Republic, and country southwest and south, to Iron Mountain, Michigan ; Trip in Lake Superior region with Professors Pumpelly, Barrvis, Reusch, Schmidt and Tschernyschew: [specimens] 18884-18908, 1893...

Van Hise, Charles Richard, 1857-1918
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U. S. GEOLOGICAL SURVEY

FIELD SECTION BOOK

Book 109.

1891

Republic, and country southwest and south, to Iron Mountain, Mich.
Trip in Lake Superior region with Profs. Pumpelly, Barrus, Reusch, Schmidt and Tschernyschew.

C. R. VanHise, 1891

18884-18908, 18934-18999, 25001-25057

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 page is also arranged so that, if desirable, a smaller scale can be used, two inches, one inch, or even 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, for instance 4025, 250 *N.*, 300 *W.*, *Strike*, *N.* 6° *E.*, *Dip*, 50° *E.* Then follow with as full a description of the ledge as possible. 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, but chips of them must be taken. 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. In all cases collect chips for slicing. 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. It is desirable that specimens 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.

Notes of C. R. Van Hise
on trip in company with Prof.
Pumpelly, concerning the Republic
area of the Marquette District,
and in the District between the
Marquette and Menominee.

Republic Michigan, Sept. 8th, 1891.

The dip of the formation containing the ore-bodies on the east side of the Republic "horse-shoe," as shown by workings which have extended in places to a depth of 1200 feet is 80° to 90°, and sometimes the rock is actually overturned.

At the West Republic mine the dip as shown by the mine plat, is 57°. The dip of the end of the horse-shoe, where the working has extended deepest — 1400 feet — as shown by the plat, is 40°. At one place, for some distance the dips become quite flat, but then again plunges down after an interval so that no evidence was found showing that the point had been reached where the flattening of dip permanently occurs.)

The Iron Ores.

The ore-bodies were found to be most irregular in their section but the plats showed some certain general relations:

(1.) The main bodies of ore are near or at the contact of the jasper formation and the quartzite.

(2.) Where the iron formation at the south end of the trough is folded into a series of sharp folds, the ore often occupies the anticlinals in the folds, that is, is surrounded upon all sides, except at the bottom, by the quartzite.

(3.) In following a given ore-body downward, the ore shows a tendency to back off from the contact plane into the solid jasper. When once the ore-body gets entirely within the jasper, it always dips out within two or three levels, and often quicker; at the same time the other branch of the ore-body, continuing down along the contact plane is often found

to correspondingly expand.

(4) The ore bodies are generally associated with soap rock, which has generally a dyke-like form. In one case the soap rock is bounded upon both sides by the quartzite.

(5.) An examination of the open pits shows that the ore formations occurring at the contact of the quartzite and ore formation are located at points at which there are also cross jointing or like sharp folding; that is, in places where the jasper is shattered. In such places the ore-bodies are in chimneys, which terminate abruptly at the ends and often give the ore-bodies a rectangular form.

In places the ore was found to pass gradually into the banded jasper. Here was evidence of extensive re-arrangement and replacement. In tracing a silica layer into an ore body, the change takes place thus:

The silica is first removed, leaving a pitted vesicular layer in place of the solid jasper. After this process is complete, or during its continuance, iron ore is introduced, filling up the spaces. This secondary ore is more coarsely crystalline than that originally present between the bands of silica and wholly changes the structural appearance of the rock.

The above facts led to the following provisional conclusions:

(1.) The ore and jasper formation as a whole existed in nearly its present condition before the quartzite was deposited, as shown by the contained fragments in the overlying conglomerate.

(2.) The plane of contact between the jasper formation and the quartzite has been a plane along which water has passed in large quantities.

(3.) At places where the

ore formation has been closely folded or shattered along this plane occur the accumulations of ore. In other words, the ore occurs at places where most favorable for the percolation of water.

(4.) The ore deposites are produced by the removal of silica and the substitution of iron ore.

