Menominee, Michigammi and Marquette districts of Michigan ; Misah district of N. W. Minn. ; N. Y. with Merrill ; Mass. + Conn. with Emerson ; Southern Appalachians: specimens 25660-25785. No. 184 1895

Van Hise, Charles Richard, 1857-1918
[s.l.]: [s.n.], 1895

U. S. GEOLOGICAL SURVEY

FIELD SECTION BOOK

Menominee, Marquette and Menominee districts of Michigan.

Marquette district of N. E. Minn.

N. Y. with Merrill.

Mass. & Conn. with Emerson.

Southern Appalachians.

1895

E. R. Van Hise

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.

Iron Mountain, Tuesday, July 9.

We walked south on the Mil. + Northern to the Menominee river. Examined the exposures along the P.R. on the north side of the river in reference to the occurrence of any fragmental rocks. None were found.

25660 A gray schistose porphyritic granite in places has a somewhat fragmental appearance if not closely examined, but a close examination convinced me that it is a sheared igneous rock.

We now turned east, following closely the ridge of greenstone-schist, hoping to find the contact between the schists and the slate. Went on this course to the Upper Quinnesec Falls, but saw only the greenstoneschists and the schistose granite.

We now turned N.E. A short distance from the river a fine grained very schistose rock was seen, which, however, was taken to be a much sheared phase of the green-schist.

About 1/3 of the way from the Falls to the Keel Ridge Mine on the side of the road is a silky sericite
25661-2 fissile slate. These rocks are so much sheared that it is possible that the supposed exposure of green-schist really belongs with the slate. It is plain that the folding is so close that it would be difficult to exactly locate the contact between the two classes

of works without very good exposures.

At the Keel Ridge mine the ore is black and soft for the most part, but in some places chunks of blue-black specular ore are seen. Judging by the transition varieties and by the dump, the ore occurs in the slates, that is, the only rocks besides the ore seen are more or less ferruginous varieties of slate.

From the Keel Ridge mine we walked to the Penobie. Here we found the same black soft granular ore as at the Keel Ridge Mine, and the only dump material aside from the Cambrian was again a ferruginous and siliceous slate.

We next walked to the top of the ridge above the Penobie, and along this ridge to the hill S. of the Chapin Mine. At the west of this hill are abundant
7563 outcrops of lean hematite schist, which so far as far as its appearance is concerned might be an original jasper or recomposed material. The specimen represents the coarser more siliceous phase. This slate dips to the N. at a high angle, about 80°

We next crossed the depression of the Chapin Mine to the limestone, which is N. of the N. end of that mine. This limestone is gray, compact finely laminated, and not very cherty although some nodules of chert are seen. Like the hematite slate, it dips at a high angle, 78° to the

N. The limestone is cut by cross fractures, which in some places are very close. If the Chapin iron ore horizon belongs stratigraphically above the limestone, as is supposed, the structure in the center of the Huronian trough must be an anticline, overturned to the N.

Wednesday, July 10,

Drove to the Lower Twin Falls and examined the green schist. The most prominent structure of the more foliated varieties is a fine E. & W. fissility. This fissile schist is also cut by two sets of joints, one of which is nearly horizontal, and the other of which has a steep inclination — about 60° to the N. Fragments broken parallel to the fissility and the two sets of joints make inclined prisms with nearly rectangular bases, 25664-5, the first of which has its orientation marked upon it. 25664-5

At the upper Twin Falls the greenstones are jointed throughout. Some of the pieces showed joints in five different directions. In places the greenstone showed spheroidal parting, with filling material between the spheroids. Where much sheared these spheroids were pressed into an oval shape, as described by Williams.

After leaving Twin Falls no exposures were seen until about 1 mile S. of Granite Bluff.

The country is level and sandy. Adjacent to Granite Bluff, granite of different kinds is the predominant rock, but dikes of black schist cut the granite. For the most part the granite is rather massive, having merely a coarse gneissoid foliation. In places, however, there are narrow shear zones, in which the rock becomes a schistose granite. At one of these shear zones the foliation was seen to have the double curve so characteristic of the zones of schist between more massive parts.

Thursday, July 11,

11

I crossed Iron Mt. drove S across the Menominee river; thence W. to the Little Popple. No exposures were seen except the green-schist at the Menominee river, until the valley of the Little Popple was reached, N. part of 12-38-18. Here on the E. side of the valley
25666 was found a somewhat dense hornblende-schist or gneiss.
25667 At the crossing of the river a peculiar schist which looks like a tufa was found. To all appearances this schist is a continuation of that of the Menominee.

From the Little Popple river we continued W. to the W. side of Sec. 2; thence N to the Pine river (S. side of 12-39-18.) The country is low

and sandy, and no exposures were seen.

We now followed the Pine river up to the first Falls. On the way we saw a test pit near the river containing lean ferruginous material, and soapstone which appeared to be some kind of altered eruptive. Continuing to the Falls we found the
25668 actinolite-schist of Brooks, which here is in nearly vertical position, and strikes as mapped by Brooks.

We now went N, hoping to find the quartz conglomerate which was mapped by Brooks, but did not find the same in ledge. However on the trail numerous boulders of the material were found corresponding to his description, which doubtless
25669 come from his quartz-conglomerate. Specimen 25669 was taken from one of these loose pieces. The specimen does not show any fragments of iron-bearing material, but other boulders were seen which contained these. At about the place where we expected
25670 to find conglomerate, a ledge of slate was found.

We now walked N. E. to the wagon road, but saw no further exposures.

Continued to drive N. toward the Commonwealth mine, but saw no exposures. At the Badger mine, about 3/4 mile S. of the Commonwealth, work is going on in a material essentially the same as that at Commonwealth. At one of the

25671 test pits a peculiar white schistose rock was abundantly found. This rock is apparently a schistose quartzite, but it may be a sheared eruptive.

On our drive from Commonwealth to Iron Mt. via Twin Falls, no outcrops were seen, although an extended view could be obtained at many points, until the ledges of greenstone and greenstone-schist were found which are a continuation of those occurring at Twin Falls.

Friday, July 12.

Drove E. from Iron Mt on Quinnesec road. About half way to Quinnesec stopped and went N. to the limestone. It is massive, jointed and very similar to the limestone N of the E. end of the Chapin mine. The dip here was found to be about 78° to the S.

25672 Limestone at the S. face of the cliff.

25673 " " " N. side " " ridge.

