



Trip of Pumpelly, Willis + Van Hise in Georgia, North Carolina + Tennessee (continued) ; Trip to Iron Mountain, Missouri ; Trip in Northern Michigan: [specimens] 12403-12458. No. 95 1890

Van Hise, Charles Richard, 1857-1918
[s.l.]: [s.n.], 1890

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U. S. GEOLOGICAL SURVEY.
FIELD SECTION BOOK

No. 95
1895.

Trip of Punnett, Willist & Van Nise in Georgia,
North Carolina & Tennessee. (continued)

Trip to Devil Mountain, Missouri.

Trip in Northern Michigan.

12403 - 12458

SURVEY OF THE PRE-CAMBRIAN ROCKS OF THE N.W. STATES.

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 figure attached, showing the amount and inclination of the dip. Denote slaty or other very plainly bedded rocks by lines running in the direction of the strike, with figures and a dip arrow attached as before. In all cases where there is the least doubt about the true bedding directions, 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 as 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.

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.

3. The ruling of the left hand page is also arranged so that a smaller scale can be used. Each one of the black lines may represent a section line and the red lines quarter sections and "forties." The scale of the maps may thus be reduced, if desirable, to two inches to the mile (the ordinary town plat scale.)

4. Collect a specimen from each separate ledge of rock, or wherever there is a change of rock on any one ledge. In case of trips made on foot or in canoes, for long distances, neighboring ledges, unquestionably of one kind of rock, need not be sampled, the position and extent of the ledge being marked on the map, with a note that it is of a rock identical with specimen so-and-so. Under the same conditions small sized samples, trimmed to a uniform size of $2 \times 2\frac{1}{2} \times \frac{3}{4}$ inches will be allowed, but in all other cases *large sized specimens*, trimmed to a size of $3 \times 4 \times 1$ inches, must be selected, in accordance with § 3, chapter IV, p. 44, Regulations of the U. S. Geological Survey. In all cases collect chips for slicing. All specimens are to have numbers painted on them, in white on a black background, in the field.

5. 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., etc.

12403-12438

#95
Book

(Continued from Book 94, page 55)

April 12th, 1890.

We rode on train from Cranberry to Blevins; then followed the railway on foot to station beyond Pardee Point.

The rocks at Blevins, as seen on foot are found to be as described in the previous day's notes; that is, they consist of alternating and intermingled granite, granite-gneiss, and coarse and fine regularly laminated schist. The granite in many places is cut through in every direction by coarse and fine veins composed of quartz and feldspar of the kind commonly described as pegmatitic. The instances of this sort could not be surpassed by similar occurrences in the Lake Superior region.

Plots. 952. Dykes in decomposed granite near Blevins station, Doe River, Tennessee.

2

Photo. 953. Fissile structure in granite on plane of motion & Doe River, Tenn. (Lost in heavy shadow.)

The explanation as suggested to me of their origin by their occurrence as described by Cross seems particularly applicable. It seems most probable that they are contemporaneous or of nearly contemporaneous origin with the granite — pegmatite only in the sense that water may have had much to do with their fluid condition. Upon this idea they would represent the final stages of the formation of the granitic complex. The last material which breaks through the hot but crystallized granite cools more slowly and becomes more coarsely crystalline than the containing mass.

At one place was found a large mass of gabbro which at its outer border has such relations to the granite as to show that the gabbro

is the later rock. The large mass of the gabbro contains large porphyritic crystals of feldspar. Near the granite these crystals disappear.

Photo 956. Disintegrated mass of "gabbro" showing rounded core.
Dor River, Tenn.

After leaving the main mass of gabbro, on either side are found much squeezed dyke-like material of black color, which is supposed to represent a smaller intrusion of the same material as the gabbro. From the point this gabbro was seen, were found many black dykes cutting across the granite or intruded between its layers.

The dykes are for the most part much squeezed, or at least have a most remarkable cross jointing, often combined with lamination parallel to their sides. The conviction can hardly be escaped that they have been subjected to intense

dynamic action. The dykes cut across the granite in general, however, in a nearly vertical way, suggesting that there has not been any overturning of the granite since their appearance.

Photo. 954. Dyke in granite. Takeouts show fissile structure dynamically induced at the contact. Doe River, Tenn.

Photos. 957-958. Dyke in granite. Doe River, Tenn.

12403 Much schistose or slaty material which breaks into lozenge-shaped fragments. Supposed to be a much squeezed eruptive.

12404 Gabbro from large mass above described.

12405 Schistose material (diabase?). From much squeezed dyke in granite.

No attempt was made to sample the very numerous phases of granite gneiss, granite veins, green dyke

rock of various degrees of coarseness
seen on the way from Elevine to
Pardee's Point.

A short distance before Pardee's
Point is reached the contact between
the granite and quartzite is seen upon
the railway cut.

After reaching this contact I went
back for some distance — about a
half mile — and sampled the various
phases of granite up to the contact.

12406 Pegmatitic granite

12407 Coarse red granite.

12408 Fine-grained red granite

12409 Fine-grained pink and white mottled
granite.

12410 Pinkish white fine-grained granite

12411 White granite-gneiss which contains garnets

12412 Fine-grained regularly laminated
 12413 gneiss. Interlaminated with 12413,
 coarse white granite which contains
 large porphyritic crystals of feldspar
 and numerous garnets of considerable
 size.

12414 Specimen showing the manner in
 which the gneiss and granite, 12412
 and 12413, are interlaminated. 12412,
 12413, 12414 are from the same expo-
 sure and are only a short distance
 from the contact between the granite
 and quartzite.