The large exposures of conglomerate overlying the ore-formation on the southwest angle of the Republic horse-shoe contains fragments of quartzite, two feet in diameter, and also large fragments of banded jasper and ore. The fragments of pure ore are small and inconspicuous. A few fragments were seen which appeared to be granite. At the exposure nearest the

jasper is seen a distinct cleavage parallel to the sides of the Republic tongue, while the pebbles are concentrated into bands which cut across this cleavage, although the longer axes of the pebbles correspond to the cleavage.

The manner in which the rotation of the pebbles from their natural position to their present one is beautifully shown by the crinkled jasper into the adjacent original jasper.

Here the folding has been so sharp as to make the once continuous belts of jasper appear in zig-zag lines more nearly parallel to the cleavage thus: VVVVV

The pebbles of the conglomerate have been revolved as well as sheared and elongated. The exposures in the original ore formation at this point show how persistent is the original sedimentation of the ore formation and to what a degree folding would have to be

carried on in order to obliterate bedding. There is little doubt that if shaly rocks had been subjected to folding as severe as the ore formation at this point, that all evidence of the original bedding would have been obliterated.

Sept. 9th, 1891.

We drove northwest along the Republic tongue towards Michigamme Lake.

Before reaching the Riverside mine we examined various finely laminated hornblende-gneisses (squeezed greenstones?). These were found on the left hand side of the road. The same were also seen on the right hand side near the quartzite mapped by Merriam; that is, near the center of the west half of Sec. 1, T. 46 N., R. 30 W.

18884 Hornblende-gneiss from this exposure.

Passing over to the Metropolitan mine, the material found appears not to be from the genuine ore formation, but a recomposed ferruginous quartzite, the equivalent of the ore-conglomerate of Republic.

Forg. Char not distinct

18885 Layer of quartzite between the

ferruginous layers, which shows the fragmental character of the formation.

About 75 steps to the northeast
1888 6. is an exposure of 1888 6, ferruginous
Bruss mica-schist. A little way from the mine is an exposure of greenstone or greenstone schist
1888 7. which contains 1888 7, a tongue of granite. This granite Penn fully thinks different from the granite mass and suggests that it is a dyke.

The large exposure of granite crossing the strike of the rocks southwest of the mine was found to show evidence of several series of dynamic movements.

The most prominent schistose structure has a strike of N. 5° — 10°. E., which differs considerably from the schistose structure of the rocks of the Republic ~~tongue~~ tongue.

Another structure, the next most prominent, had a strike parallel

to this tongue, and running parallel to this is a dyke of schistose greenstone which also has a laminated structure parallel to its sides.

We next visited the exposure of greenstone and granite near the road at the Southwest corner of Sec. 35, T. 47 N., R. 30 W. Here the greenstone and granite intricately interpenetrate. Which is the later was not certainly determined. Pegmatitic veins of granite are found in the greenstone, as found by 1888 1889 but this may be due to later aqueous thermal action even if the greenstone be the later intrusive.

The large ledge of greenstone in the NE¼ of the NE¼ Sec. 34, T. 47 N., R. 30 W. shows on its east side a laminated structure parallel to the Republic tongue but in the interior of its mass

1889. becomes, 1889, massive greenstone.

An examination of the south-east pit of the Standard Mine gave the same impression as the Metropolitan; that is, the material being worked, instead of being in the original jasper formation, is recomposed rock.

1891 Ferruginous quartzite; one of the more siliceous layers, which apparently shows the fragmental character of the rock.

1892 Micaceous quartz-schist, which shows the extremely laminated character of this rock and gives evidence of the intense shearing action to which it has been subjected.

Passing to the Northwest pit of the Standard, the same material was found as at the previous location. Also here was seen lean soft ore, but not in great quantity, showing locally that more secondary

concentration and oxidation had occurred. Upon the dumps was also found a quantity of
18893, actinolite-garnetiferous chlorite-schist much like that at the Spurr mine, except that the garnets are small.
18894. Quartzose lean ore, shows the fragmental character of the formation very clearly, and leaves little doubt of the recomposed character of the rock.
18895 Quartz-schist, from the dumps.
18896 Quartzite, having a strike northwest and southeast, and a nearly vertical inclination; just northeast of shaft.

