Northern Michigan and Wisconsin: [specimens] 25071-25165. No. 144 1892

U. S. GEOLOGICAL SURVEY

FIELD SECTION BOOK

Northern Michigan and Wisconsin

C. R. Van Hise

25011-25165

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.

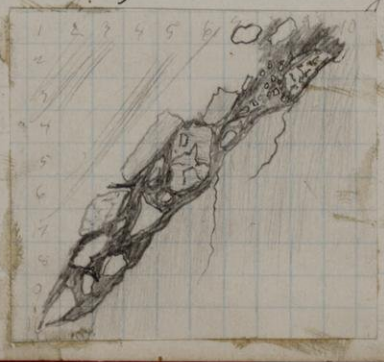
4. On the last twenty-five pages of the book give, as may seem desirable, a general account of the examination of the region mapped in the previous pages, correlation of observations, sketches, cross sections, etc.

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

Ishpeming, Mich. May 31, 1892.

In company with Matthews and Phillips I drove north on the Deer Lake road to the point where the road west of Deer Lake on the quarter line of Sec. 34, makes a sharp bend to the west.

From this point we went east along the valley between the quartzite and green schist. About ⅛ of a mile east of the bend the contact between these two formations was found. The strike of the green schist at the contact is approximately east and west and its schistose structure dips at a high angle, 75° to 80° to the south. The contact of the quartzite and schist dips 55° to the south, so that the fibers of the schist abut against the contact plane at an acute angle, as shown by figure:



Above the contact plane is a genuine basal conglomerate, the fragments of which are mainly derived from the schist, but which also contain numerous large fragments of quartzite, some of them being 8 inches and 9 inches in greatest diameter. Besides the green schist and quartzite pebbles there are also present abundant fragments of a rose acid schist which is like the acid schist subsequently found in a vertical attitude west of the quarry. There can be no doubt that the green schist had become foliated as it now is before the formation of the conglomerate.

After an interval of a few paces a quartz-schist is exposed to the south, and after another interval of about the same amount appears the large continuous ridge of quartzite. The quartzite is but little squeezed; it seems to be merely undulated by the interstitial deposition and has all the appearance of the Upper Huronian quartzite.

25071 Green schist at north side of exposure.

25072 Green schist 5 feet from contact.
25073 Specimens of the conglomerate.
25074 Specimens of pebbles from the conglomerate.
25075 Quartz-schist from outcrop to the south about 10 steps from contact.
25076 Quartzite from ridge 25 steps to the south.

The valley between the quartzite and green schist was followed for some distance to the east, and while the two rocks were found near to each other, no farther contact was observed.

We then turned north and went across the green schists for a little way.

After a short distance, about 150 paces east, the green schist changes its character
25077 to 25077. This rock appears to be a more acid schist, and may be above the green schist proper and may have furnished the acid pebbles of the conglomerate.

Continuing onward to the east there
25078 appears 25078, a green schist porphyry or slate-conglomerate containing bright red

particles of feldspar. As a rock very much resembling this, in a more massive condition and presenting more closely the appearance of a porphyry, was seen at the end of the wagon road it is probable that the rock is really a porphyry. Both 25077 & 25078 belong below the contact.

We now turned back to the road and went west to the quarry. The quartzite,
25079 we found to be regularly bedded and dipping to the south. It contains one layer 6 to 8 inches thick of fine grained
25080 25081 conglomerate, which holds very numerous fragments of bright red jasper unmistakably derived from the Lower Huronian iron formation. This occurrence, combined with the presence of the quartzite pebbles in the conglomerate, shows that the Seal Lake quartzite formation is later than a lower quartzite and the iron formation of the Lower Huronian; and considering that similar conglomerates are often unconformably upon the iron formation, there is little reason to doubt that the

great mass of the Seal Lake quartzite is Upper Huronian.

The quartzite was followed for some distance west and is always plainly bedded, merely indurated, not foliated, and dipping steeply to the southward. Just to the north of this quartzite is a siliceous schist, striking in a general E & W. direction and with vertical dip, but locally being folded in the most complicated way, and in one or two places passing into a genuine Reibung's breccia. The very intricate folding of the schistose rock and the simple tilting of the quartzite is the plainest kind of evidence that the siliceous schist had undergone severe orographic movements before the deposition of the quartzite; hence between the two there is an unconformity.

Bearing in the same direction is the presence of complicated veining in the schist and its entire absence in the quartzite. In one or two places the quartzite appears to face in a thin sheet the north side of the siliceous schist knobs, and in one place the two were interlocked in a way

not fully explained and needing further study. The whole can, however, be regarded as produced by an irregular rugged coast outline of siliceous schist, along which the quartzite has been deposited; subsequently folding and perhaps a little faulting has occurred.