From these points it is easy to see the diagonal arrangement of the topography, as compared with the formations. At the Chapin mine the highest ground is in the lean material S. of the mine. At the Pewabic mine the highest ground is in the Cambrian sandstone. E. of the Pewabic the ridge separates into two belts, the northern of which is the Cambrian, and the

southern of which is the limestone, the ore formation being now in the lower ground S of the ~~road~~ ridge.

We now drove to Quinnesec, and there in test pits saw the ore formation material immediately S. of the limestone. The southernmost exposure
75674 of limestone is here very cherty. This very cherty limestone is nearly solid at first, then bits of it are interlaminated with the ~~two~~ massive limestone, then the massive limestone becomes predominant, and it takes on its usual massive jointed form. This change gives the same suggestion as seen in the 1/4 N of the E. end of the Chapin, - that is, that the limestone may actually grade into the ore-bearing formation.

We now drove N. across the limestone ridge, - then NW to E. of Lake Antoine, and then N and NE through Secs. 21, 15, and 14, - 40-30. The road was followed to the creek in the extreme N.E. of Sec. 14. We then crossed the little creek in the N part of 14. Went NE and N.W. to about the middle of the E. side of Sec. 11, then crossed the main creek to reach the quartzite range. First found heavy ledges of quartzite which dip to the S.W. at an angle of about 50°. Crossing this quartzite toward the granite, the dip became higher and higher, and at the NE

part of the broad quartzite ridge was about vertical. Just N. of the quartzite is a deep defile, immediately beyond which is the granite. The quartzite is very vitreous, and has when freshly fractured a sugary appearance, apparently showing that the movement has been so severe as to granulate the original quartz grains. The quartzite is cut by veins of quartz and chert, and in its aspects is very similar to the vitreous cherty Mesnard quartzite of the Marquette district.

25675 Quartzite of the S.W. edge of the exposure where first found.

25676 Quartzite at the N.E. edge, just before descending into the defile. The quartzite is cut by great trap dikes, which have a trend approximately parallel with the strike.

25677 A more massive phase of the greenstone

25678 A peculiar schistose phase found at one locality.

To the S.W. of the ridge across the creek about ½ or 1 mile W of the place visited, was seen a considerable exposure which is supposed to be quartzite. The quartzite appears to strike into the granite, or the granite appears to cut across the trend of the quartzite. My own observations, combined with those of Brooks, and the appearance presented, lead me to believe that the quartzite is folded into minor folds, which have a southwesterly pitch,

although it is probable that there is here merely an overturn of the quartzite in the regular succession, corresponding with the overturn at the Chapin mine.

Upon returning, just before the little creek is reached in the N part of 14, a ledge of coarse
25679-80 grained thoroughly crystalline marble was found, which was too massive to give strike or dip. This ledge shows that the marble belt which Brooks found S. of the quartzite at the Falls of the Sturgeon, continues N.W. to this locality.

Near the middle of Sec. 14, probably somewhat S. of the middle is a row of test pits, which trend approximately parallel with the quartzite range. In these test pits there is the usual lean ferruginous chert of many varieties characteristic of the iron formation
25681-2-3 represent 3 phases.

We thus have in passing from the granite to the S.W. the full succession of Lower Huronian, - quartzite, limestone, and iron formation. The appearance of this iron formation here makes it easy to understand the general structure of the range, as given by Brooks.

In going S. from the Falls of Sturgeon River we have this same succession.

The re-appearance of the limestone in the Lake Antoine - Lake Burnée area, and the iron formation N. & S. of it, would be evidence that a subordinate anticline has appeared in passing

from the Falls of the Sturgeon N.W., thus making the three belts of the iron formation. On Brooks' hypothesis, the three ~~together~~ would probably come together in passing to the S.E. by the time Norway is reached.

The only point difficult to understand is the limestone mapped by Brooks north of Lake Sumée. It may be, however, that the limestone extends entirely across the Sumée valley, the ore formation here having been eroded away.

We next drove to the Traders or Lake Antoine Mine, a short distance N.W. of the old Cornell mine. Farthest to the S was a
2568 1A test pit from which quartzite was thrown out. With this was quartzose slate and the ordinary ore formation. A short distance to the N.E. is another pit containing ore formation material, and 100 or 150 paces still farther to the N.E. is the so-called Antoine or Traders mine, which is working in an open pit upon a lean ore, averaging 45%, but low in P. The succession, as given by the mining captain from his underground explorations, combined with the test pit work, is as follows:-

Beginning at the S. is limestone; passing to the N.E. there follows: quartzite, 50-75 ft., Cornell ore vein, 200 ft., red slates like Chapin

slates 300 ft; Antoine ore vein, 150 ft known; red slates, thickness unknown, width unknown; seam of red ore, flat.

The average dip of the iron ore formation at the mine is about 75°. The captain says it averages the same all the way across.

The captain, who has worked in the Hamilton mine, reports that at a depth of about 1400 ft, the dip of the ore formation, which at the surface is 80° to the N., becomes not more than 35° to the N. This fact, combined with the dip of the exposures of the Antoine mine, leads me to believe that the structure from the Antoine to the Hamilton is a syncline, rather than an anticline. The actual known facts of occurrence could apparently be as well ~~as~~ explained by the hypothesis of a subordinate synclinal there as an anticlinal. However, if this hypothesis is true, the Antoine limestone is above rather than below the ore formation, and this is contrary to what is observed both at the Sturgeon river section and in the section through Secs. 11 and 14 – 40 – 30. In order to make the Antoine area, it would be necessary to believe that another belt of ore formation material lies between the quartzite and the limestone at both of these places, but of this we

have no evidence. So far as present facts are to be had, it is therefore probable that Brooks' general structure of the region is correct. The slate S of 4ft Falls and on the Menominee river is probably Upper Huronian material, which wraps around the N.W. plunging anticline of the Lower Huronian. Whether the Twin Falls greenstones are of the same age as those of the Quinnesec Falls and Sturgeon Falls, ~~is~~ no evidence is available to determine. The likeness of these rocks and the presence of Upper Huronian rocks associated with each of them, very naturally led to Brooks' conclusion that these, with the intrusive granite, are all Upper Huronian and this must be reckoned among the possibilities.

Florence, Saturday, July 13.

Drove to the E. side of Lake Eliza. Crossed the lake to outlet, and visited localities representing Brooks' formations 16 and 17. A section was taken from S. to N.

25683A The greenstone is apparently a nearly massive diorite, although it has some schistose phases.

A short distance N of the greenstone is the slate formation 16. On the S side of

25683B the exposure the slate is coarse, ferruginous,

and apparently actinolitic.

In going #N across the exposure the rock
25684 becomes an ordinary slate, and on the N side
25685 the coarser varieties are mica-slate.