We next passed the test pits about 300 to 400 steps to the northwest, in the SW¼ of the SE¼ Sec. 27, T. 47 N., R. 8 W. Here again there is little doubt that the material taken is recomposed, although the case is not quite so plain as at the previous places.

Above the ferruginous material is quartzite as before.

The next drive to the Klondyke mine, where the contact between the ore formation proper and the ore conglomerate are beautifully exposed.

1897 Ore formation. Has all the characteristics which are typical
1898-99. of it, while 1898-99, recomposed ore material occuring in bands in the quartzite and in contact with the ore formation, has all the characteristics of the rock found in the shafts and mines visited during the day; confirming the conclusion as to the recomposed character of the former. The quartzite overlying the conglomerate contains in places narrow layers of ore-conglomerate. In general in receding the ore-formation it becomes more ferruginous and the recomposed material at times very closely simulates the original formation; minute rounded

granules of quartz and less frequently pebbles only showing the difference. If this material were powerfully sheared as has been the Republic tongue to the northwest, it would probably more closely resemble the original rock. As it is at one place it was impossible to say where the quartzite ends and the ore formation begins. As observed by Pumpelly, the ore taken from the mine seems about equally in the place of the original formation and the decomposed rock.

The percolating waters along the contact plane have removed silica and introduced iron on both sides. This fact is the clearest evidence that the final concentration of the ore body is later than the upper Huronian rocks.

The unconformity between the Upper and Lower Huronian

at the Klondike shows in two ways: (1.) by the discordance of dip, which however is very slight, the ore formation being about vertical and the overlying quartzite having a dip of about 85° to the west; (2.) By the irregular erosion surface of the ore formation, which appears both in small irregularities and also in the fact that when the conglomerate is followed it is found to continually cut across different layers of the lower series.

September 10, 1891.

Starting from Republic we drove to the Riverside mine. About 1/4 mile before reaching this locality was found 18900, granite-gneiss.
18900. This rock has a strongly developed schistose structure parallel to the trough, and with vertical inclinations.
Parallel with the structure are coarsely pegmatitic veins which show no lamination and are presumably later than the foliation of the granite.

Passing to the old Riverside shaft, was found on the dump
18901. pile 18901, magnetic ore;
18902 garnetiferous ~~schist~~;
18903 Chloritic and garnetiferous schist;
18904, pyritiferous and garnetiferous magnetic rock.

At the lower Riverside shaft mining was progressing in

in magnetic ore, associated
with which is siliceous material
1890-6, which appears to be recomposed
rock. The mining captain
says the garnetiferous and
chloritic ore strikes nearly east
and west and becomes heavier
towards the east, that is, towards
the dow in the formation here
found. At the eastern end
of the mine, the ore is said to
be 15 feet thick. Below the
ore the captain said there is
a slaty ore which is said to
have a steeper dip than the
magnetic ore and to occur in the
jasper. This seems to confirm
the conclusion that the ore
now being mined is at the
contact plane of the two forma-
tions, and probably for the most
part in the Upper Huronian,
and that there is an unconfor-
mity between the Upper and
Lower Huronian. The presence
of pyrite and magnetite sug-
gests that along the contact

plain have passed reducing matters carried downward by the percolating waters.

Near camp in the middle of the south line or nearest line to the N.E. ¼ Sec. 28, T. 76 N., R. 30 W.,
1907. is found 1907, quartzose schist,
1908. and 1908, mica schist.

Passing from this point to the northwest, at various places pits were found, all of which appear to be in decomposed material.

1909-1933 (1909-1933, unmentioned by E. R. Hamer to specimen place at Republic mapped by Brooks showing bright of quartzite schists ore formation)

See Book 282

September 11, 1891.

We drove to the Magnetic Mine, NW 1/4 Sec. 20 T. 46 N., R. 30 W. Just south of the buildings is
18934. an exposure of 18934, mica schist, which contains large fragments of what appears to
18935. be granite or gneiss. is part of one large fragment.

On this exposure was also seen numerous irregular roundish areas of 18936,
18936. quartzite, which appears, however, rather to be a harder layer in the quartzose area which has been broken up by dynamic action rather than drosion fragments.