The siliceous schist appears to grade into the ordinary green schist to the northward, but this relation was not sufficiently studied. At one place the folded siliceous schist is quite ferruginous.

Ishpeming, Michigan, June 1, 1892.

From the road to the west we walked in to the quartzite mapped by Rominger as lying in the green schist area lying northwest of Hunter's lake, in Secs. 29, 30 & 31, T. 48 N., R. 27 W.

His description of this quartzite (Geology of Michigan, Vol 4 p. 46 f, so far as it goes was found to be accurate in every particular. The quartzite is for the most part pretty heavily bedded. It is a pure vitreous quartzite, unfolded and not sheared, and dipping steeply from 50° to 60° to the southeast. The strike at one place was found to be N. 65° E. The heavy quartzite beds are underlain by layers of thinly bedded quartzite which in the lower horizons pass into a graywacke-slate. The quartzite ridge is a sharp narrow one, the dip of which is approximately horizontal and which is broken down only at one place so far as followed. The narrow ridge often slopes steeply to the south with the inclination of the

layers of the quartzite. Upon the north side the ridge breaks off across the layers in places forming perpendicular cliffs. The ridge is perhaps on the average 100 feet high.

Both north and south of it is a ravine; on the south side is a creek; on the north side a rill. Both north and south of these narrow valleys and circumscribing the quartzite ridge are precipitous bluffs of peridotite often largely altered to serpentine. At the east and west ends the ridge dies out and the two valleys run into a single wider one, on both sides of which is the peridotite.

How this block of quartzite perhaps 3/4 of a mile long could have been gotten into the middle of the greenstone area without a double fault is hard to explain. The quartzite has all the characteristics of an Upper Huronian rock. The supposed double fault by means of which the quartzite may have dropped down into the schist, at the east and west ends of the ridge may run together. It is to be noticed that the dip of the quartzite is the same as

that near Deer Lake. Was it tilted before the supposed faulting, and how far has a possible series of faults increased the apparent thickness of the greenstone schists?

7.7 June 2 and 3, 1892.

Visited Merriam and Maurer's camp north of Amasa.

With Maurer we saw the exposures of ferruginous slate near the dam in Sec 15-45-33W. This is plainly a ferruginous phase of greenstone. West of the exposure is a line of magnetic attractions which has been traced for two miles. The dip of the slate is at a high angle to the west and it is possible that the iron-bearing belt runs to the west of the slate.

We next visited the limestone and slate ledges on the Hemlock river in Sec. 34. A short distance to the west of the interlaminated

slate and limestone, on the west side of the river is an outcrop of typical green schist. The limestone dips at a high angle to the east. About ½ mile to the north is a beautiful greenstone conglomerate, the fragments of which are well rounded and which contain numerous typical volcanic bombs with their zonal structure perfectly developed. The remaining fragments are well rolled and the conglomerate, while mainly composed of volcanic material, appears to have been worked over by water. This exposure suggests that there was a cessation for a time of the ejection of volcanic material and that in the bed limestone and slate began to form; or it may be that the volcanic action permanently ceased, the limestone being on one side of a sharp synclinal fold.

The outcrops of ferruginous chert in Sec. 20 were next examined. These beds, where the strike was most accurately determined have an east & west trend and are vertical or dip at a high angle to the south. The belt has a width of 200 or

300 paces N. & S. and extends some distance E. & W. At various places one sees along planes of faulting dynamic breccias or conglomerates. A number of test-pits sunk south of the exposures are in the same breccia. For the most part the chert is not heavily ferruginous, but in places it becomes a chert containing "bands and shots" of ore, the thick bands being ½ inch in diameter.

Friday, June 3, 1892.

At the Hemlock mine, according to Mr. Armstrong the superintendent, above the black slates which overlie the ore is a considerable thickness of chert, which perhaps is the equivalent of the chert formation to the north.

25082-25083 From the Hemlock mine were taken ferruginous quartzites which have all the characteristics which have been

taken as evidence of a recomposed iron formation. This explanation still appears the most probable one, especially for such a rock as 25083 in which there is present what appears to be ore as well as quartz. However it is not impossible that such a rock may have originated from an original sediment in which a part of the material was mechanical detritus and a part iron formation material proper, that is, a ferruginous carbonate.

Above the amygdaloid which outcrops east of the mine, or composing its upper part, is a recomposed amygdaloid which passes up into an amygdaloid-
25084 conglomerate, 25084. This conglomerate is plainly water deposited and is the analogue of the conglomerate underlying the limestone of Sec. 34 in the township north.

Saturday June 4, to Thursday June 9th.

Smith Pumpelly and Gibbs visited Smyth's camp and examined with him his work about Michigamme Mountain, near the Inter-range prospect, and the country to the west as far as the Michigamme river.