Photo 955. Intercalated white
 granite and black gneiss, 12412-13

12415 Peculiar quartzitic looking granite
 at the same point as 12412, 12413, 12414.
 (Is this granite and does it belong
 here?)

12416 Porphyritic diabase(?) From dyke
 cutting 12413, 12414, 12415 vertically

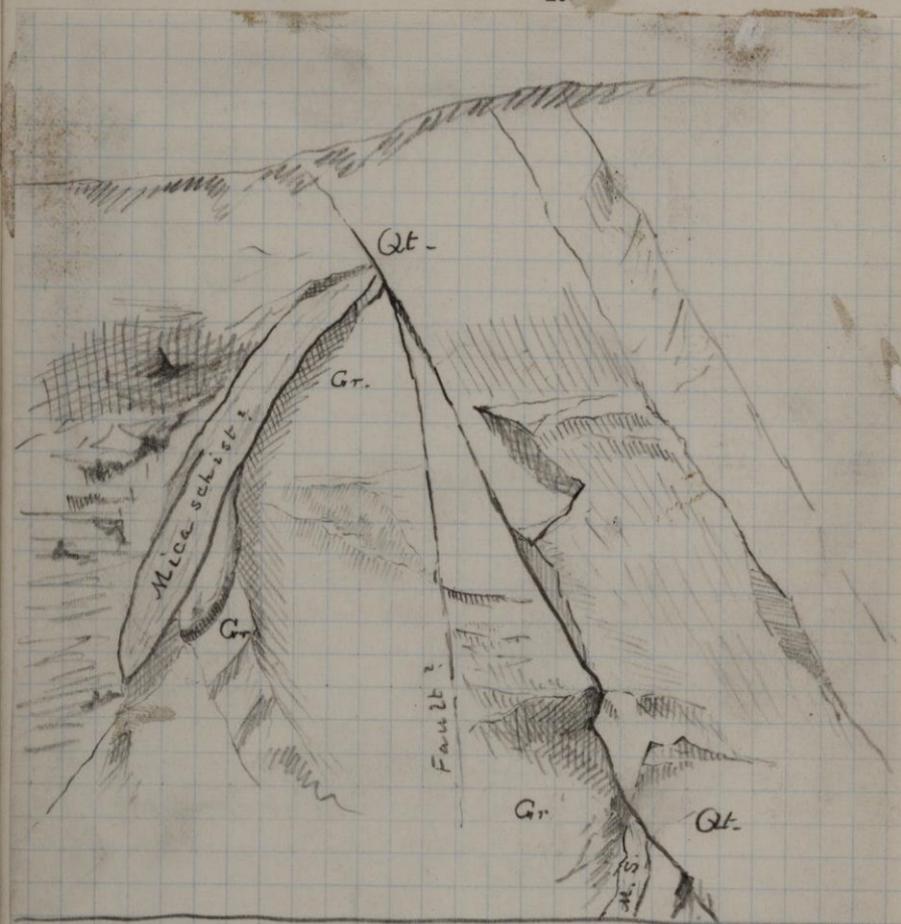
The change in the granitic complex from that containing large pink feldspar to that containing only white feldspar is very gradual. The coarse white feldspathic granite 12413 is as coarse-grained as any of the pegmatitic pink varieties. It is found in somewhat uniform layers parallel to the bedding of the black fine grained gneiss 12412. Has it been intruded along the rift of the rock?

If the explanation suggested of the origin of the mixture of pegmatitic and ordinary granite is true, it is probable that such an interlamination as we have here is indicative of a similar origin.

The contact between the granite and the quartzite is perfectly sharp. Near the contact the quartzite varies in strike from N. 65° E. to N. 80° E. and the dip is 40° NW. (Willis); that is, away from the granite mass.

T.

R.



Gr = granite

Q = Anorthite -

Mica schist = dyke or plane of movement -

MS = mica schist possibly faulted down -

Contact quartzite on
Granite - Das River Town

The basement granitic rock was doubtless originally the same as the fresh exposure of granite and schist a short distance from the contact 12412, 12413, 12414, only that at the contact the schistose phase of rock is very much decayed. The bed of schist pinches out at the bottom of the exposure, as shown by the figure, (Willis) and is cut off above by the quartzite. Also a little point of schist, apparently pinching out, is seen below.

Pumpelly suggests that these two areas were originally one, their present relations being due to faulting (See figure.). In the pinching out of the layer of schist near the contact this exposure is not different from the fresh black schist in the granite. Many belts of this schist or gneiss in the exposure mentioned, represented by 12412, 12413, 12414, have such well defined oval terminations as to suggest, in blasted out blocks, that in the

coarse white granite are fragments of schist. Unless these fragments are of very large size, however, the whole of the schist area is not included, and thus emphasize the oval forms.

This peculiar appearance of the blocks quarried out of the fresh granite area suggests that the blocks at Bluff Mountain, which appear to contain fragment-like areas, are derived from an exposure like this on the railroad in which the black schistose areas in the forms of ovals, the length of which as compared with their breadth is very considerable.

If this should turn out to be the case, what is said as to this occurrence indicating an eruptive origin of the granite later than the slate would not apply. The regularly laminated easily cleavable character of the schist adjacent to the contact suggests that in the granite here there has been movement, but this appearance of the schist may be due merely to

weathering. However, along the line of contact between the granite and quartzite the white massive granite takes a distinctly laminated character, cleaving it to thin plates quite unlike the ordinary massive rock. It is quite plain that movement has taken place along this line of contact, whether the parting of the schistose layer in the mass be due to faulting or not.