Passing south to the last main pit of the Magnetic Mine the following downward succession was seen:
18937 Peculiar coarse schist overlying magnetic pit.
18938 Clear quartzose schist

O at top of ferruginous exposure.
18939 The same containing a large crystal of hornblende. Just overlying material mined for ore.
O
18940 magnetic ore.
18941 Pyritiferous ore. much of the ore contains pyrite although in far less quantity than shown in specimen.

Passing toward the granite, is
O
18942, ferruginous rock, which is heavily quartzose and appears to be fragmental.

West of the first pits are other pits on the Magnetic property, and here was found about the same succession where prospecting had been carried on, but south of these pits were exposures of banded and ferruginous material, which while quartziferous and actinolitic, showed least appearance of fragmental origin.

R

18943
18944
18945
18946 } Different phases of ore and jasper at this place.

br
18947 Granite south of the ore formation, the lamination of which is parallel to the ferruginous schist.

br
18948 This coarse granite is cut by fine grained granite, which appears to be a dyke-like form in the pit, but the two are affected by the common shearing above mentioned which cuts across the contact of the two rocks.

The next drove to near the center of the east line of Sec. 18, T 48 N., R. 30 W., where a diamond drill was at work. Near this place is a large test pit which shows material in nearly all respects like that seen at the Magnetic. No full suite of specimens was

18949 R obtained, but, 18949, one, was taken from the stock pile as giving strong evidence that both the coarse magnetite and the pyrite are due to secondary infiltrations, as suggested of these materials at the Riverside.

18950 Quartzitic layer which has a strongly fragmental appearance, from stock pile.

The next drove to the Ellsworth, in the south part of Sec. 30. Here is seen an exposure of jaspery schist not far distant from the granite. This material resembles in most respects the ferruginous schists 18943-46.

All the test pits examined appear, with the exception of the Ellsworth and the last ones mentioned at the Magnetic, to be recomposed, and it is not certain that these exceptions are different in char-

ader from the other ferruginous rocks.

A section was now made from the granite to the wagon road at a line a short way east of the eastern pits of the Magnetic; that is, a little west of the north and south quarter line of Sec. 20.

18951 Massive granite. The north face of the granite is strongly sheared, becoming —
18952, laminated granite.

About 50 feet north, the granite appears,
18953-54, schistose feldspathic quartzite. This is believed to be recomposed material belonging to the Huronian, although very crystalline.

About 25 feet farther north the material has become —
18955, quartzite, which in places has interlaminated with it,

18956, a peculiar schist which contains crystals with a radial arrangement.

Passing to the south, a few feet further the rock becomes
18957, a decidedly garnetiferous quartzite, and has mingled with it
18958, garnetiferous schist.

Passing a little further
18959. south is found, 18959, sericitic quartz-schist. This exposure is about 50 to 60 steps from the granite. Although very crystalline, 18952-59 are believed to represent the lowest members of the Lower Huronian at this point.

Passing now about 100 steps north and 100 west, appears
O lean magnetitic schist,
18960-62 This rock has more quartzose phase interlaminated with it.

Passing now north to the road, and then about 200

steps east, is found a ferruginous mica schist,

18963-64.

The above section is at the head of the bought about the elbow. The rocks strike north. 35° W., and the dip of all, except the mica-schist last mentioned and the granite, is 45° to 46° to the north. The mica schist is much more steply inclined, 65° to 70°, and shows how rapidly the steep inclinations appear. All the rocks of the Huronian, even of the Upper series, are very crystalline, and it is not surprising that the lower clastics next to the granite are so much metamorphosed. The ferruginous rocks, 18960-62, seem to apparently to the older Huronian series.

September 12, 1891.