At Michigamme mountain the following succession has been made out: At the base is a greenstone-conglomerate; above this is a schistose graywacke, in places conglomeratic; above this, ferruginous graywacke on the north side, and on the south side, equivalent to it, a chert and jasper containing a little fragmental material. On the north side of the mountain is a nearly iron-ferruginous layer in the ferruginous beds. The whole is regarded by Smyth as a synclinal plunge to the east. This explanation looks plausible, and the only possible chance which I see for another is that the southwest side of the mountain represents an original

jasper and that the ferruginous graywacke of the remainder of the mountain is recomposed material. If this is the case, no marked evidence of the transgression plane was found.

At the places visited on the west side of the mountain last year, where occurs the purest jasper, the change or contact was found where it suddenly changes into quartzite above, and below was found a plane where is a breccia, and then appears typical ferruginous graywacke.

(See Smyth's notes for specimens.)

Smyth does not believe there is any transgression plane in the mountain. If this is the case, the ferruginous material must be regarded as the alteration of an original formation in part mechanical detritus and in part carbonate. Where the latter predominates the purer jaspers are produced. If this explanation be accepted the rock becomes the analogue of the iron formation of the east end of the Penokee series.

The limestone about the mountain was nowhere closely connected with the mountain rocks. It everywhere seems to be more closely folded. Above the limestone, on lithological grounds, I feel inclined to place the supposed break between the Lower Huronian and the Upper Huronian.

East of Michigamme mountain, and a little north, in Sec 34, Smyth showed us very feeble ferruginous cherts which he thought to be the chert of the limestone but which is intermediate in appearance between this and true jasper. Later we learned that Brotherton had here found 4 or 5 feet of good hard ore.

Crystal Falls, Michigan
Saturday, June 18, 1892.

Trip of Pumpelly, Channing and Van Hise.

We first visited the Main mine along the railroad track west of the river. The ore taken out is soft and it is said to rest upon the red and black slates. The latter outcrop a short distance to the south, and here they strike about N. 25° W. magnetic, and dip 58° W. that is away from the granite which is seen to the east across the river.

We next went to this granite, which we found outcropping in several knobs for a distance north and south of half a mile and having a breadth of perhaps a fourth of a mile. The area as platted by Finlay and Mathews is much larger
2508S
2508G This granite was found to be a homogeneous mass rather basic in character, and showing no evidence whatever of shearing. It weathers red. At two of the ledges it has a bedded or jointed

character which in the two places seem to be discordant in direction and which also differs from the strike of the slates across the river.

On the west slope of the larger ledge of granite near the river, was seen numerous small felsite dykes cutting it.

25087 Granite cut by felsite
25088 From a larger felsite dike. Some are 6 to 8 inches across.

At the west foot of this large ledge, in
25089 a test pit is exposed black slates, which
25090 in places are arenaceous, and in other places are carbonaceous or graphitic. These slates were also found at the northwest corner of the granite ledge within 15 or 20 feet of the granite, but like those at the test pit are wholly unaltered. If the granite had been injected since the slates were deposited it is difficult to understand the lack of metamorphism in them. If the slates, or more properly shales, were deposited later than the formation of the granite there must

have been deep water here ∓ It would take but little digging to expose the contact. ∓

We now drove to the Claire open pits. This is like all of the Crystal Falls ore-bodies, soft, in white or dirty chert, which becomes, as the rock becomes leaner, chert containing bands and shots of ore. In places the ore is brecciated.

We next drove to the Drum mine. This ore-body strikes NW-SE approximately and has a high dip, 70° to 80°. The central part nears the surface and from this, with a horse of rock between, the ore plunges in opposite directions.

25091 Chert or hanging wall.

25092 About 1/8 of a mile away, on the hill to the S.E. is found black slate or shale, and beyond this it is said the ore formation again appears.

Driving now to the Mastodon; we found this ore body to be at the bottom of a steeply northwest plunging U-synclinal. In the center of the syncline, above the ore, the chert and jasper are sharply plicated. Above the ore and chert is Cambrian conglomerate and sandstone 15 or 20 feet thick. Immediately below the Cambrian, at the north west end of the pit, is a block of the
25093 hard steel ore, 25093, which occurs also in narrow zones of the Dumm mine. This ore is much seamed and creviced.

Sunday, June 19, 1892.

We drove to the Mansfield mine and to Michigamme Falls.