The quartzite at the contact is strong, rich in feldspar, and has the appearance of a rock in which the induration is due to the deposition of interstitial silica. The quartzite contains pebbles of white quartz a half inch or more in diameter, but contains few large feldspar fragments. Massive quartzite is interlaminated with slaty phases.

12417 Decayed granite.

12418 Schist.

12419 Granite from the exposure which is in contact with the quartzite. 12419

is next to the quartzite.

12420 Quartzite in contact with 12419.

12421 Quartzite a little farther on.

Photo. 959. Contact of quartzite over granite (far view). Doe River, Tennessee.

Photo. 960. Contact of quartzite on granite. Doe River, Tennessee.

About 450 feet from the contact, along the railway, the quartzites and slates are heavily bedded; consist of interlaminations of finely crystalline gray quartzite, which show to the naked eye no distinct pebbles or large fragments of feldspar, and of other beds which show large fresh fragments of feldspar. These conglomeratic beds also contain white quartz pebbles, and in places numerous red quartz fragments which have a jaery appearance, such as are very common on lake shores.

In places the conglomeratic bands are not more than a fraction of an inch in thickness. These bands sharply alternate with the fine-grained non-conglomeratic phases; so that a specimen well selected shows nicely the character of the whole ledge. This is just such a rock as one would imagine, if completely metamorphosed, would result in producing a rock like the French Broad augen gneiss.

124²²
124²³

Conglomerates from this place.

Photo. 961. Quartzite with conglomerate layers, 400 feet from granite. Doe River, Tennessee.

Photo. 962. Bluff of quartzite 400 feet below granite. Natives in the distance. Doe River, Tennessee.

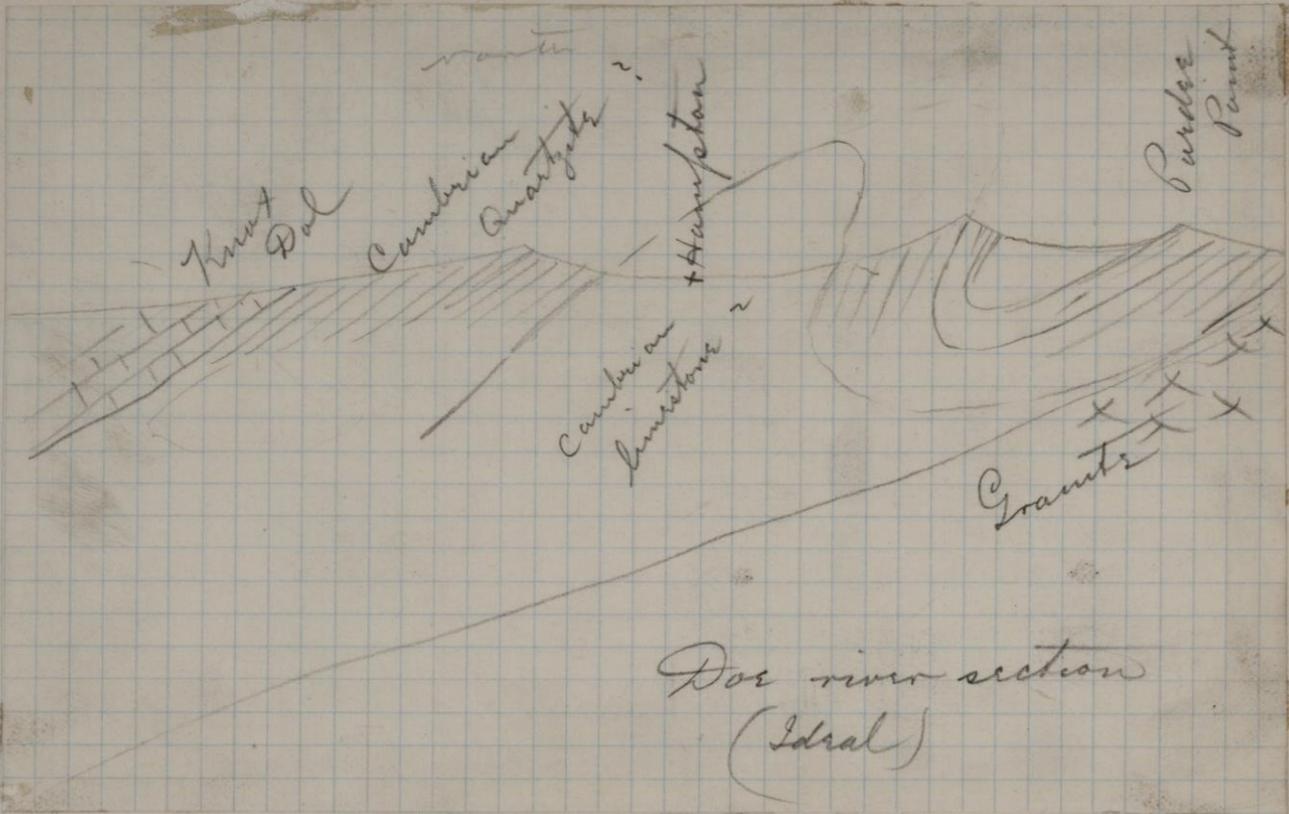
At one place in this exposure Pumpelly found what he took to be a garnet. The whole exposure is

very little metamorphosed, and if, as supposed, it is a garnet, it is probably of clastic origin, being derived perhaps from the garnetiferous granite.