A set of specimens were taken across the Eastern belt of the iron-bearing formation as mapped by Brooks, passing from the highest to lower numbers at the east side of the Republic horse-shoe, as follows:

18965-70 As shown by the specimens, the siliceous bands at the higher horizons are red, that is jasper. In passing to lower horizons the siliceous bands lose more and more of their redness, becoming nearly white in the outer bands where the quartz is but little stained with oxide of iron. These facts, taken in connection with the secondary concentration of the ores, suggested in the foregoing pages, render it probable that the reddening of the silica by iron oxide accompanied this concen-

tration of the ore, and became less and less complete as the contact plane between the ore formation and granite is receded from. The change represented by these specimens was found to be constant along the east side of the trough all the way to the end of the horse-shoe. Between the completely jasperized chert and that which is not at all stained with oxide of iron there are all gradations. The process generally begins upon the outsides of the bands or oval areas of silica, although occasionally beginning in the interior. The bands of silica in the ore and jasper formation are highly discontinuous, each silica layer being in the nature of a more or less extended oval. At times they are continuous for several or many feet.

Crossing the first belt of
greenstone as mapped
by Brooks, in passing to
lower formations, appears,
1897-72 lean hornblendic and
actinolitic slate, in which
the silica is white.

Passing still lower to the
next narrow band of horn-
blendic and actinolitic and gar-
netiferous schist,
1897-3 the alternate layers of
the material are found
to be very persistent, although
layers die out as is the
case in the higher members
of the iron-bearing formation.
One such layer is seen in
the specimens.

We now turned to the west,
until we came to a road which
passes near the contact of the
quartzite and granite. The granite,
1897-4. near the contact becomes much

18975. Sheared granite, 18975, which is intermediate in its character between the granite and the lower quartzite of quartz schist. Probably it is either decomposed granite or granite disintegrated before the beginning of Huronian time.

18976 Quartzite next above 18975. This
18977. rock continues for a short distance and then appears, 18977, garnetiferous schist.

After an interval appear ledges of garnetiferous and micaceous schists,
18978-79, and contains quartzose layers,
18980-81. These rocks perhaps represent mingled chemical and mechanical detritus.

On passing to higher members of this series along the road is
18982. seen, 18982, greenstone, and then coarse lean magnetitic and actinolitic schist.

The granite of the above se-

tion near the contact shows a prominent foliation parallel to the structure of the overlying iron bearing rock, while a little way back appears another schistose structure which cuts across it at an angle. These various structures show that the granite has probably had a much more complicated history than the iron bearing rocks. The succession and relations at the contact here are so nearly like those just east of the Magnetic, described in yesterdays notes, that one cannot doubt that the two represent equivalent successions. The clastic characters of the fragmental rocks next to the crystalline granite have suffered nearly complete obliteration. The two series appear to grade into each other, and taken by themselves, aside from the evidence furnished by the region as a whole, might readily be taken as evidence of increasing metamorphism in conformable series, or as evidence of the intrusive character of the granite.

September 14, 1891.

We drove from Witbeck to Lucas's camp, about 8 miles to the west. We left road near the center of the east and west line of Sec. 8, T. 45 N., R. 30 W., and walked between two small lakes to the northeast angle of the smaller, in the NW ¼ of Sec. 8; then turned west and traveled along its north side to its mouth.

At the mouth of this lake — where was a dam and a shanty, SW ¼ of the NE ¼ Sec. 7, — was found in and south of the stream 18983-84-85, micaceous quartz-schist. These all are believed to be metamorphosed detrital rocks belonging to the Huronian, although they contain quite a large quantity of apparently fresh feldspar. The quartz schist contains quartz-veins accompanied by feldspar, which have been sheared, in other words, pegmatization has begun.

Passing a short distance to the northwest, first across a creek in the west half of the NE 1/4 of Sec.
18986. 7, was found 18986, fine grained gneiss. This rock is quite different in its appearance from the quartz-schist at the Shanty, and shows all the appearance of an original rock.

On the ridge northwest of the creek are numerous exposures of
18987, granite gneiss, which are cut by pegmatite veins. The granite a little distance from the boundary between the two kinds is coarse, and in places almost massive. Nowhere were seen any hornblende schist dykes.

Sept. 15/91.

We visited Evans's workings in Sec. 16, T. 45 N, R. 9 W.

18988 The ore so called, 18988, was found to be a clean ferruginous material which contains quartz as layers apparently of a fragmental character and which also contains, even in the richer parts, much quartz, apparently fragmental in its character.