The bedding is as represented by Brooks. This cut by a cleavage which strikes N.E. and S.W. roughly. The discrepancy between the cleavage and bedding, as measured by Leith, is 65°. In places the more siliceous varieties of the slate show contortions and even brecciation.

We now re-crossed the lake and made a section from N. to S. along the E. end of the ridge in the S.E. 1/4 of Sec. 25. The rock
25686 first found is a light gray quartzite, which breaks with a sugary fracture, as though the quartz were granulated. The rock has evidently been intensely sheared.

In passing S the quartzite is found to be much veined with quartz, and in places is actually brecciated, but there are also present
25687 undoubted sheared conglomerates, which contain white quartz pebbles. Some of these have escaped granulation, and show distinctly the vitreous character. Certain phases of
25688 the quartzite upon the weathered surface are almost crovaculitic in appearance.

In continuing S. the white quartzite

25689 conglomerate grades into gray quartzite,
25690 which in places is also conglomeratic. This
gray quartzite appears to contain magnetite,
25691 and in the cracks within it are small veins
of iron oxide

Near the S side of the exposure the quartzite abruptly terminates, and heavily ferruginous rocks are found. That nearest the
25692 quartzite is a coarse actinolitic rock, which
25693 grades into magnetitic chert, and this into
25694 hematitic slate, which has quite strongly the appearance of the ordinary iron ore formation.

In the afternoon we drove S. to the Pine river to the first fall, that is, the locality visited 2 days before. At the previous trip a specimen of the actinolite-schist (Sp. 25668) on the N. side of the exposures was found. The section was continued S, the object being to ascertain in what way the actinolitic schist varies into the hornblende-schist. It was found that this change is a gradual one, numerous interlaminations of the two kinds of rocks occurring.

Starting with the actinolite-schist and going S, the hornblende-schist first appears as very narrow laminae a frac-

tion of an inch across. These belts of hornblende-schist become wider and wider, until they are several inches across, and continuing still farther, they are a foot or several feet across. However, even after the hornblende-schist ~~layers~~ is reached, layers of the ferruginous slate are found. At the southernmost exposures only the hornblende-schist was seen.

25695 Interlaminated actinolite-schist and hornblende-schist.

25696 Hornblende-schist from belt about 4 inches wide.

25697 Actinolitic schist adjacent to 96.

25698 Weathered piece showing interlaminated actinolitic-schist and hornblende-schist.

25699. Hornblende-schist from belt 2 ft wide.

25700 Actinolitic slate near -99

25701 Hornblende-schist still farther S.

25702 Coarse schist near the bridge.

One of the reasons for revisiting this locality was that it occurred to me that the hornblende-schist might belong with the green-schist series, and that the locality might give a contact between the sedimen-

tanic and igneous series. However, it is perfectly clear that the two are here interbedded, and that we have a case of real gradation. The hornblende-schist in places weathers with a peculiar rough appearance, which is suggestive of a tuff, and it may be that the interlaminations are explained as due to different layers of sediments and volcanic ashes. If this hornblende-schist proves to belong to the green-schist series, the occurrence at the Falls would strongly support Brooks' conclusion that the schists are high members of the Huronian.

We now traversed the ridge of quartz-schist and quartz-conglomerate in the SW part of 28. The rock first found is a
25703-4 quartz-conglomerate, in which the quartz pebbles are all granulated, and the smaller ones extremely elongated.

Continuing S the rock changes to a
25705 fine grained sugary schistose quartzite which is stained at parting planes by oxide of iron. This belt of schistose quartzite is of some width. Upon the N side
25706 of the exposure the schist-conglomerate was again found.

This quartzite and quartz conglomerate are very similar to that N of lake Eliza. The quartzites of both of these areas is very crystalline, and so far as lithological character is concerned, it could not possibly be separated on any good ground from the quartzite visited yesterday N.E. of lake Antoine. The quartzite at the latter locality is purer, more vitreous, and less ferruginous, but none of these tests would be safe criteria upon which to judge that one quartzite is of a different age from the other. The structural relations are, however such, as shown by Brooks as to make it highly probable that one of the quartzites belongs to the Lower Huronian and the other to the Upper Huronian.

Sunday, July 14

Went N of Cryotal Falls on Ry track for a short distance to the valley of the Paint. Here at the N. the red and black carbonaceous slates are exposed.

East of the slates is a peculiar slate, containing slate pebbles, and having a conglomeratic appearance.

East of this is a belt of considerable

width of chert and ore breccia. This runs diagonally across the river. Still farther to the E. across the river are numerous outcrops of the ore formation.

Monday July 15.

Drove S. from Crystal Falls to the N.E. part of 42-32. Here examined Brooks so-called Huronian granite. Beautiful large exposures were found. These showed all gradations from a diorite having the ordinary green color, through diorite with red feldspar, to a rock containing a good deal of quartz, and which may properly be called a granite. The gradation is quite unmistakable, and the greater part of the rock, as far as examined, is of the more basic varieties. The acidic phases of the granite are like the granites E. of Crystal Falls.

N. of the granite range is a flat without exposure, and N. of that is a ridge upon which are numerous test pits. In the pits farthest E. are the black slates. N. of these is the usual ferruginous chert ore formation containing chert ore, and in the most westerly pit were found a peculiar conglomer-

25707 25708 25709

atic slate (25707), and chert breccia (708) and ferruginous chert (709). This succession is essentially the same as that seen on the Paint river N. of Crystal Falls, but in reverse order, as though on the opposite side of a fold.

We now drove S. to the S.W. part of 35-42-32, and followed the Paint river finding Brooks quartzite and mica-schist.

25710 25711

The first is a coarse micaceous quartz-schist, the fragmental character of which is quite unmistakable, and above this is typical mica-schist, containing othrelite crystals. These micaceous quartzites and mica-schists are identical with those of the Michigamme formation at Michigamme lake. The granite adjacent to Crystal Falls is wholly different from that of the Basement Complex, and all our observations confirm Brooks' conclusion that the mica-schist of this area and the granite are the youngest portion of the Upper Huronian.

We next went to near the center of the N.E. 1/4 of 19-42-32, where are exposed ferruginous black slates, which occasionally contain bands of chert, and a beautiful

25712 chert breccia. There were also phases of

25713 intermediate rock, which have a slaty
25714 matrix and numerous fragments of chert. At a first examination these have ~~the~~ strongly the appearance of a conglomerate, but a close examination shows that all of the fragments are angular, and that they are all of chert or slate, that is, there is no foreign material. The plastic character of the slate as compared with that of the chert leads to the conclusion that it is an autoclastic rock. The breccia is very similar to that seen N of Crystal Falls.