The feldspar making the augen are in part white and in part pink, while in other physical characteristics they resemble the feldspars of the adjacent granites. In the white granite is found blue quartz, and in the conglomerate is a very similar blue quartz.

The evidence that the fragmental material of the quartzite and conglomerate are derived from the adjacent granite is as strong as it could be, unless a coarse conglomerate were found in which the complex masses of the various phases of the granite and schist were contained, when it would be possible to certainly identify the detritus.

12424 Quartz-schist some distance



Dol river section
(Ideal)

farther on towards Pandel's Point.

On the way from the contact with the granite the general folding of the slates and quartzites were followed out, and it was concluded that we have here an overturned synclinal, the slates upon the granite being in their normal condition.

Below Hamptons the quartzites and slates again have a dip parallel to those of the granite, indicating that in the valley of Hampton an anticlinal axis has been passed. (See ideal sketch by Willis.) If these relations are the true ones, the slates and quartzites belong below the Knox dolomite of the valley, as they appear to do, and the series as a whole is taken by Willis to represent the Cambrian. Willis says a similar series of rocks, about 2500 feet in thickness is found on the Nolachucky, some 25 miles southwest of the Doe River section, and there are believed

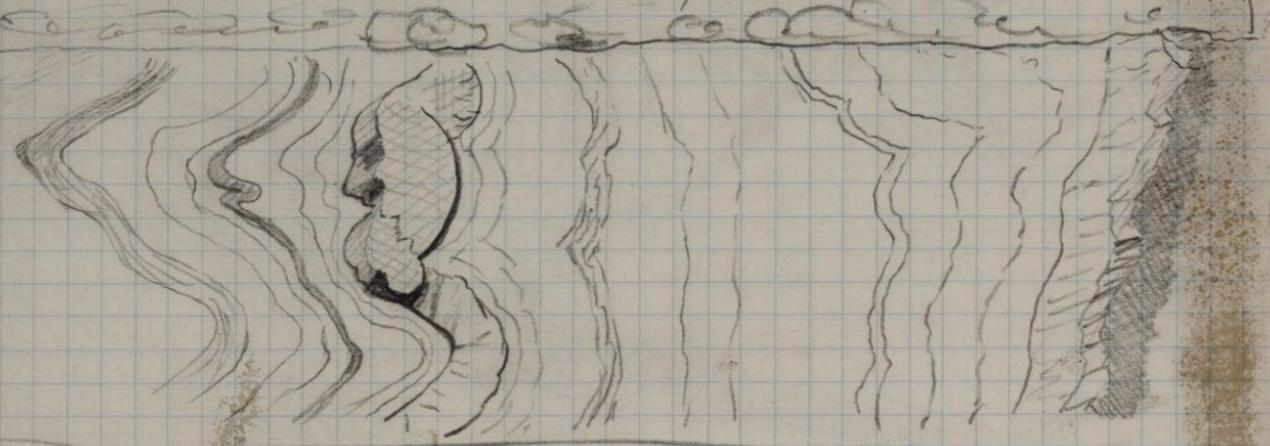
by him to be the equivalent of the Doe River slates and quartzites, with perhaps also a part of the Knox, which near the shore line of the granite is replaced by mechanical sediments, or else is not present at all. These Volachucky rocks lie athwart the strike of those of Doe River. The granite complex is known to extend over a large area in the southern part of the Roan Mountain sheet.

In the trough of the supposed synclinal between Parder's Point and Hampton's the folding of the massive beds of quartzites are more intricate and interesting, as a result of which there are numerous subordinate synclines and anticlines, and alternating areas of overturned and normal dipping rocks. The bowing of some of the massive quartzite areas is startling in its rapidity, beds 18 or 24 inches in thickness of pure vitreous quartzites being bent 90° within 3 or 4 feet without showing

West

East

River drift -



Section at first tunnel above Hampton

Dar river Tern.

normal dip to East

the slightest signs of fracture. This
bowing takes place in the quartzite,
as it might perhaps in some
elastic substance as whale-bone,
almost within its own radius and
without the slightest signs of fracture.
The compensations in the layers
are mostly made by movement
along the planes of weakness, which
separated the harder and softer
layers, and by the filling in of the
arch by movement of the softer
material forward. Usually the more
massive layers do not appear to be
appreciably thickened at their sharp
bows. There must have been interior
compensation in the brittle quartzite,
either by movement of the individual
grain over each other, or else by their
fracturing and regelations. However,
of this there is not the slightest
evidence in the rocks as examined
macroscopically, although a micro-
scopic study might perhaps result
in discovering the character of the
changes. (See sketch by Willis showing

intricate folding and the manner
of compensation of the beds just
after passing through first tunnel
above Hampton's)

12425 Quartzite showing peculiar weather-
ing along joint of compensation in
the intensely folded layers of Par-
dee's Point.

12426 Chips from massive quartzite layer
 12426A just where bed at right angles.
 12426B One specimen shows slicken-sides
 12426C where movement has taken place
 12426D between the layer from which this
is taken and the adjacent softer one.
This specimen is from the interior
of the bed.

12427 Slate and quartzite taken from
place showing what might possibly
be taken as tracings of annelid
borings.

12428 Completely vitreous quartzite
some distance beyond Pardick Point

toward Hampton's.