On our way to the Mansfield mine we examined the greenstones. These are for the most part very dense basic rocks, in places are amygdaloidal, and a short way before reaching the Mansfield, on the railway track, the rocks appear as if composed of globular-like masses, the interspaces of which are filled with a different material. This peculiar character suggests that the lava in cooling had separated into spheroidal or polygonal blocks, and that the clefts had been filled by secondary action + Something like this is figured by Williams in Bulletin 62. + The uppermost rock of this series at the Mansfield is a greenstone conglomerate which is plainly water-deposited, the fragments having come mainly from the underlying greenstones. This rock strikes approximately N 70° E.,

and dips steeply to the west, about 70°. If the conglomerate is below the ore and the slates are in a syncline, the fold must be overturned.

East of the river, by the bridge, are red ferruginous slates not unlike those at the Hemlock river along the magnetic line in Sec. 15-45-33.

Going north from the Mansfield for some distance, are shown by pits, cherts containing bands and shots of ore, the typical soft ore formation of the Upper Huronian.

In continuing onward toward the falls, before reaching the latter place, we passed over an exposure of typical greenstone conglomerate, but the larger number of exposures are of the massive variety of greenstone. Just below the falls, in the greenstone is a layer of well banded material, 25094-95-96, the first being finely laminated, the second from a coarse ash-like phase, and the third from a very dense greenstone-like layer.

25094
25095
25096

It seems hard to explain the regular lamination of this material except by water action. The strike is here N. 25° W., magnetic.

Following this belt up towards the dam, it rapidly swings towards the west, until it reaches a nearly E & W course. This renders it probable that the greenstone conglomerates take a bow to the west following the Michigamme. The dip of these slates is about 80° to the east, the opposite of the iron-bearing slates at the Mansfield.

Now passing down stream towards the bend, the greenstone becomes a well laminated greenstone conglomerate with well-rounded pebbles which are plainly water worn, but like others of the conglomerate being mostly composed of greenstone debris.

25097 Specimen of non-conglomeratic phase.

The uppermost exposures here become like those at the Mansfield.

Passing a little farther downstream to near the SE corner of Sec 7, a black
25098 slate 25098 is found, which while highly cleaved appears to strike E & W. with a vertical dip. This certainly indicates that the slate belt swings to the west and it is probable that it runs to the NE of the greenstone conglomerate cliffs at the dam, although the lowlands which afford it a gap. If this hypothesis is true, there is no evidence that the Mansfield slates do not continue beyond the dam, and in the bend along the greenstone conglomerates may be a favorable place for the formation of ore-bodies.

Mr. Gruenberg, the discoverer of the Mansfield, says that between the ore-body and the greenstone is 20 or 30 feet of slate.

Florence, Wisconsin.
Monday, June 20, 1892.

From Florence we drove to near the center of the SE 1/4 Sec 25, north of Lake Eliza, and saw the exposures described by Brooks & Geol of Wisconsin, Vol III, pp. 488-489). The quartzite has been sheared, the pebbles are elongated, and on the south side of the hill are magnetite-actinolite-schists containing carbonaceous or graphitic material, with pyrite. The whole seems clearly to be Upper Huronian.

25099 Sheared quartzite.
25100 Pebbled phase of same.
25101 Actinolite-magnetite schist.
25102 Mica-schist.
25103 Black carbonaceous slate.
25104 Magnetic ore.
The last four all from the explorations.

The exposures near the explorations show the effect of intense and close plications with a nearly vertical dip, that is, they are

a closely buckled monocline.

Norway, Michigan.
Monday, June 21, 1892.

We drove to Sec 7, T 41 N, R. 30 W., where is the Appleton mine, and then walked up the Sturgeon river to the contact between the Archean and Huronian.

The Archean is found to be the typical basement complex, consisting of
25-105 coarse black hornblendic gneiss, which is cut through and through with red
25106 granite. Each of these occur in large masses, and along the numerous contacts the gneiss and granite are sometimes minutely interlaminated. At many places dikes of granite are seen passing from large masses of granites and penetrating the schists and then dying out. At places along the contacts the schists are so cut with stringers of granite as to have a gemmine

pegmatized appearance. The relations are practically identical with those between the black gneisses and granites east of Thessalon on the north shore of Lake Huron. The contact between the granite gneiss complex and the Huronian is beautifully exposed on the east side of the river. At this contact the upper surface of the granite is a broken ledge. This is 2 or 3 feet thick, and then appears 25107
25107 schistose conglomerate containing numerous well rounded pebbles of granite, in every respect like the solid
25108 granite just below, 25108. The matrix of the schist is sheared and crystalline but the larger pebbles and bowlders of granite have escaped much crushing. The strike of the layers of conglomerate and fine sediments is about N. 70° W., magnetic, and the contact is for some distance nearly parallel to this but cuts somewhat across it. The river a little lower down swings to the south and west and the contact is in the bed of the river.