18989. In 18989, may be seen the alternations of the richer and poorer bands.

About 200 or 300 steps to the west of the working is an outcrop of mica schist having various phases.

18990-91-92. As shown by 18990, a coarse band cuts across the schistose structure. This band may represent the true bedding. The strike and dip of the schistose structure appears to conform with that of the ferruginous rock.

At Scholdick's, on Sec. 21, T 45 N,

R. 31 W., above the rocks of the
18993. pits, is 18993, micaceous and
ferruginous quartzite, which in
general is regularly laminated
as shown by specimen, but is
locally minutely folded as
18994-95. shown by 18994-95.
In these cases the cleavage
passed parallel or nearly so to
the sides of the folds, as seen in
18995. 18995. This renders it possible
that cleavage and bedding in
general correspond, although the
thickness of the layers found
would give no indication of the
real thickness of the original
sediments because of duplication
by folding.
Interlaminated with 18993-94-95 is
18996, quartzite in thin layers, and
18997, garnetiferous schist.
The material from the test pit,
18998, lean ore, contains numerous
roundish grains of quartz. This pit
is a few paces to the south of the
ledge from which 18993-97 are
taken.

About 100 paces to the south west, and underlying the ferruginous
18999 material, is 18999, another garnetiferous mica schist, which like that underlying the ore, contains white quartz veins.

25001 Greenstone schist, in overlying mica-schist.

There is little doubt that above the workings are mechanical sediments probably belonging to the Upper Huronian. If merchantable ore-bodies exist, one would expect them to be found between the present workings and the limestone.

25002 Micaceous and chloritic schist strikes N. 25° W., magnetic; dips NE 7°(?). About 1/2 mile ~~south~~ of camp at which are the mining pits.

Passing up Fence River about 1/2 mile, appears —

25003-4, schistose greenstone, which weathers in a peculiar fashion, giving strongly the appearance of volcanic surface rock.

Above this appears, after an interval of 4 feet,
25005, limestone, regularly bedded, striking N. 15° W., and dipping about 54° to the east.

Above this limestone after an interval of 6 or 8 feet, appears again
25006, greenstone schist. The limestone on weathered surface has a lenticular parallel mesh-like structure which apparently gives evidence of dynamic movements in different directions. The limestones and exposures in this vicinity are extensive. Dr. Manner on following up the river from the above point to the dam found numerous alternations of the greenstone schist and limestone. The facts seem to indicate

alternations of limestone formation and volcanic outbursts, although it is not impossible that some or all of the greenstone schists are subsequent intrusives.

September 16, 1891.

In driving south towards the junction of the Fence & Michigamme, granite was found at intervals in the road for a distance of about one half mile south of a bold bluff which faced south in the south part of Sec. 21, T. 44 N., R. 31 W.

The south slope of this granite is faced in places by
25007. hornblende-schist, which, however upon being traced is found to cut back into the granite and is believed to be a schistose dyke.

In passing to the Inter-range mine the road leads past Michigamme Mountain, and at the northwest angle the material is plainly fragmental and ferruginous quartzite. In places this material appears to contain particles of fragmental jasper, as shown by

25008. Going to the Inter-range prospect, near the quarter post between Secs. 3 and 4, T. 43 N., R 31 W., the material mined, while in places a nearly pure ore, is apparently but a more ferruginous phase of the Michigamme Mountain quartzite, as shown by the leaner parts.

25009- 10-11-12. In one of the pits occurs a good deal of soapstone. The strike of the formation, according to the captain, is northeast - southwest, and the dip at an high angle to the southeast.

Returning to the road, it was followed to the town line between 43 and 44.
We then turned west between Secs. 4 and 33 and passed over Michigamme Mountain. From the east slope and top the rocks exposed are the same ferruginous quartzite heretofore seen. However, on

the west slope, near the top and a short distance before the quarter post is reached, is found,
25-013. banded ore and jasper, striking about N. 15° W. (estimated no sun) and dipping at an high angle to the northwest.

Just above this material is
25014, lean ferruginous quartzite.