Tuesday, July 16.

Drove from Randville to Felch Mt. Again examined the locality at which the granite dike cuts the iron formation.

Photos 1181-2 Looking NE at granite dike from distance of 35 ft. Breadth of granite dike about 15 ft.

We again examined the pits of the old Felch Mt. mine, and in one of them
25715 found a quartzite or quartz-schist, which may represent the Upper Huronian.

We next drove to 3 miles N of Felch Mt. to ~~Ford~~ Sturgeon river, at the old logging dam. Here the great conglomerate which was once visited before was again examined, and

found to grade as before described both longitudinally and transversely into a rock which
25716-7 in every respect resembles a gneiss. The
25718-9 conglomerate contains granite, white quartz, quartzite, gray black, and white cherty and ferruginous pebbles. The conglomerate is much sheared, and the pebbles elongated in a common direction. In many cases they have pressed against and distorted one another. The belts of conglomerate are arranged very nearly parallel with the schistosity. They vary in width from a few inches to 15 or 20 ft. Many of the narrower belts have oval terminations. The conglomerate also has a peculiar cross structure, which resembles much sheared false bedding.

Photos 1183-4 Represent the ordinary varieties of the conglomerate.

Photos 1185-6 Represent the cross structure, possibly false bedding sheared into lenticular areas, and

Photos 1189-90 Represent alternations of the conglomerate with the gneissoid phases, as well as the dying out of one belt of the conglomerate.

The schist-conglomerate and gneiss are intruded by a basic eruptive in a most complex way. At the N is the great mass

of basic eruptive. Within the belt of conglomerate and gneiss are several bands of basic eruptive which roughly follow the conglomerate bands, but which cut across them in a minor way. Within the main mass of the greenstone are considerable areas of conglomerate, which may be connected below with the main area, but one of these appears to be a mass within the greenstone. At the contact of the main mass of greenstone and the conglomerate there are numerous interlaminations of the two, the greenstone having intruded the gneiss parallel to its layers or schistosity. At one place a dozen alternations of the two were seen within a foot. Moreover, for some distance from the greenstone the gneiss and conglomerate seem to be impregnated with the material from the greenstone, so that it has a greenish color. This impregnation at one place has gone so far as to apparently make a greenstone matrix which contains separate pebbles from the conglomerate, the matrix of the conglomerate being apparently absorbed by the greenstone, but the more resistant pebbles resisting and floating around in the magma

The greenstone adjacent to the conglomerate also has fine pegmatite veins running through it in various directions, some of the widest of these being 2 inches in diameter. There was no evidence of an independent granitic intrusion, but the pegmatite veins appear clearly to be the result of an inter-action between the basic igneous rock and the more acid fragmental rock. At one place along the contact of the fragmental and igneous rock there is a belt of very coarse hornblendic material, which is cut through and through by the pegmatite veins.

25720 Normal greenstone.

25721 Very coarse hornblendic material adjacent to gneiss through which are reticulating pegmatite veins.

25722 Edge of gneiss in contact with preceding, containing small pegmatite veins.

25723 Gneiss at distance of about 2 ft. from previous one, showing gray color, which is probably due to the impregnation of the basic material.

25724 } Spec. of the greenstone which contain
5 } 6 } 7 } inabsorbed pebbles from the conglomerate.

Photos 1187-8 Interlaminations of gneiss and greenstone, where there is intricate parallel intrusion.

Photo-1188 A The greenstone containing pebbles from the conglomerate.

The above case is one of the most complex cases of intrusion which has come under my notice. It is of very great interest because of the decided contact effects upon the fragmental rock, as well as upon the igneous one. Also the inter-action of the two rocks, producing small pegmatite or graphite veins is of very great interest. The injection of the igneous rock was before the last strong folding, since the schistosity of the greenstone and of the gneiss and conglomerate are parallel.

Ishpeming, July 17.

Took a walk over the Ishpeming area, and picked up one or two specimens of interest.

25728-9. Folded and faulted jasper from the old Cleveland mine, showing shearing of original iron and the granular character of secondary iron which has filled the cre-

vies parallel with and cutting the original banding.

25730-1. Peculiar specular hematite, showing ridging on sheared surface which in cross section is shown to be due to minute displacements.

Drove to Summit Mt., and walked S. and N. into the Palmer gneiss. Here, on the E. side of a little cross valley some distance back into the Palmer gneiss, is
25732-3 a sheared conglomeratic quartzite, which seems beyond question to be fragmental. This quartzite grades downward into the sheared white granite, and it is impossible to get the exact point of junction. This is one of the best cases of the transition seen in many places in the Marquette district of the crystalline grading up into the fragmental rock. This narrow belt of quartzite, which extends off perhaps 100 paces, and then apparently dies out, is doubtless due to a subordinate fold, by which the lower quartzite is infolded in the Palmer gneiss, exactly the same as it is north of Clarkstung.

Marquette, July 15.

Walked S.W. to the N.E. cor. of 33; then walked along the base of the hill which is in the N part of 33-34 - the purpose being to re-examine the slate and conglomerate at this locality, in order to discover if possible their true relations.

At the base is a sericitic schistose quartzite, which passes up into a sericitic slate or graywacke, and this is immediately below the conglomerate. The conglomerate is from 6 to 30 or 40 ft. thick, and it grades up into the ordinary vitreous Mesnard quartzite. The conglomerate contains very numerous fragments of white quartz and cherty quartz, and of ferruginous pebbles, and the matrix is also heavily impregnated with secondary ferruginous material. Besides these pebbles there are less frequent pebbles of sericitic slate or quartz-schist, identical in character with the slates and schists immediately subjacent.

At the contact of the slate and conglomerate there is always evidence of movement. Sometimes there is a considerable crack between the two, so that on the face of the cliff the slate falls down. At other times both the slate and the quartzite have slicken-

sided surfaces, and in other instances there is vein quartz along the contact. In one place this vein quartz and slate vary from a few inches to 15 inches thick. In a number of places there are interlaminations of the vein quartz and the slate. The vein quartz is impregnated with iron oxide, exactly as is the conglomerate. At various places the conglomerate immediately adjacent to the contact seems almost like a breccia, as though the conglomerate had been broken again by dynamic action, and in this narrow belt of conglomerate the most of the sericitic slate and schist pebbles are contained. At one or two places the ~~conglomerate~~ slate at the contact is finely fissile, showing the most intense interior movement. Everywhere at the contact between the slate and the conglomerate the two appear to be in complete unconformity.