The contact on the west side of the river

is out of line with that on the east side, taking the line of strike as a guide, showing there is a flexure or a fault here, or else the irregular character of the pre Huronian ledge. There are several alternations of coarse conglomerate and fine siliceous schist,

25109 25110 25109, 25110. The first has strongly the appearance of a felsite, although there can hardly be a question that it is a fragmental rock. Only the shearing and metamorphism has rendered it very crystalline, and it contains no large fragments to reveal its detrital origin. The dip of the conglomerate is nearly vertical, but appears to be slightly away from the granite. The first layer of non-conglomeratic rock

25109 is about 4 feet across, and the second

25110 about 10 feet across, after passing a

25111 third layer of conglomerate, 25111, 20 feet or

25112 more across there appears 25112, mica-schist, and again beyond this the conglomerate again comes in. Many of the pebbles of the conglomerate are large enough to be called bowlders. These

larger fragments decrease in size in passing away from the contact.

The contact of the Archean complex and the conglomerate was followed for some distance to the east. At one place the Archean schist comes very close to
25713 the contact, and here in the conglomerate are numerous fragments of the hornblende gneiss.

Continuing east the granite becomes an augen gneiss, and here above the contact the conglomerate has large pebbles and bowlders of augen gneiss. In the conglomerate are also plentiful pebbles of white quartz, but none were seen of chert or jasper. The pebbles of the conglomerate are often elongated and show the effects of the squeezing action, although as a whole the coarser grained phases of the conglomerate readily reveal its fragmental character. Its matrix is, however distinctly crystalline and it is a genuine schist-conglomerate.

Tracing the conglomerate to the east not far from the river it is developed

in its typical form on the south side of the hill, and then across a narrow valley about 25 steps wide appears
25114 typical white quartzite, and this has a dip of about 70° away from the granite-gneiss complex.

If between the schist-conglomerate and the quartzite is a transition it occurs in the area which is not exposed. Near this place in the granite-gneiss is a dioritic dike, but this was not observed to cut the quartzite nor the conglomerate. Is the quartzite an upward extension of the conglomerate or does it belong higher up in the series, there being perhaps in the valley between the two a fault?

We now went to the west side of the river. Immediately south of the granite, and dipping under it at about 70°, is
25115 white banded quartzite, 25115, and red
25116 quartzite 25116.

The absence of the schist-conglomerate on this side of the river, and the fact

that the quartzite appears to dip under the granite further suggests that along the north side of the quartzite formation is a faulting line

Passing south across a narrow
25117 ravine appears beautiful greenish sheared quartzite. In continuing south down
25118 the gorge, the quartzite is vitreous, sheared, and it dips to the north toward the granite. The dip varies, but in some places is not higher than 60° although in general it is greater, being estimated at 70°.

25119 The quartzite opposite the Appleton on Sec 7 also has a dip to the north. It here does not appear so vitreous as in the gorge, and is less sheared.

At the Appleton, accompanying the
25120 ore, is jaspery material 25120. The lime-
25121 stone 25121 just south of the Appleton has a flat dip, 20° to 30° to the south.

The structural relations of the limestone, ore formation, quartzite, and conglomerate at the falls can be little more than guessed. The limestone may make a plunge

to the north before reaching the quartzite and pass under it, giving a place for the ore between the two.

On our return trip to Norway we examined the ridge of ore formation
25122 north of the Vulcan mine. This resembles the formation at Appleton and neither appears to be recomposed. The Vulcan ore bodies are certainly on the south side of a broad exposure of ore formation material near the valley of Black slate, while the Norway is in a synclinal trough in the limestone. Between the Norway and the Aragon is an anticlinal in the limestone and the Archean is on its south side. This anticline may continue to the west toward the Vulcan and the limestone thus come near the surface and be north of the Vulcan ore bodies. If this be true this would make all the mines of this district at the same horizon, would make the hill of ore formation north of the Vulcan a folded body, and would much lessen its

apparent thickness.

We visited again the open pits of the Norway which show the recomposed ore at the contact of the ore formation and the Potsdam. The pebbles of Huronian material contained in the Potsdam are all rich, suggesting that the silica of the lean or chert jasper has been leached out since Potsdam time, the silica perhaps being required for the enlargement of the quartz grains of the Potsdam.

25173 Chamming found one pebble 25173 in which the process of enrichment has affected only the outer part of the fragment, leaving the core lean siliceous material. These Cambrian ore pebbles are porous, indicating that while the silica has been taken out little or no ore has been added to replace it.

The question naturally arises, to what degree the ore in the Huronian rocks directly under the Potsdam are post-Cambrian concentrations. That this occurred to a considerable degree can hardly be doubted.

Norway, Michigan,
Wednesday, June 29, 1892.

Ride down from Norway to Metropolitan.

For some distance the road ran north of east, being north of the prominent iron formation hill of the Vulcan, and near the limestone. It then swings north between the limestone and the granite area, and then north into the latter.