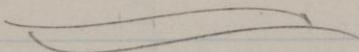
After passing into the quartzites, conglomerates and slates, not one basic dyke like those so abundantly seen in the granite area was found, although they were closely looked for along the excellent exposures for several miles. These dykes are manifestly later in age than the granite, and cut the masses of this rock to the top of their present surfaces. These dykes were not counted between Belvoir and the contact, about $2\frac{1}{2}$ miles. This ought to be done; but in thinking it over it seems to me, a moderate estimate of those seen along the single section of the railroad would amount to between 20 and 30. That these dykes in the granite-gneiss complex could be later than the quartzites and never cross the junction between the granites and quartzites is inexplicable upon any other hypothesis than that the whole

granite area, including the intrusive dykes, were all in their present position before the slates and quartzites were deposited.

Another general relation which not only applies to this region but to that of Bluff Mountain against the eruptive origin of the granite later than the slates and quartzites, is the fact that no dykes of granite are ever found in the clastic rocks. In areas in which there are large bosses of eruptive granite later than the beds cut, it is generally the case that apophyses from the granite mass cut the surrounding rocks in dyke-like forms. Their absence here is only less strong evidence that this granite mass is older than the slates and quartzites than the absence of the basic dykes.

The one doubtful point which has arisen in connection with these

water against the greater age of the granite-gneiss complex is the fragmental-like areas of Bluff Mountain, and this occurrence may well have other explanations, as has already been suggested.



Pilot Knob, Missouri, June 22, 1890

The main workings of the old Pilot Knob mine at top of mound were visited.

The ore was found to be a compact blue hematite, grading into slaty phases, and passing above, apparently by gradations, into conglomerate. The matrix of this conglomerate is ore, while the pebbles are for the most part porphyry, although jasper-like pebbles are frequently seen. The porphyry pebbles are often much decomposed.

In passing upward to the top of the Knob from the massive ore the rock becomes more and more conglomeratic. At the top of the Knob the pebbles occupy as much space perhaps as the iron oxide. The pebbles have been penetrated in place by streaks of iron oxide and often times it is difficult to

determine at what point the pebble ends and the iron oxide begins. The question arises, whether the ore is an original deposit or a secondary formation? If the ore is a secondary infiltration, what is the nature of the original rock.

The appearance of the whole is very strongly suggestive that the solid ore bed, as well as the conglomerate is a mechanical detritus in place, perhaps modified by subsequent processes of alteration.

The rock found below the ore, after an interval, is porphyry. No contact of the two were seen.

✓ 12429 Normal conglomerate over ore bed at Pilot Knob.

Photo. 1007 Photograph of boulder of conglomerate. Not printed although negative good

12430 Same, containing a large somewhat decayed porphyry pebble.

- ✓ 12431 Conglomerate containing small porphyry pebbles.
- 12432 Specimen of ore, containing pebble(?) of jasper, the two grading into each other.
- ✓ 12433 Hard blue ore of Pilot Knob below the porphyry.
- ✓ 12434 12435 Slaty ore from Pilot Knob, at higher point on mound on east side of Knob. The dip is to the west and about 14° (Pumpelly), and this ore bed may very possibly be the same horizon represented by 12433.
- 12436 Decayed conglomerate from top of Knob.
- 12437 Fragment of porphyry pebble in conglomerate at top of Knob, showing gradation of fresh porphyry into much altered porphyry.
- ✓ 12438 Porphyry from first exposure on

road in going down slope.

A "new mine", so-called, on the north slope of Pilot Knob has been opened. This is apparently the tumbled down detritus of the Knob, the ore constituting the matrix, while the hard conglomerate fragments are worthless. The lean slaty ore of the top of the Knob has in these fragments been leached until soft and red, and probably contains less silica than the original ore. The material is very roughly stratified and slopes at an angle away from the hill. The upper part of the outcrop is a soft, yellow material which differs fundamentally in its appearance from the black substance mined.

The question arises whether this detritus is pre-Cambrian or post-Cambrian. Nothing was seen to certainly determine this point;

but the analogy with Iron Mountain suggests that the black material being used as ore is pre-Cambrian, while the yellowish material above this ore is post-Cambrian residual material.

Photo. 1008. Showing relations of iron ore, conglomerate and residual yellow earth on northeast side of Pilot Knob. From a distance of 36 feet.

Photo. 1009. The same, from a distance of 22 feet.

The granite quarries in the vicinity of Graulleville were visited.

The granite is a beautiful red one in which quartz and feldspar are the chief constituents. The rock is cut by one series of vertical and one series of horizontal joints, so that it is particularly easy to quarry, and gives easily very large dimension stones. Some of the blocks taken out, while not of great lateral dimensions, were 15 or 20 feet long. The weathering in this vicinity is very instructive! It has followed the joint cracks, and as a result has left huge round boulders standing up above the present surface of the country. Some of these huge blocks of solid granite are 40 or 50 feet across, and stand 15 or 20 or 30 feet above the level of the region.

At one of the large openings these blocks are seen above the solid granite, there being between the

blocks and the latter a comparatively thin layer of granite which is somewhat affected by decomposing action. Pumppelly believes that a glacier passing over such a region would be able to move the blocks, and perhaps the layer affected by decomposing action, but would not be able to get fragments of any considerable size from the solid granite below.

✓
12439

Red granite from Graniterville.

Photo. 1010. Granite quarry north of Graniterville, showing jointing, weathering of upper surface, and huge residuary blocks. Looking N.W.

Photo. 1011. Same, looking north.

Photo. 1012. Huge granite blocks formed by weathering. Taken at a distance of 50 feet, from another quarry, about a mile or a mile and a half north of Graniterville.

Photo. 1013. Another view of the same.

Photo. 1014. Another view from the
same.