It was concluded as a result of the examination that the conglomerate is an intraformational one, and that the slates and sericitic quartzites and sericitic quartz schist below are simply a downward continuation of the Mesnard formation. It is believed that many of the slate and sericitic

quartz pebbles are due to dynamic action near the contact plane, but some of the larger pebbles are apparently

and it appears further that the lower part of the formation was compacted, rose above the water locally, and yielded fragments to the conglomerate, the phenomena being in all respects like those described by Walcott in his intraformational conglomerates. It is further to be noticed that the material of the lower formation is everywhere argillaceous that is, was material which would be readily compacted into a rock and yield fragments to an overlying formation, without any considerable time gap. The chert and jasper fragments are explained by the veins of chert and jasper which are found in the green-schists in the immediate vicinity of Marquette. These have been known for a long time to occur at Michigan St., and were this morning found at a projecting point along the lake immediately S. of the Hotel Marquette.

The following specimens were taken:-

25734 Sericite quartz-schist, the northernmost rock along the hill.

25735 Graywacke-slate immediately in contact with conglomerate.

25736 Fissile slate at contact.

25737 Contact specimen of slate and conglomerate, showing by bending folia the differential movements between the two, and also showing a vein of iron oxide at the contact.

25738 Brecciated conglomerate containing many pebbles of slate immediately at the contact.

25739 Another contact specimen of conglomerate showing a much bent slate pebble.

25740 Conglomerate containing pebble of quartz which has something of a granular appearance, as though it were a quartzite.

25741-2 Sericitic quartz-schist pebbles like sericitic quartz-schist below, which are rather well rounded.

25743 Quartz pebble which has somewhat of a quartzitic appearance.

25744 Pebble showing crystals of secondary oxide of iron, and illustrating manner of iron impregnation of pebbles, as a consequence of which many of them appear at first sight to have been derived from the iron formation.

25745 Chips from pebbles of conglomerate.

25746 Quartzite immediately above the conglomerate, about 8 or 10 ft from the slate.

25747 Chert and jasper from a vein in Mona schist at point immediately S. of Hotel Marquette.

25748 Jasper from vein at same place.

North Shore, July 19-23.

At a point near Split Rock River the anorthosite and diabase were seen to have the same relations as at Beaver Bay, and between Beaver Bay and the palisades. Great Blocks of anorthosite were seen in the diabase, and at one locality the anorthosite was seen to dome up over the diabase for a distance of 20 or 30 ft. This case of the anorthosite passing over the diabase is on a much greater scale than the inverse relation at Beaver Bay illustrated by Lawson.

All of the facts observed at Split Rock River, Beaver Bay, and vicinity would seem to be best explained by regarding all of the anorthosite masses as inclusions intruded in a complex manner by the diabase. The magnitude of the inclusions, although great, would not approach the quartzite inclusions described by Cross in the granite of the Cripple Creek country.

P. H. McGarry, Manager,

NORTHWESTERN HOTEL COMPANY.

Virginia, Minn., ______________189

~~North side~~ ~~South~~ South side of body

~~Leone Jack cut~~ S N 70° W

Dip 50 south. ~~E~~ Slight pitch west

South side of body Oliver

dip 25° Ethel South

Pitch at Oliver OD 8°

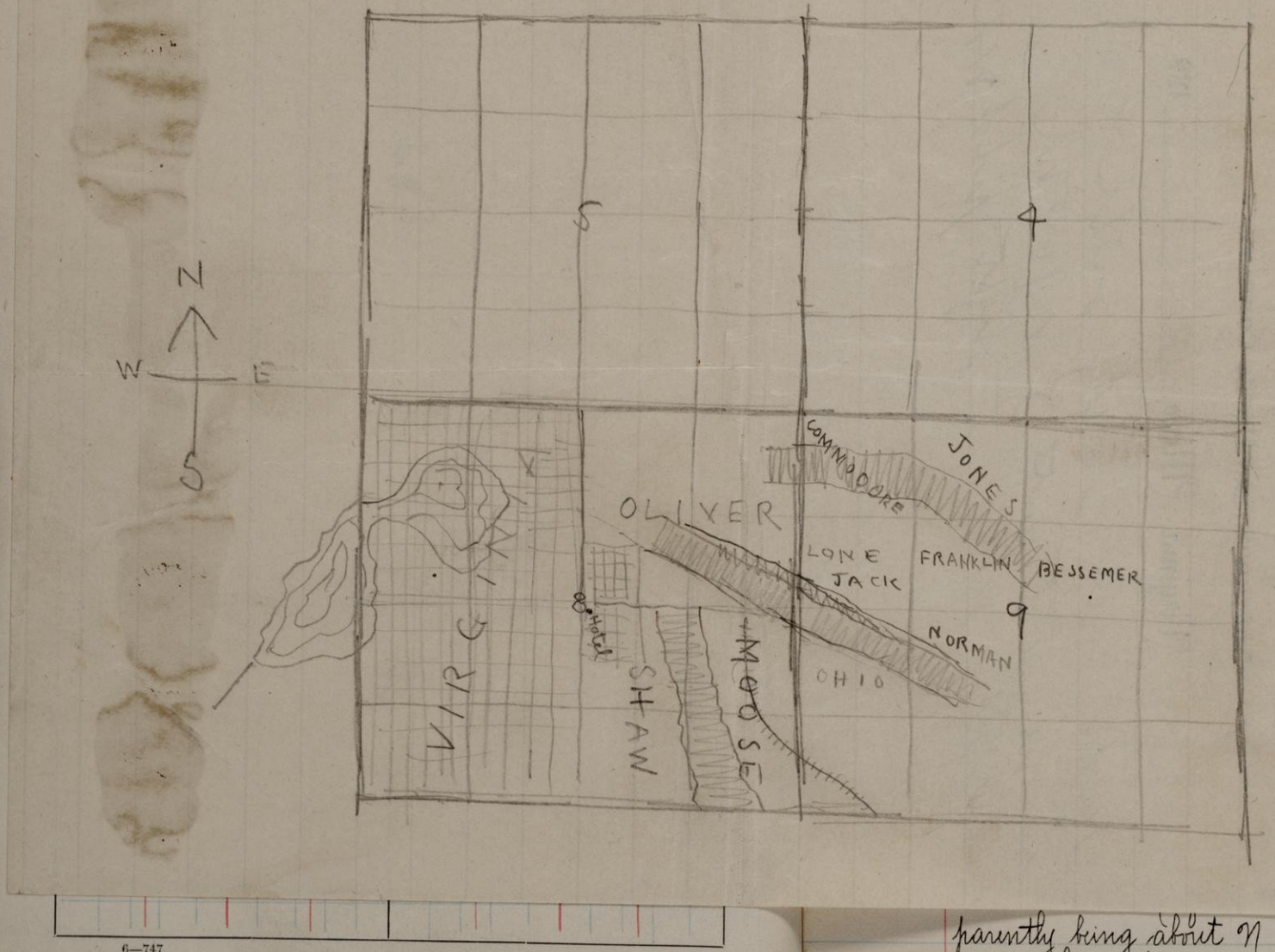
S.