After coming to this area we found ourselves among the rocks of the typical basement complex. The various granites, granite-gneisses, hornblende-schists and dioritic schists all intermingled in the usual confused way were seen. These rocks continued for perhaps 10 miles when we came to the Calumet ore belt, Sec 8, T. 41 N. R 28 W., Mich. This we did not stop to examine, but Pumpelly says the ore is in mica-schists or allied rocks.

In passing on towards Metropolitan it was noticed that the granite-gneiss has a prominent foliation E & W. In places the fine interlaminations of the black hornblende-gneiss and the granite gneiss were also in the same direction

In the afternoon we drove north from Metropolitan on the Ford river road, to Sec 8, T. 42 N., R 28 W., Mich. Here we found in the northern part of the section a red granite-gneiss with a marked schistose structure in an E & W. direction, that is parallel to the Felch Mountain trough.

Turning again south, we took a road running west to the dam in the south part of the section, and here was found for a distance of a quarter of a mile or more a beautiful sheared conglomerate 25124-125, containing abundantly white quartz pebbles plainly derived from a quartzite, almost as plentiful granite pebbles,

25124
25125

various gneissic and felsitic pebbles and occasionally pebbles of chert and jasper from an earlier iron ore formation as shown by 25124.

25126
25127 White quartz pebbles from this conglomerate. These pebbles certainly appear to be derived from a quartzite rather than from veins.

Interlaminated with the plainly conglomeratic beds are fine grained layers 25128, which have been so powerfully sheared as to closely resemble granite-gneiss. The specimen was taken only two or three inches from a belt which is plainly conglomeratic.

Just north of, but not in contact with the conglomerate, is green schist containing granite veins, 25129 and 25130. This was regarded when first examined as a part of the basement complex.

Following the conglomerate west to the dam, it is exposed for a distance

across the strike of fully 300 feet, with a vertical nearly E & W cleavage to which the longer diameters of the pebbles correspond.

25131 Non conglomeratic phase of rock at dam, interlaminated with the typical conglomerate. This resembles closely an Augen gneiss.

In going toward the south side of the exposure the rock becomes more
25132 and more to resemble a granite-gneiss. The pebbles die out and the rock on the south side of the exposure taken by itself would undoubtedly be regarded as a granite gneiss, although there can be no question but that it belongs to the clastic formation.

The conglomerate is cut in the most intricate manner along the road by a
25133 pegmatized green schist 25133 which is undoubtedly the same as that first found north of the conglomerate 25129 & 25130.

On the west wall of the gorge the schist is found both N. & S. of a belt of conglomerate.

25134 Schist north of conglomerate
25135 Schist south of conglomerate.

To the north the conglomerate was not again seen, the schist 25134 extending for at least a hundred steps down stream, but south of 25135 the conglomerate reappears. This schist is pegmatized through and through and is plainly the same as 25133. On the west side of the stream the contact between the granite and schist is seen and the two have been closely folded together. We have here at these exposures a coarse grained schist which would ordinarily be regarded as Archean on lithological grounds pegmatized and cut by granitic veins, and this cutting a most profoundly metamorphosed fragmental rock which when fine grained becomes undistinguishable from a true granite-gneiss

but which has conglomeratic layers showing it to be Upper Huronian.

This conglomerate locality Prof. Irving visited in 1887 (Note book 58 pp 34-36) but he and Pumpelly at that time found in it only fragments of quartz. None of granite, granite gneiss or jasper were seen. It was then supposed by them that this conglomerate belonged in the Archean, whereas the pebbles contained in it clearly demonstrate that it is Upper Huronian.

Metropolitan, Michigan.
Thursday, June 24, 1892.

From old Metropolitan we drove east about 1½ miles to the point where the road passes into a swamp. Here a section was made from the granite a little way to the south to the road.

Just north of the granite is a little
25136 valley & then appears mica-schist which is interlaminated with coarse
25137 garnetiferous mica schist 25137. These schists much resemble the basement schists of the Huronian at Republic.

Going north, in a test pit is exposed
25138 ferruginous mica schist 25138, and then after a short interval appears magnetic
25139 and jaspery slates 25139 & 25140, belonging
25140 to the iron ore formation.

Forming the top part of the exposure of iron formation just north of the road is
25141 25141-142, ferruginous quartzite. This
25142 quartzite is actinolitic and ferruginous

but it appears to be different from the ore formation proper, and probably represents the base of the Upper Huronian. It has, however been so sheared by the Upper Huronian folding that it is difficult to be certain of this conclusion.

Just north of the road appears a coarse
25143 dioritic schist, which Pumpelly says occupies a large part of the center of the Felch mountain trough. This whole succession, not including the diorite, has a high dip to the north, 60° or 70° as I remember it.