Iron Mountain, Missouri, June 23, 1890.

The workings at Little Iron Mountain were first visited.

At a large open pit here the Cambrian strata are seen to abut against and die out as they come in contact with the pre-Cambrian rocks. A fragmental zone, estimated to be 15 feet thick follows along the slope of the hill. This seems to be a pre-Cambrian mantle, as it follows with a somewhat uniform thickness the slope of the solid rock below, while the Cambrian strata die out as they abut against it. For a foot or two at the contact of the Cambrian strata and this mantle there has been an intermingling of material, but upon the whole this contact is so sharp as to render the above conclusions as to the relations decisive. Large fragments of ore are contained in this mantle, and the whole of it is mined, the ore being taken

out by sorting.

The porphyry is in places very hard and quite fresh. Its upper part has a peculiar brecciated appearance, which may be due to disintegration and penetration of the ore in pre-Cambrian time, or, second, may be an actual pre-Cambrian conglomerate. In some places it looks as though the latter might be the case, but a larger examination of this and other points leads to the conclusion that this peculiar breccia in the porphyry is not a true conglomerate, but represents the results of complicated decay, combined with vein action, by which the iron is deposited as the porphyry was dissolved.

Upon going down into the pit a vein of compact ore, varying in width from 10 to 30 feet, is seen. This vein has a steeper dip than the slope of the hill. As a consequence of this, in passing down, porphyry appears

between it and the mantle above men-
tioned, decomposed porphyry being
above and solid porphyry below.
In passing up the vein and mantle
come together. Above the mantle is
the limestone and sandstone. These
relations are shown by the accom-
panying rough sketch.

The vein in one place dips about
 45° , but in depth becomes much
steeper, a short distance below the
level at which we were reaching
the vertical

With these facts before us, it becomes
evident that the vein hematite and
magnetite is the source whence the
loose material for the mantle has
been derived. In the sandstone and
limestone of the Cambrian, pebbles
are seen, not only of the iron ore,
but of both the iron ore and por-
phyry.

The porphyry is cut in one

place by a tolerably thick dyke of greenstone.

✓ 12440 Fresh porphyry.

✓ 12441 Porphyry-bruccia, showing pseudo-conglomeratic appearance above described.

✓ 12442 Greenstone dyke in porphyry.

12443 Ore from vein in porphyry. The fragments of ore are of precisely the same character.

Photo 1015. General view of Little Don Mountain open pit, looking NE; from a distance of about 300 feet.

The Cambrian strata are seen above, and the place represented by the mantle and vein is shown in the pillars and in the part ruined out.

The line of separation between the vein and residual mantle is not perceptible at this distance.

Photo. 1016 Close view of the pre-Cambrian mantle.

Photo. 1017 Nearer view; looking SW.
Taken to show thinning out of the Cambrian strata as they come against the pre-Cambrian mantle.

Photos. 1018 and 1019. Nearer views of the relations between the Cambrian and pre-Cambrian ^{then 1915} at Little Iron Mountain; looking W.

Photo. 1020. ~~Masses~~ of hard ore in porphyry, the vein dipping to the NW.

We next visited the old workings on the top of Iron Mountain and went down into the shaft, an incline on the east slope of the mountain.

Upon top of the mound were found veins of ore like that described at Little Iron Mountain. One of these, of very much larger size, has been worked out. This is the case with the major number found, but work is still being carried on in some of the veins. These cut through the porphyry in all directions and vary greatly in size. The fine veins in the porphyry adjacent to the large veins give a pseudo-conglomeratic appearance, like that described at Little Iron Mountain. This is, however, here seen ~~not~~ to very clearly not to be a true conglomerate. Pumpelly suggests that the whole is really a "stockwerk".

In going into No. 2 shaft the ore-deposit was found to be a conglomerate of iron-ore, the boulders and matrix alike being mostly derived from the vein material. It is simply a pre-Cambrian placer in which the heavy iron-ore has been concentrated in the upper and steeper inclines of the streams, while the lighter pyrophyllite has been carried farther away. The Superintendent informs us that other valleys of the same sort are being worked, although the one visited is the largest. This valley is of considerable width at the top, on the upper slopes, and grows narrower and narrower in passing downward. Its appearance above makes it probable that the whole upper part of the mound was covered with a residual mantle of iron conglomerate like that found on the incline, although perhaps not so concentrated.

These numerous inclines clearly represent pre-Cambrian degradation and sorting. In the early days of

working in Iron Mountain the deposits were mainly taken from the upper part of the mound not covered by Cambrian strata.

We have here, besides the iron ore, a great thickness of completely decomposed porphyry making a yellow earth. The ore is mainly found upon its upper surface as a mantle.

The degradation and erosion of pre-Cambrian time has further been influenced on this upper surface by Post-Cambrian decomposition. Possibly no considerable amount of ore has been added, the chief effect being perhaps to alter the porphyry.

- 12444 Fresh porphyry } Below ore on
12445 Decomposed porphyry } incline some 300
or 400 feet below shaft.

For fuller understanding of relations of ore, porphyry, residual material, and stratified rock, see blue prints of Iron Mountain, Nos. 1, 273.

It is plain from the foregoing that the Iron Mountain deposits consist of three classes. First, the original vein deposite in the porphyry; second, the pre-Cambrian placer concentrates which are covered with a mantle of stratified rocks; and third, the residuary deposite, which are not at the present time covered with stratified rocks, but which may represent material like the second class, upon which farther effects have been produced by the agents at work, since the covering of stratified rocks has been removed in case such ever existed.