(In the first land just west of the mountain we found numerous test pits which showed lean ferruginous slates or shales.).

Passing along the line to the west is found just south of the line and running nearly parallel to it, a long ridge which at 625 E and 25 S. of the northwest corner of Sec. 4 T. 43 N., R. 31 W. is
25015, limestone, which here strikes N. 70° W., magnetic, and dips 35°-38° south

Passing west to the corner and turning to the north is found at 1100 N., and 25 W. of the southeast corner Sec. 82, T. 44 N., R. 31 W.,
25016-17, quartzite, which shows by the compressed grains that it has been highly squeezed. This quartzite is interlaminated
25018 with 25018, quartzose limestone, which in places becomes purer than in the specimen. The strike is N. 75° E., magnetic; dip 65° south.

At 390 N., 145 E. of southwest corner of Sec. 33, T. 44 N., R. 31 W., is
25019, limestone. Strike N. 36 E., magnetic; dip 68° southeast.

September, 17, 1891.

25-020 is limestone in river opposite camp of Lottie Mine.

Going to test-pit southeast of above we find the material consisting of alternations of brecciated chert and sandstone containing a great deal of ore. A short distance to the northwest is a
25021 limestone ledge, 25021, which strikes N. 45° W., and dips vertical. A little way from this point toward the south the dip is 70° southwest. This limestone contains numerous veins and interlaminated layers of chert or quartz.

Going some distance further south and a little west, appears
25-022 a ledge of solid arenaceous limestone.

Pumpelly suggests that the material in the pit is a leached arenaceous cherty limestone which has become brecciated and in

which iron has been infiltrated.

In passing east from the last limestone southeast of first pits appear red and grey soft slates representing shaly layers in the limestone; and going perhaps 40 rods in this distance appears the main pit of the Lottie prospects. Here the ore is a soft red hematite,
25-023, in which however is to be found
25-024, pieces of solid limestone, which on its outer part has become ore. This last pit was found to bear N. 13° W., from the topmost point of Michigamme Mountain.

25-025 is sandstone; supposed residual material by solution of limestone between the grains between the pits first and last seen.

25-026. Peculiar siliceous slate on road between Crystal Falls and Hemlock, about 5 miles from Crystal Falls. It stands out sharply

among the green-stones with which it is associated on account of its lighter color. It apparently cuts the green-stone. It is affected by an east and west cleavage, but a close examination shows it to be a series of closely compressed folds which have a sharp pitch towards the south.

About two miles before Hemlock is reached is found fine grained greenstone, the upper part of which is amygda-
25-027, 25-028. loidal, 25-028.

The flowage structure stands nearly vertical. The amygdaloidal part contains numerous amygdules of white chert,
25-029, which are in sharp contrast to fragments of banded jasper
25-030. and ore, 25-030, which certainly appear to be fragments of the ore formation caught in the lava.

25031. Amygdaloid outcropping just east of Hemlock Mine and believed by Captain Warner to be the foot-wall of the mine, which in a general way, strikes north and south and dips at an angle of 45° to 60° to the west.

25032-
83-34 Various slates from the dump-pile of the Hemlock Mine showing material which is associated with the ore.

25035 Ore of the harder variety from the Hemlocks. The most of the ore is soft and crushes to pieces. In the ore within the mine are occasionally seen cherty layers, 25036, 25036, which run parallel to the formation of the original slates.

September 18, 1891.

We drove from Iron Mountain to Quinnesec. At the latter place we examined the test-pits made by a man named Buell.

At one pit some hundreds of feet south of the limestone the succession as given by Buell from north to south is as follows:

25037 Ore and jasper conglomerate nearest the limestone.

25038 Quartzose slate which resembles the Penokee quartz slate formation.

25039-40 Ferruginous quartzites which beautifully show the fragmental character of the rock.

25041. Lean ferruginous slate.

From test-pit some distance to the southeast, that is at a considerably higher horizon 25042 is seen 25-0424 banded

magnetitic ore and quartzite.

An examination of the foregoing series renders it evident that the whole is detrital, that they belong to the newer Huronian, and that the proper place for exploration is higher or lower. On this immediate vicinity of course lower, that is, and the original material from which is derived the ferruginous clastic deposit now being explored.

