie slates. The slate and quartzite fragments in the conglomerate cannot be

identified with absolute certainty with those forming the animikie, although they are presumed to be the same. If they are, this gives us without any doubt the relative ages of the rocks, the conglomerate representing a series of sediments younger than the underlying animikie. The mass of dolerite occurring here is in the main a dike, but it seems to send off off-shoots which are parallel with the bedding, thus forming sills in the sediments. One of these sills appears to have followed almost directly along the contact of the conglomerate, and of the underlying animikie slates and quartzites, including some of both series, and consequently rendering the relations just at this particular place somewhat obscure.

There is bare rock here for some distance along the shore, so that the characters of the sediments and of the dolerite can be readily seen. As we go farther east along the shore we find a small bay which has notched the shore, and on the east side of this little bay which is reached just before we turn into "T" Bay we find the conglomerate and slates fairly well exposed, and with

their relations better shown. The lowest rocks here are the animikie slates which in general show their normal characters and are flat lying and are approximately horizontal. Locally they are contorted as the result of the intrusion of the dolerite dikes. These slates are overlaid by a skim of conglomerate. A sill of basalt has followed the irregular plane between the conglomerate and the animikie. The original depth of the conglomerate cannot be estimated as most of it has been removed leaving it now only in patches here and there upon the dolerite. The conglomerate contains quartz pebbles, pebbles of granite and pebbles of animikie slate, hence it is younger than the animikie. This conglomerate seems to be the basal conglomerate of the Keweenawan, and corresponds with the one which we studied day before yesterday in Sawyer's Bay on the west side of Thunder Cape. In Sawyer's Bay the predominate pebble was derived from the iron-bearing formation of the animikie. In the case of this conglomerate west of Silver Islet, the predominate pebble seems to be granite with the slate pebbles next in abundance. This is the

first time that the basal conglomerate of the Keweenawan has ever been found in actual contact with the underlying animikie. At least, no published descriptions of such a find have ever been made.

From T Bay on Northeast along the shore there occur a dozen or more dikes with beautiful cross columnar parting. They cut through the animikie slates. None of the Keweenawan conglomerate or its overlying sediments occurs immediately along the shore here, although it is known from our work of two days ago at Sawyer's Bay that these sediments occur inland at some distance. Reached Silver Islet village, and met the son of Captain Cross, who cares for the property of the Silver Islet mine. In conversation with the young man he spoke of a conglomerate occurring near there and, at our request, led us to the place This occurs on a cliff between Surprise Lake and Lake Superior. Surprise Lake is a small lake, back of lake Superior, which was formed by a bar which has cut it off from the main lake. The water level is about 20 feet higher than that of Lake Superior.

The conglomerate which Mr Cross showed us is best seen by ascending the

cliff from the Surprise Lake side. Here we pass over a steep talus and then over about 50 feet of exposed animikie slates, and then , in actual contact with, and above this animikie slate, comes a conglomerate which is absolutely identical with that studied two days since, at Sawyer's Bay. It is the basal Keweenawan conglomerate. At this place the maximum thickness of the conglomerate is about 6 feet, and when followed to the Southwest it ~~can be~~ found to practically feather out. It was traced to a point where it had been reduced to a thickness of 3 inches. Here the cliff ended, and the conglomerate could, of course, not be followed any farther. That this conglomerate is younger than the underlying animikie is shown by the large angular fragments of the animikie slates which are found lying in the conglomerate at various angles to its bedding. Above the conglomerate, there occurs about 20 feet of white quartzite with some very thin discontinuous ~~clean~~ clayey partings. Above this comes interbanded red and white to yellowish bands of dolomite sands. These sediments belong to the basal sedimentary deposits of the Keweenawan as described by Irving.

At this place we have the best section that we have yet seen upon which to s study the relations of the Keweenawan sediments to the animikie. In fact, here again we find the actual contact which has not before this field season been found. In the case of both sedimentary series here present, the animikie and the Keweenawan, we find the bedding in both essentially conformable. There is a very marked difference, however, in the petrographical characters of the rocks forming the two series. Moreover, the highly metamorphosed condition of the pebbles of animikie in the overlying Keweenawan conglomerate show clearly that a great lapse of time occurred between the formation of the animikie and the formation of the overlying conglomerate. The formation line of the Keweenawan as shown by Irving's maps, is about as correct as can be shown upon the scale used by him. Detailed mapping would, of course, show minor irregularities in this line. For instance, the Keweenawan conglomerate has already been noted as occurring in ~~a the~~ thin skim on the animikie on the west side of T Harbor, a point which is

Sea Gulls.

Photographed from tug Georgina as the gulls swooped down for fish fragments which were thrown to them.

considerably southwest of the formation line as given by Irving.

Both animikie sediments and overlying Keweenawan sediments can be seen at this cliff to be intruded by two dikes of basalt. One of these is about 15 feet wide, and the other very much wider, but, owing to the breaking down of the hill could not see just how wide this last one was. Erosion has removed the Keweenawan sediments from the south slope of the Lake Superior side of this ridge, but upon this side the animikie slates and one of the dikes are well exposed.

Followed the road from Silver Islet to the bay ~~west~~ East of Silver Islet. The animikie slates occur at the mouth of Silver Islet Creek, then farther Northeast along the shore, narrow trap dikes appear, although one cannot see the sediments through which they cut. At This place is the home of Mr Frue, inventor of the Frue Vanner, and, nearby is the blacksmith shop in which the first machine was constructed. All of the buildings are now deserted, and are used chiefly by picnic parties from Port Arthur. We lunched on the veranda

Tug Georgina in Nepigon Narrows, July 1900.

This and following two views show Spits between Island and Mainland in Channel Leading into Nepigon Narrows.

of Mr Frue's house.

East, along the shore, across the bay beyond the President's House, we find the Keweenawan sediments first come down to the Lake Superior shore. Here there are several narrow bands of red conglomerate separated by sand stones at the bottom, and then, above, come the normal buff sand stones with the red marls above. Continue on around shore and see almost continuous out-croppings of the flat lying Keweenawan sediments. At several places along the shore basalt dikes cut through them. At one place also I note a small fault with a throw of about eight feet. This sedimentary series continues Northeast along the shore to the point on the west side of Black Bay. We camped here in the large Bay opposite Sandstone Island.

July. 30th. In spite of a strong wind we cross the head of Black Bay to Edwards' Island. On the west side of this island there are exposed conglomerate beds containing pebbles of basalt, red feldspar, porphyry, and other acid rocks. This conglomerate is, therefore, not the true basal conglomerate of the Keweenawan, since it contains these

Nearer to the Spits

Still Nearer to the Spits

basic and acid lavas, but was formed after some of these had been erupted. Numerous exposures of basalt occur along the shore of the island as we follow around the North shore. At the north-west side of the island as one goes west along the shore back of the point north of the fishing station, one can see the top of a flow with a ropy surface. The surface of the flow is as beautifully preserved here, and as perfectly developed, as that to be seen in the case of the lavas of recent volcanoes. Crossed Southeast to Point Magnet. Here basalt is exposed. At this place we ch chartered the tug "Georgina" and were carried up to the south end of Nepigon Narrows. After leaving Point Magnet, we passed a flat rock which comes up just above water, which consists of coarse grained dolerite and is said to be strongly magnetic. We followed the inside course, inside of the islands, and passed numerous cliffs of basalt, showing well developed basaltic columns. In order to get into the "Narrows" we turned in between the mainland and the large island Northwest of Lamb Light House. On the main shore and point west of this island, the red sand stones