Returning now to the Calumet road we again went south to the Archean which here consists of granite, granite-
25144 gneiss, 25144, and black hornblende-
25145 gneiss, 25145. The strike of the foliation of the granite is nearly E & W. but the foliation of the hornblende-gneiss appears to cut across this.

Going north now about 50 steps
25146 quartzite is found at the base of the ledge,

the upper part of which is crystalline
25147 limestone 25147. The contact between
the quartzite and limestone was seen.
Along this contact plane there has
been much secondary mineralization
producing coarsely crystalline amphi-
bole or pyroxene and other minerals.
The limestone also for some distance
away from the contact is mineralized
to a considerable degree. The quartzite
is broken across by numerous clefts
and cracks and has a granulated
appearance. It is doubtful if the
microscope will now show any
evidence of original fragmental characters.
The strike of the limestone is N. 80° W
and it dips rather steeply to the north.
If this ledge were extended in this direction
it would pass within 25 steps of an
exposure of the Archean a short distance
to the east. This limestone and quartzite
is but a little way to the west of the
exposures of schist and ore formation
near the road running east from
Metropolitan. As the quartzite and
limestone are so near the granite

its stratigraphical position with reference to the schists and ore formation is probably between them and the granite. If this is the case, the succession would then be quartzite, limestone, mica and garnetiferous schists, ore formation, upper quartzite, greenstone. It is however of course possible that the quartzite and limestone does not occur underground in the interval between the schists 25136 & 25137 and the granite.

We now went to the iron workings of the mountain. Driving up the hill along the road from the old town the
25148 first rock seen is mica-schist. This has a dip of 60° or 70° to the north. Above
25149 this schist appears jasper, having a strike E&W and a dip about the same as the schist.

At the easternmost of the old shafts among the ore and other loan material,
25150 was found actinolitic magnetite-schists which also appears to contain a good deal of remaining carbonate.

At an open pit a short distance to the west was found outcropping impure
25151 25152 limestone, in which the ore is developing. The ore here appears clearly to be produced either by the alteration of or substitution for the limestone. The limestone and ore here dip about 80° to the north. Both N. & S. of the ore-bearing limestone is exposed ferruginous quartzite. 25153
25153 (north) 25154 (south) which appears to be recomposed material, but which may be produced by the change in an impure ore formation in which was deposited originally a good deal of fragmental silica. In 25154 are seen numerous roundish small fragments of ~~jasper~~ which have a very marked fragmental appearance. This is very like the supposed recomposed material at Kindigamme mountain and it is not impossible that 25153 & 25154 represent the Upper Huronian. However, if this is the case, there must be faulting here to show this both north and south of the ferruginous limestone,

or else the limestone is at the center of a sharp anticline.

25155 Graphitic and ferruginous schist, from a large open pit farther west

We now went to the granite dike cutting the ore formation at the south face of the cliff. This is the dike described by Irving ‡ Note book 58, pp. 32-33‡ The ferruginous rocks here are very like 25153 & 25154, that is they have the same recomposed appearance. The granite is a typical rock of its kind and cuts across the ore formation in a perfectly sharp but irregular manner. It was traced for 50 paces or more north from the cliff. It does not cut the cliff of ferruginous material vertically, but inclines to the east. That it was an original molten dike which has crystallized out as granite can hardly be doubted

‡ See Photo. negatives # 1124 & 1126. ‡

In the afternoon we drove west from Metropolitan to Randville.

After going 2 or 3 miles, by the road was
25156 found white siliceous quartzite, which has a strongly fragmental appearance.

Our next stop was at the Groveland mine. Here the bluff north of the Groveland was examined and was
25157. found to be a ferruginous quartzite.
The material taken from the mine,
25158 appears to be no more than an unusually
25159 ferruginous phase of the quartzite.
Both Pumpelly and I thought that the work is being done in the recomposed or formation. If this is not the case, the original deposit must have been mainly a mechanical sediment.

In the valley to the south, at a test pit, was found
25160 what appeared to be genuine jasper, 25160. This low ground having the jasper formation and lying between the siliceous bluff and the limestone ought to be the place to look for it, particularly along the contact of the jasper and limestone.

Iron Mountain, Michigan,
Saturday, July 9, 1892.

Mr. Gibbs and I drove to the Quinnesec Falls. We crossed the river at the dam and walked up stream to the Horse Race. For the most of the way were seen the green schists, but some distance before the Horse Race was reached we found mica schist 25161 cut by a granite dike 25162 2 feet in diameter. This exposure is near the river and at a point where the rock is exposed by a large fallen tree.

25161
25162

Sunday.
July 10, 1892.