Photo. 1021. General view of old open pits and veins on Iron Mountain,

showing mantle, porphyry and veins where ^{veins have been mined}

Photo. 1022. ~~Photo. 1022. Vein of blue-print showing in section~~ ^{blue-print showing} in section ~~on east side of~~ ^{line on east side of} mountain.

Iron Mountain up to June
30th, 1890 ^{3,177,545} 3,177,545 tons have been

taken. Of this amount, from incline No. 1 has come 22888, from incline No. 2, 34095; from shaft No. 1 81949; from incline No. 3, 299. Total from underground pre-Cambrian placers material 139231. All the above numbers long tons.

Ishpeming, Michigan, June 28, 1890
Prof. Pumppelly, Mr. Rhinelander & myself
drove from Ishpeming to the Saginaw Range
and visited the Goodrich Mine. We saw
again and photographed (1022-1022a) the
conglomerate overlying the jasper at this place.
The relations were again seen to be just as
remembered. The conglomerate, besides
containing all the materials derivable from
the underlying jasper formation, contains
numerous coarse white vein quartz pebbles,
where these came from is not certain, but
white veins of quartz similar in character
has been observed in "lower quartzite."

The ore is in part taken from below
the unconformity in the hard jasper
formation, but also is in part the matrix
of the conglomerate. The latter is in all
essential respects like that at Pilot Knob,
except that in one case the underlying
rock is a porphyry and in the other is
a ferruginous jasper. This unconformity
implies, as it seems to me, a very considerable
time break. The banded and contorted
jasper containing or below the uncon-
formity must have been essentially in

its present condition before the break occurred, including its content of hard ore and its jasperization; for both these materials are abundantly found in the conglomerate.

Later in the day we visited the Humboldt or as it is now called, the Barron Mine, and here we saw exactly the same phenomena as at the Goodrich. The conglomerate is of very considerable thickness, as on the Saginaw Range — at least several hundreds of feet thick. There is the same break between it and the underlying jaspery formation. The conglomerate has been mixed as an ore as at the Goodrich.

Is it possible that the hard ore jaspery horizon and the green schist granite-gneiss complex belong together — that some of the granite is later in age than the hard ore formation? If this were assumed to be the case the Eureka series at Marquette would be easily explained. The conglomerate at the Goodrich, Saginaw, Fitch,

Humboldt, Republic and other places, and the quartzite overlying the ore would then represent the base of a newer series. In this series in its upper member, and at its contact with the lower series are the ore horizons. It may be that the conglomerates containing granite fragments are the equivalents of this ore-conglomerate.

12446 Fine grained conglomerate from north of the Saginaw. The conglomerate like this at the Godrich contains numerous fragments several inches in diameter.

Clarksburgh, Michigan, June 29, 1890
 The American Mine was first visited.
 The section as described by the pit boss
 is as follows:-

Below the ore is soap-rock 2 to 4 feet thick; below this is the jaspery formation. The soap-rock is overlain by granular ore; this by another layer of soap-rock; this again by granular ore and silty ore; and this by quartzite, the lower part of which is an ore-brecchia like that of the Saginaw Range. The dip is South; the strike about East & West.

The dyke-rock (for the soapstone is really a dyke) has here evidently formed the base along which percolation has taken place just as in the Renokee region.

✓
 12447 Slate, or soap-rock from below the granular ore

12448 Granular ore in contact with slate rock.

12449 Brecchia, just underlying and forming the basal member of the quartzite—the hanging wall of the mine.

He next visited the place at which the granite "sets back" on the east side of ~~the~~ 25th & 48th, R. 29th, Mich. He found the locality more interesting than described by Merriam.

The granite was found to make the southwest point of the promontory, and in following along the west face of the granite the quartzite was encountered in contact with the granite. The contact at this place strikes W 10° S., magnetic, and the dip is about 60° to the south, the latter estimated. The quartzite as seen on the face is then folded under the granite.

Photos. 1023 & 1024. Contact of quartzite and granite. Looking east, first from 12 feet distant, second from 25 feet distant. Where photographs were taken the quartzite and granite are not in actual contact, but a short distance lower down are together.

✓
12450. The quartzite is a pure white vitreous rock, 12450.

- J
- After an interval of a foot without exposure, at the upper part of the contact appear augen-gneiss, 12451
 12452 The Augen gneiss is interstratified with a well developed schist 12452.
 The Augen gneiss gradually passes into massive granite, 12453, which however
 12454 up the fresh surface appears to have a schistose structure, 12454.

The schistose character of the granite adjacent to the quartzite is believed by Rumpelly to be due to movement within the solid rock along the place of junction during the period of folding. The leg of the fold has been stretched.

Upon passing north to the next ridge (perhaps 200 steps) the quartzite is again found, but it is here dipping in the reverse direction at a high angle — about 60° — that is, to the north.

Prof. Rumpelly thinks the whole appearance is due to the flattening of the trough near its outer border, so that tongues of the granite and quartzite

are found in a plane by the complex folding. This suggestion certainly is supported by the opposite dips of the quartzite at this locality, and the question arises, How far these tongues of quartzite extend to the east alternating with the granite ridges. Brooks maps the quartzite as extending for some distance behind the granite. Perhaps Merriam did not observe this because as soon as he struck the granite he did not go farther north, thinking that it was not at all probable that the quartzite would be found here to occur.

Crystal Falls, Michigan, June 30, 1890.
We first visited the Armenia Mine
near the S.E. corner of the NE $\frac{1}{4}$ of SE $\frac{1}{4}$ sec.
23, T. 43 N., R. 32 W. Mich.