Returning now to Iron Mountain, a hill of lean ferruginous material south of the Chapin mine which had always been supposed to be of the same character as the rock containing the ore body is found to be
25048-44 recomposed ore and jasper, which
clearly shows its fragmental character, and 25045 contains quartzose
25045 layers which are like those of basic

ed at Quinnesec. (?) In strong contrast
25046. to this material is 25046, a banded
ore and jasper, from a large pit
which has caved as a consequence
of mining and exposed a large
mass of this original Lower
Huronian ore formation material.
Upon the south side of the exposure
25047-48 appears also 25047-48, lean
banded slates, which simulate the
fine banding of original cherty
carbonate. Upon the south
25049. wall of the pit is 25049, soap-
stone, which accompanies the ore
so constantly.

25050 Fossil-like form which en-
tirely covers the weathered sur-
face of a large block of limestone
by road running from Iron
Mountain to Lake Antoine.

T. R.

Photo. 1135, 1136, 1137. Closely contorted ore and jasper at SE corner of Republic "horse-shoe" just below the larger deposits of ore. The ore bands thicken at the anticlines and at these places the siliceous belts very largely die out, being replaced by ore.

Photo 1138 Looking across pit at contact between the jasper formation and the overlying quartzite at the SE corner of Republic horseshoe. The jasper has a steeper inclination by 5° or 10° than the quartzite, showing that here while the two series are unconformable, that the discordance is not great, although the intervening erosion certainly is.

September 24th, 1891.

Notes taken on trip in Mr. Rhinelander's car with Profs. Pumpelly, Barrow, Reusch, Schmidt, and Tscherynschew.

25051 Actinolite-magnetite schist. Specimen taken a short distance below rich ore of Klyman. This locality is in contrast to the Republic Mine in that the downward gradation to the actinolite-magnetic schist does not occur so quickly.

Photos 1132 & 1133 Banded chert and jasper showing the manner in which the white chert changes to the red jasper, leaving the chert in rounded ovals when the process is nearly complete. From top of bluff on east side of Republic "horse-shoe."

Photo 1134 another view of banded jasper showing the wavy form which it frequently takes.

September 25, 1891.

25052 Greenstone conglomerate from bluff where in ~~contact~~ contact with the slate, about a half mile north of the Saginaw Range.

September 26, 1891.
Original Huronian near Garden River.

25053 Granite from huge bluff separated by steep ravine from great conglomerate bluff; first prominent exposure to left of road on way from Sault to Garden River. All one side of this ledge is of this solid granite. Against this, and fallen down from it, is
25054 recomposed granite or granite ~~gneiss~~ stucco. Fragments are semi-angular, packed closely together, while the cement is of the same material.

25055 Pebble knocked out of recomposed granite.

25056 Recomposed granite from small ledge some distance to the north from the main granite mass. This material skirts the solid core of granite and the

relations are believed to be the same as at the large bluff.

25057 Quartzite interlaminated with slate of slate conglomerate. The layers of slate and quartzite are without any pebbles. Their alternations gave a good determination of strike and dip as follows: Strike, N 65° W.; dip, vertical.

The discovery of the solid bluff of granite represented by 25053 and the decomposed granite which grades up into the slate-conglomerate affords a second contact between the original granite and the lowest Huronian at this locality. At the basal portions of the conglomerate, the matrix is so nearly like the pebbles that the cemented material and the decomposed granite looks almost exactly like the original massive granite that it is

difficult to discriminate between the two except upon the weathered surface.

Here the matrix is less resistant and as a consequence of weathering the pebbles stand out as angular or semi-rounded fragments which gives an appearance closely resembling that of a Reibung's breccia; yet the fact that this material grades into the ordinary slate-conglomerate in which the fragments of granite are rounded and separated by slaty matrix leaves no doubt as to the reality of the great physical break between the two. Also these unmistakable relations at the large exposures make it more than probable that the relations are the same at the locality represented by the specimen 20056.

Between the large mass of solid granite and the great