T.

R.

6—747

S. T. R.



6—747

Mesabi Range, July 24-5.

e spent in the
ity of Biwabic, Vir-

e great open pits
e to the conclusion
ore sufficiently ex-
se pitching synclinal
n at the Mountain
the sides of the through
ginia area is very
ict, the conjoint
neral westward pitching
'any E-W and N-S
odys consisting of the
and Oliver, is a
'itching trough. This
and is sharp fold
In the great open
cation of the Lone Jack,
ip on the N side
n the N side of the
. The pitch is
strike of the pit ap-
parently being about N 70 W. At the Norman
mine the dips are even steeper than indicated.

Mesabi Range, July 24-5.

The 24 and 25th were spent in the Mesabi area in the vicinity of Biwabic, Virginia, and Mt. Iron.

An examination of the great open pits at these localities lead me to the conclusion that all of them which were sufficiently exposed to determine this are pitching synclinal troughs. The dip was clear at the Mountain Iron, although the pitch on the ends of the trough was slight. The entire Virginia area is very plainly a cross folded district, the component effect being to make a general westward pitching trough, composed of secondary E-W and N-S troughs. The great ore body consisting of the Norman, Lone Jack, Ohio and Oliver, is a perfectly clear case of a pitching trough. This trough has a steep pitch and a sharp fold at the Norman mine. In the great open pit made by the combination of the Lone Jack, Ohio and Oliver, the dip on the N side of the pit is 50° S. On the N. side of the pit the dip is 75° to the N. The pitch is there 0 to 8° N of W, the strike of the pit apparently being about N 70 W. At the Norman mine the dips are even steeper than indicated.

At the Auburn the strike of the pit is about N. 45 W. The rock dips to the N.E. at from 10° to 20°. The pitch of the rock is to the N.W. 20° or 30°. By the Captain, the pit is said to be on the S. side of the deposit, and that the main body lies to the N., and that on this side the dip is in the opposite direction. If this is true, the Auburn is as clearly a pitching trough as the large deposit at Virginia. At the Biwabic the developments were not sufficient to show the character of the larger folding, although minor folds were seen.

On examination of the members mapped shows that wherever large deposits of ore have been discovered, there is a northward swing to the pre-Mesabi rocks. These in all probability indicate southward pitching synclinal troughs and thus confirm the observations made at the individual mines.

As yet the developments have not gone far enough to ascertain whether or not there is a relatively impervious basement, but if this found the ore deposits of the Mesabi will conform in every respect to the general laws laid out for the remainder of the Lake Superior region; that is they will be in places (1) where there are pitching troughs, (2) where there

is minor folding, and therefore brecciation of the formation, and (3) where a relatively impervious basement exists.

For the most part the country rock adjacent to the ore is ~~also~~ ferruginous chert, identical in its variations and types with the ferruginous chert of the Penokee area. For the most part the ore deposits have been found at the surface, and as yet have not been traced under the ferruginous chert. At the Lone Jack, however, there is on one part of the pit a capping of the ferruginous chert. This shows that at least in some places the ore bodies do underlie the lean rock.

The original taconyte of Spurr was sought for, but with indifferent success. At one locality N.W. of the Norman mine, between this and the belt in which are the Jones, Franklin, and Bessemer mines, is an outcrop of
25749 greenish lean magnetic rock which is believed to contain some carbonate, and possibly also some glauconite

In a test pit N.E. of the Norman was also
25750 found a greenish magnetic rock, which may contain glauconite

25751 The quartzite was found only at one locality in a test pit N. of the Mountain Iron.

This quartzite is identical in its character with that underlying the ore formation of the Penokee district.

The green-schists were seen in a peculiar cut on the Ry. between Virginia and McKinley, but no stop was made. A traverse N from Biwabic showed numerous exposures of green-schist which are in every respect similar to those of the Basement Complex of the Marquette and Menominee districts. By their appearance, spheroidal weathering and other characteristics, they clearly appear to be altered volcanics.

25752 was taken from the first exposure immediately N. of the Biwabic.

Aug. 5, 1895.

Work in company with Merrill about Manhattan Island and vicinity.

We followed one of the limestone belts on the Harlem RR from N. Y. City to Pawling. (Clove shut.) (See geol. maps of region viz Dana, Walcott + Merrill).

From Pawling drove NW out of the limestone areas across a ridge of schist to the limestone again. The limestone here forms a little basin in the schist and at the eastern dipping contact of the schist and limestone limonite ore occurs. While the ore body was not closely examined, its position suggests that it was a secondary concentration in a pitching trough. The open pit is now filled with water. The body of ore is above the schist and overlain by limestone, but this is believed by Merrill to be due to overturn.

After leaving the basin of limestone we drove NW to the contact between the schist and gneiss.

V5753 The schist is here a coarse micaceous rock, which sharply contrasts in appearance

7574 with the finely laminated gneiss.

This gneiss grades into a more massive rock having a decided granitic character, but it always has a rift parallel to the schistosity of the region.

We drove across the gneissoid granite tongue to the large bluff S of Poughquag,
7575 where a large outcrop of quartzite occurs. This quartzite is beautifully exposed in the R.R. cut. While much broken and traversed by joints, and apparently so sheared that all the original grains are fractured, it still distinctly shows bedding by layers of different character.

We drove on to Poughquag and then S. On the way we saw beautiful exposures of
7576 the Poughquag limestone. After the limestone was passed, before the granite was reached, the quartzite or quartz-schist was again passed.

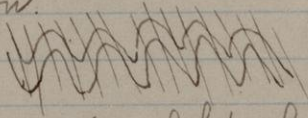
7577 Near the granite the quartzite (57) apparently shows fragmental grains ~~of~~ or cores of grains. The absence of the quartzite and limestone E. of the Stone House schist is explained by Merrill as due to overlapping.

The dips of the schistosity so far as noted during the day were all to the E.