The large open pit striking nearly north and south shows at its north end a double or more properly a treble U. The upper V is mixed ore, the second U is nearly ~~solid~~ ^{solid} rock, the third or lower U, all of which cannot be seen because its lower part is covered by debris, is ore. At its lower part the ore is said to be continuous for 75 feet wide. This synclinal is not horizontal, but pitches to the north, at a steep angle, estimated at 45° . The captain says this pitch becomes less steep in following the ore-bodies north. As shown by a shaft on the south end of the body the rocks underlying the ore are a ferruginous slate apparently intermediate between the pure ore-formation material and the abundant clay slate of the region. That these relations are probably true is shown by the fact that there are

slates on the east side of the workings which are almost pure clay slates. Contained directly in some of these slates are little belts of banded and contorted ferruginous and cherty material.

Photos 1025 & 1026. ~~show~~ show the synclinal structure of the Armenia Mine. Looking north from a distance estimated to be 200 feet.

At the Mansfield Mine (on the Michigamme River, NW corner Sec 20, within a short distance from the north line of ~~Sec~~ the section, T. 43 N., R. 31 W.) the ore formation appears to strike nearly north and south, if the old workings can be taken as an indication.

The hanging-wall of the mine is said to be green slate. At any rate this rock is the one west of the river, as shown by its being penetrated by a shaft which is to strike the ore-body at some depth. The

foot-wall is said to be the ordinary slate of the region. None of this was seen. The dip of the on-body is said to be very high to the west, varying little from the vertical. It is said to have clean walls on both sides, not having more than 8 inches of mixed on to the west.

✓
12453
12456 ✓

This western slate is apparently a tufaceous material. At least it is taken to be an altered basic eruptive. This material, with porphyritic triclinic feldspar and fine-grained superficial material, outcrops a short distance to the west of the mine.

Florence, Wisconsin, July 1, 1890.

We visited the old Commonwealth Mine. The old workings, started in an open pit of great size at the top, narrow down in depth. One chimney of ore was carried down to a depth of over 300 feet in open pit work. Most of the workings are now, however, underground and the deposits are extraordinarily irregular in form. The ore-body was nearly vertical at first, but the projections of the deeper workings show a decided dip to the north. At the upper workings the dip was rather the other way.

Evidently there is a sharp bowing within the short distance developed by the vertical workings. Another large open pit has been made some distance from the first, and the strike of the formation as indicated by these two pits is taken to be W. 15° to 25° N. The black slates are found adjacent to the ore-bodies, and apparently the mine is in the upper series just as is the Mansfield and Armenia.

Superintendent, of the

12458

Commonwealth, says that in the solid on is formed little pockets of coarse granitic material. They also found in the deeper workings of the mine veins of sulphides, pyrite or marcasite. The material also looks as though it might be cupriferous.

Ironwood, Michigan, July 2, 1890.

At the Norie Mine a diamond dull hole has penetrated vertically to a depth of 680 feet, starting at a point 700 feet across the formation from the foot-wall quartzite. This dull hole is at the west end of the property, near the NE corner of the Ashland. It started in red slates near the upper slate formation; passes into chert mingled with bands and shot of ore, in which material they are now working.

12457

drill core from a depth of 650 feet.

The large dyke at the base of the Norie has been passed through at the west end, and according to Captain Corry is 90 feet thick. The shaft from the base of the on-body of the Norie has been put down 158 feet.

At 75 feet a drift was started north and the dyke rock struck. At 150 feet another drift was run through the quartzite and this struck on like

the Ashland ore-body and is believed to be a part of it.

The plat of the Norie shows that the foot-wall quartzite is very irregular, as irregular as any erosion surface.

In the afternoon Mr. Olcott, mining engineer for the Colby, Aurora, and formerly mining engineer of the Ashland, was visited. Mr. Olcott informed me that at the west end of the Ashland the first ore-body resting upon a basal dyke had been particularly worked out. A shaft was put down something short of 200 feet, 185 as I remember — the dyke was 65 feet thick, and after going through 120 feet of rock a second ore-body was developed. This body is of considerable size & from it most of the ore at the west end of the Ashland is taken.

In the Aurora Mine, according to the plate shown by Mr. Olcott, the workings

hair reached nearly the whole length of the body on the lands of the company. Following along for the whole distance the ore lies above the basal dyke.

One would judge from appearance that at least 50% of the total amount of obtainable iron ore had been taken, considering that not all of that in the pillars will be obtained. This mine must soon sink for the Norie body, which ought to pitch on to the Aurora land from the west.

The Colby, as its workings extend eastward, does not show the same continuous large body of ore that it had in its first developed portion to the west. The dyke appears to break up into several or many parts, and the ore bodies also break up, giving a most irregular appearance to the workings of the mine — the most irregular of any of the Gogebic mines that I have seen.

Bessemer, Michigan, July 3, 1890.

I walked to the Daugler Mine east of the Colby, which was reported by Mr. Rose to be at an unusual distance north of the quartzite foot-wall. I found an abundant mass of material about the shaft and open pit from the underlying slates and foot-wall quartzite.

The remainder of the day was occupied in getting from Bessemer to Ishpeming.

Shortly after leaving Bessemer Junction, perhaps 2 or 3 miles — there was seen upon the north bank of the road what appeared to be an outcrop of horizontal sandstone. After passing this sandstone nothing was seen for a long distance except steep ridges which probably are of trap. Then followed a plain without exposures.