I drove with Merriam and Gibbs from Merriam's camp to the Amasa mine and along the Hemlock river road north to near where it crosses a creek

We found along this road for some

distance fissile slaty layers, which pass into a ferruginous carbonaceous slate, and this into an impure ferruginous limestone. Following this belt north, it apparently extends into or is replaced by the ordinary amygdaloid and greenstone schist.

Returning toward the mine pits were found which contained ferruginous slate apparently belonging to the ore formation; and then a little farther to the south appears an ore bearing conglomerate. This conglomerate is but a phase of the conglomerate containing predominant amygdaloid pebbles just east of the mine. To the west of the ore-bearing conglomerate is the true amygdaloid, and at one place the conglomerate and amygdaloid are not more than two feet apart. The areal distribution is roughly like this:
(See page 46½)

It is difficult to understand how numerous bowlders of ore bearing

slate can have gotten into this conglomerate in any other way than as water rolled detritus; yet if this is true, there is an important structural break between the ore formation and the conglomerate. As the dips are, the conglomerate appears to underlie the ore, that is the ore-formation dips to the west. The only ways that this limestone, conglomerate, etc., can be considered as newer than the ore formation are, first, that these rocks are in a bay overlapping prior folded nearly vertical rocks, in which case the unconformity is very considerable. Second, the ore formation may be regarded as older and overturned. Another possible explanation is that the conglomerate is a friction breccia. If this is the case, it will probably be found to occur only locally. It may be supposed that the ore slates of the conglomerate are from an older formation from the immediately adjacent iron-bearing member, but for this supposition there is not the slightest evidence, and the likeness of the pebble and ore formation bear strongly against it.

Monday, July 11, 1892.

Mr Gibbs and I again visited the Commonwealth, Badger and Florence pits. All have the same appearance. They are irregular deposits of ore in the peculiar characteristic soft ore jasper, not usually bright red. In all the dip is high. In none were observed any folds such as occur at the Armenia and Mastodon. In the Florence stockpile among the ore taken from an underground working is a good deal of soft brown limonite which looks like that from the mines of the Upper Marquette. No such ore has been discovered in the Lower Huronian.

Tuesday July 12, to Thursday July 14, 1892.

These days were spent in Smyth's camp on the Yuha river near Soldiers.

Sanford and I went about 8 miles south of the big hill of granite where Rumpelly said Smyth had found a slate-conglomerate on or near the granite. Here the southeasternmost exposure of granite occurs, and just across a narrow ravine appears a belt of rocks with a N. & S. lamination in which are numerous roundish eyes of feldspar, the whole presenting to me the appearance of a squeezed porphyry. At one place in the rock is a large fragment of granite 3 or 4 feet across clearly defined from the porphyritic looking rock. These seem to me to be more like a fragment caught in an eruptive than a water-worn block.

25163 The porphyritic rock nearest the granite.
25164. The rock at the outer part of the exposure and farthest from the granite.
25165 From the inclosed granite block

Friday
Republic, Michigan, July 15, 1892

Smyth took me to the locality where he has found a contact between the lower quartzite of the Lower Huronian and the granite. This contact is a little way to the west from the place cited by Brooks as showing an unconformity between the two series.

Facing the north side of the granite is a layer of conglomerate several feet in thickness containing numerous large bowlders and smaller fragments of granite, schist and quartzite. One of the granite bowlders is three or four feet in greatest diameter. Many are as much as a foot in diameter and these are usually very well rounded. The granite fragments are identical with the solid mass of granite adjacent. The schist or gneiss fragments resemble the gneiss of the Archean. The conglomerate has been considerably squeezed so that as viewed in one direction the bowlders and pebbles are elongated, but where they can

or seen in a section transverse to the foliation they present a rounded appearance ~~with~~ ~~reasonably~~ sharp contacts with the matrix, although the metamorphism has been such as to carve the outer ~~skins~~ of the bowlders to merge to some extent into the matrix.

A little way from this conglomerate is an exposure of the ordinary typical lower quartzite, and immediately above this follows the actinolite-magnetite-schist of the Lower Huronian. The Upper Huronian conglomerate is some distance to the north. As the dips are high, it does not seem possible that in any way this conglomerate can belong at the base of the Upper Huronian rather than at the base of the Lower Huronian. Near the conglomerate the solid granite contains, running into it for some feet, narrow layers or stringers of conglomerate. It appears to me that they represent sifted in detritus on the granite ledge, broken and creviced at the time of the deposition of the conglomerate.

Smyth was inclined to believe that the relations are better explained by the intrusion of the granite into the conglomerate at this point. On the west side of the Republic trough is an area of actinolite-magnetite schist so far out into the granite area as to make its position very difficult to explain. Smyth says that he finds a huge block of the actinolite-magnetite-schist within the granite at another locality a little way to the northwest, and he believes that the relations are explained by the intrusion of the granite.