Whether the quartzite would show dips in another direction was not noted, ~~for~~ but flat isoclinal minor folds dipping E were seen on the E side of the quartzite hill.

Aug. 6.

We drove from Pawling S on the road which runs along the schist ridge at the W side of the valley. For the most part it is near the contact of the schist and limestone. At one place a long spur of schist (R5758) was seen to project S into the limestone, but if there is but one schist the limestone between must be an anticline. On the spur of schist were seen numerous minor overturned folds dipping E. What was supposed to be bedding was marked by the difference in weathering and in quartz lenses. Across this the schistosity runs in a parallel direction.



The minor folds have a southern pitch, and clearly show by their distribution across a complexly folded district.

We crossed the S end of the great ridge of schist to Reynoldsville. At the S end of the ridge the minor flexures to the eastward cutting schistosity were beautifully shown by the differential weathering and by the quartz veins.

We now drove from the last village and took first road E, where the schist and gneiss are again close to each other. Between the two there is a sharp contrast.

X5759 Crinkled schist near gneiss, showing large crystals of mica, with cleavage across foliation statically developed.

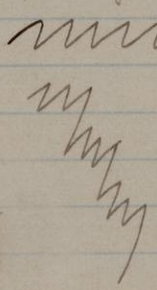
X5760 Another phase of schist at the same place.

Returning to main road and turning N a little way the schist and gneiss are found within 4 ft. of each other.

X5761 The gneiss is finely foliated, and mica has developed along parting planes.

X5762 The schist again shows finely numerous eastward dipping isoclinal folds. When the folds are so numerous and so symmetrical, it seems as though the pressure must

have been normal. When the minor plications have longer limbs in one direction than in another, the pressure must be inclined to the shearing planes.



We next drove to the RR cut S.E. of Whaley Pond, and here the granite is but slightly gneissic. It is, however, similar in essential character with the gneissoid granite near the contact, and there can be no doubt that they are phases of the same rock.

r5763
r5761

We now drove back to Reynoldsville and then N.W. a short distance to the road going S. which was followed to the road running E. to Patterson, when the latter course was taken. The granite S. of Reynoldsville is very massive. The break from the lower lying rounded granitic topography to the much more rugged topography of the schist is as usual a distinctly marked one. The schist just E. of

25764 the granite again shows corrugations, filled by quartz-veins, the two being cut across by the schistosity. It appears that openings must have formed parallel to the bedding just as there do between the leaves of a book, when pressed at right angles to themselves. This must have been subsequently followed by the secondary quartz. We now drove to Patterson, then to the E side of the level limestone valley, then N and NW. to Pawling.

In the afternoon took train to Buster, and drove to the Tilly Foster mine. The ore is here magnetite in the gneiss at a place where there has been intricate folding, fracture and faulting. While the mine was not closely examined, the impression was received that the magnetite is a secondary concentration at an area of exceptional disturbance. In the evening returned to N Y City.

Aug. 7

Went by train up Hudson to point about 2 miles S of Sing Sing. Here we found the gneiss cut by granite, and also injected parallel to the foliation. Since the injection the rock has been folded, and this gives it an intricate structure. In all respects, as could be remembered, this rock is like the gneiss N of NY City, examined in the spring, and called Fordham. We walked nearly across a gap with no exposures and came upon the typical Manhattan schist, which however is considerably injected by granite veins. Near Sparta, S of Sing Sing at the RR cut is a narrow exposure of gneiss injected by granite, which is flanked on both sides by quartzite, and this again by limestone, and the latter by schist. It is plainly an anticline with eastward dipping axial planes, overturned as usual, so that on the N side of the exposure the quartzite dips under the gneiss and granite.

25765

At the N the actual contact between the gneiss and quartzite is seen. There is from 4 to 6 inches of selvage due to slipping at the contact plane, and on one side

is gneiss and upon the other is quartzite. No evidence of conglomerate was found.

r5766 Quartzite SEe of the gneiss.

r5767 Gneiss at contact immediately adjacent to selvage.

r5768 Quartzite adjacent to selvage.

r5769 Quartzite 4 inches N.

The quartzite and limestone to the SEe. are thin. Those to the N are thick, or at least broad in exposure. But in this quartzite numerous minor folds are seen, and these doubtless occur also in the limestone. The quartzite to the NW is cut by a coarse pegmatite and granite veins several feet in width. The Sing Sing limestone is cut by dikes of granite, the thicker ones of which are coarse. Also in the limestone are considerable masses of granite presumably intrusive.

r5770 Granite from mass in limestone.

In the afternoon took the train from Sing Sing to Peekskill.

25771 Garnetiferous schist of Peekskill.

N of Peekskill the coarse granitoid gneiss again appears, and to the N of it are again found the quartzite, limestone, and schist, these rocks making the depression of Peekskill creek. The actual contact between the gneiss and quartzite is again found on the S side of the inlet, and the contact is in all respects like that N of Sing Sing.

Going up Peekskill Hollow creek for a little way, the schist is found to be a finely fissile mica slate with sheeny sides, but with no coarse crystals of mica. It is much less metamorphosed here than at any place before seen in SE N.Y. The limestone bed which appears along the creek is ordinary blue limestone, somewhat crystalline but wholly different in appearance from the white crystalline limestone seen elsewhere in the region. This limestone, however, appears to be continuous with the coarse limestone of Peekskill creek.

On the S side of the gneissoid granite

mass N of Peekskill the limestone and schist only were seen.

Aug. 8

Took train from N.Y. to Pelham. Walked to New Rochelle and took boat to examine the exposures on the Sound.

We found the entire district much injected by granite. The granite is interlaminated with the schist, sometimes very closely, a series of interleddings or injections occurring within a few inches. Parallel injections are so close in places as to make the rock a banded gneiss. In other places the parallel bands of granite are widely varying up to several feet across. Some large ledges are composed wholly of granite, others of schist. As the granite is more resistant, it is probable that the proportion of schist is greater than appears at first thought. While certain exposures simulate in a remarkable degree the Fordham gneiss, it still appears to me, on account of the abundance of the mica and the

minute laminations of the rock that the area belongs to the Manhattan rather than Fordham. The Fordham has a certain density like a sheared granite which the Manhattan lacks. If the rock is truly Manhattan, this is one of the most remarkable cases known of metamorphism and injection combined.

Road on Ry from N.Y. to New Haven, and at New Haven examined the schist on the N side of the bay. For the entire distance between the 2 cities the schist appears to constitute the country rock, but if so it is injected in the most complex manner by the granite. For considerable distances the granite appears to occupy nearly the entire country. On the N side of Haven Bay the schist is finely fissile (Dana's hydromica slate). The schistosity is nearly flat. On the E side of the Bay granite is the only rock found for some distance. The Triassic sandstone and trap occupy the center of the bay.

The time between Aug. 9 and Aug. 20 was spent with Hobbs alone, and with Hobbs, Dale and Emerson in studying the general structure of the Sheffield and Cornwall sheets, and when Dale and Emerson were with us especially the northern part of the Sheffield sheet. As Hobbs has detailed notes and specimens of the different localities, notes were not taken.

Aug. 20, 1895

With Emerson visited localities about Hinsdale and Dalton

R577 At Hinsdale on the RR track apparently above the limestone is gneiss, called East Lee gneiss by Emerson. Its apparent position over the limestone is due to overturn according to him. The gneiss is regularly banded, the bands being dark and pink. The bands in the specimen are thin, but in the exposures are often coarse. The gneiss could not be discriminated from the Lake Superior banded and injected gneiss, but is regarded by Emerson as

a metamorphosed sediment.

r5773 r5774 Hinsdale gneiss E. of r5771. and in contact with limestone. Its present position due to overturn.

r5774 Hinsdale limestone. R.R. sta. at Hinsdale

r5775 Hinddale gneiss - center of core N of Hinsdale. Cleavage surface of feldspar is curved and its exterior granulated. In the Hinsdale gneiss are black bands of hornblendic and garnetiferous gneiss, which Emerson supposes to be metamorphosed sediment. Upon account of the regularity of the bands I would take the same to be r57 eruptive, and to this possibility Emerson agreed.

r5776 Becket gneiss. Cambrian. From Club House section. Dalton-Hinsdale line.

r5777 Washington gneiss. Dalton Club House section. The normal gneiss is the black phase, but it contains everywhere heavy or narrow veins which are composed largely of blue quartz. This gneiss is at the crown of a narrow anticline. The strike

of the schistosity is E + N. approximately. The anticline is flanked on both sides by
25778 Cambrian conglomerate - bearing numerous pebbles, some of them 4-5 inches long. In places they are much sheared, so much so as to be entirely destroyed. The pebbles of the conglomerate are often surrounded by tourmaline crystals. The conglomerate as shown by the bands on the E side of the gneiss, strikes N + S, and runs across the structure of the gneiss. The quartz of the Washington gneiss is probably the source of the pebbles. Some of the pebbles which are not granulated show a blue color, showing that they have been probably derived from the blue quartz bands of the underlying formation.

25779 Allanite-bearing gneiss. Probably Washington gneiss. In Dalton Brook. 10 rods N of brook contact of the Cambrian.

A short distance down the brook from above and only a few feet from the gneiss, the Cambrian conglomerate again appears, and about 10 rods farther down the stream, perhaps 100 ft. in section above the conglomer-

-ate, comes typical tourmaline-bearing
R5780 Laurian (Becket) gneiss

R5781 Hoosac schist at Dalton, opposite Brown
Bros. Mills. In exposure it shows curious
crinkling & with cross-schistosity. In these
respects and in general appearance this
schist very closely resembles the Berkshire
schist.

The few days following Aug. 20 were spent
on an excursion with Emerson at various
points in western Mass.

Johnson City, Tenn., Sept. 9, 1895.

Road S.W. 3 miles, then up creek which supplies the city with water.

Along the drive S.W. and also E. after turning S.E. the heavy beds of Knox dolomite were observed. They dip at angles perhaps averaging from 45°-60° into the mountain, that is to the S.E. After the gorge was entered after passing the Knox there were seen several outcrops of black finely fissile graphitic or carbonaceous and pyritiferous shale. Above this follow heavy beds of quartzite. (Keith's Cities) In the stream this quartzite is perfectly vitreous and on the slopes of the mountain the cement disintegrates and the quartz grains protrude, giving the rock the appearance of a sandstone. This is clearly due to weathering. The quartzite appears to be quite conformable with the shale. In passing up towards the cove the dip of the quartzite passes from high 70° to 45° or less. As a rule the dips are lower up near the cove than lower down the stream, indicating a possible approach to the trough of a syncline. In the higher parts of the

V578V

section before the cove is reached the quartzite becomes interbedded with graywacke and slaty phases. By the time the cove is reached the rock is distinctly a slaty quartzite or graywacke. In the gently flowing part of the stream in the cove, a rock has disintegrated into a red clay. This may be derived from the limestone but no solid limestone ledge was found. Just at the edge of the cove the slate is a good deal weathered.

7583 represents a quartzitic phase of the altered rock.

On the S side of the cove a fine grained conglomeratic rock is found.

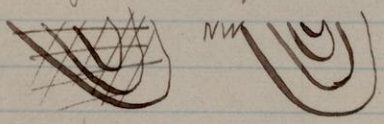
7584 A fragment of conglomerate taken from a boulder. No reason was seen for putting a strip of Cambrian sandstone S of the limestone, as is apparently done on Keith's preliminary maps.

We now returned to the main road and went around NE end of mountain to SE side. From little past Okolona we went SW up creek to contact of the Citico and limestone. Found the two a short

distance from each other, and apparently conformable. Both seemed to be dipping at about 80° SE suggesting that locally at least this side of the synclinal is overturned.

In going up the cove in the ~~afternoon~~ forenoon, where the Lecco came in beyond the cove, it dips to the SE.

Synclinal perhaps of this form:-



Returning toward Johnson City we went up creek at contact of Lecco and limestone at NE end of mountain. Found limestone along NW bank of the creek on the side streams and on the other side, and also in the main creek itself after it turned to the SW found only fragments of Lecco. At both places the Lecco was weathered, but have no doubt that if fresh it would show it would show the bitheous quartzite characters of the morning.

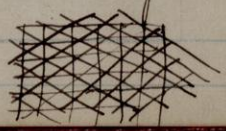
Nowhere during the day did I see any fragments or ledges of the

quartzite which were strongly sheared. The sandstone and conglomerate have been almost perfectly indurated by the cementation process, so far as microscopical appearances can judge. The microscope may show dynamic effects.

The limestone on the road NE of the end of the mountain has a gentle but persistent pitch to the SW. There can be little doubt that the knoll is in a great westward plunging synclinal, and from my observation today I would suppose the latter to be a quartzite in normal position above it.

The weathering appearance had remarkable structure in the knoll at various places, the rock having been fractured through and through and re-cemented.

25785 shows a very common structure. One structure is the parting; another fracture has occurred almost at right angles to this, and across this, forming chunks, are two parallel sets of fractures, thus:-



Continued Book 185