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U.S. Geological Survey: lithological descriptions: white quartzites, cherts and limestones and rocks intermediate between the above and the chloritic and siliceous states. Book VI 1885/1886

Geological Survey (U.S.); Van Hise, Charles Richard, 1857-1918
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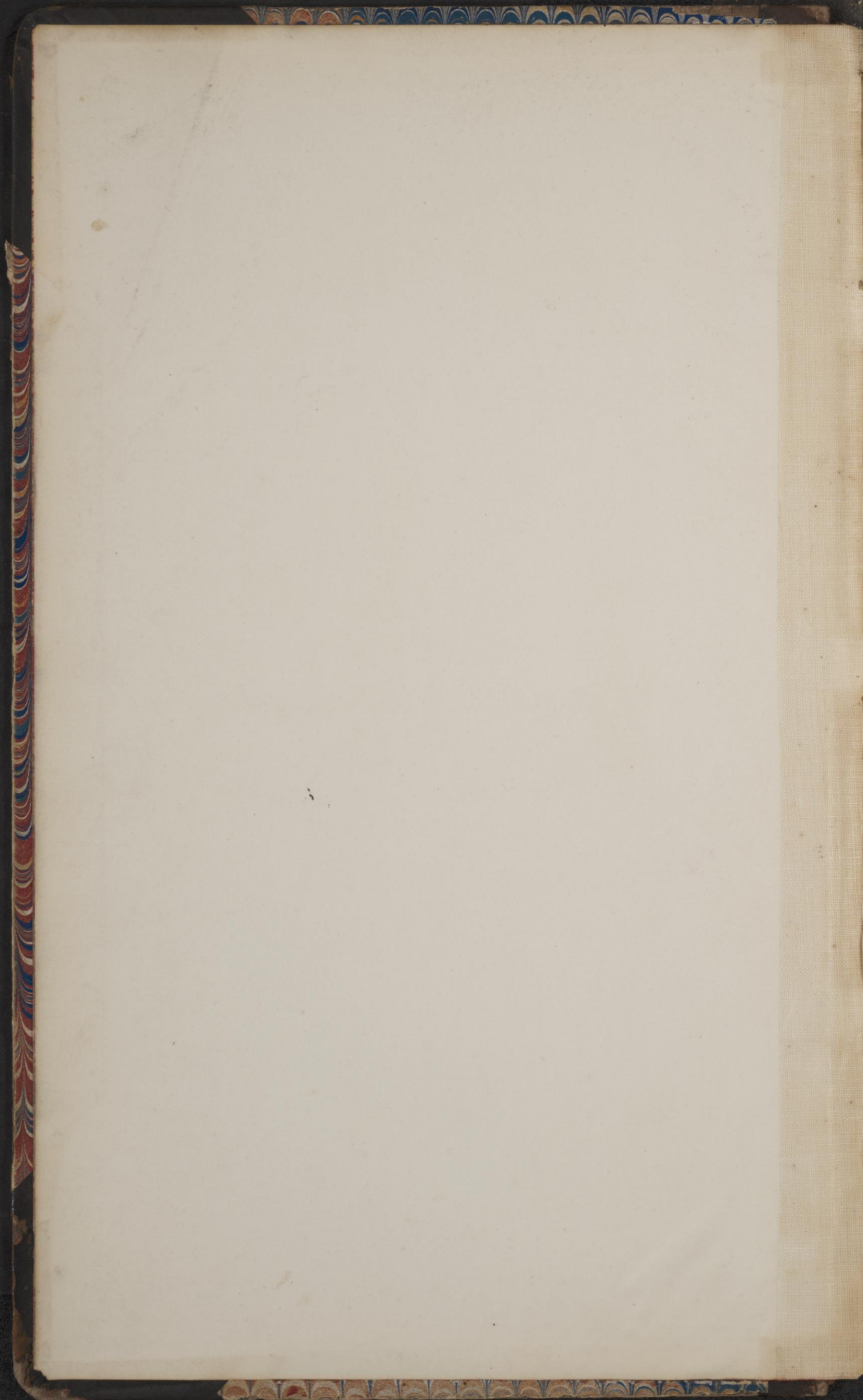
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U. S. Geological Survey

Lithological Descriptions.

Book ~~V~~ VI

Penobscot Iron Group.

Penobscot Gap

Boxes	Specimens 1885
130	9559
128	58
127	57
	56
	67
	52
	53
	54
	55

Vis. Berl. Sm. Spec.
1500
1445
1502
1501
1461-4530 m.s.
1458
1451
1403
1452
1404
1444

West of Penobscot Gap

Box	Specimens
129	9641
	42
	49
	50
	51
	52
129	79
	80
	9681
	82
	84
	92
	96
	97
	98

East of Penobscot Gap

Spec. 1885	Spec. 1884	Vis. Berl. Sm. Spec.
9617	7617	2045
18	19	2057
19	13	2049
20	10	2059 1/2
21	24	2060
22	22	2064
23	06	2061
24	04	2081
25	01	
26	00	
9081	7599	
9104	96	
85	90	
86	92	
87	90	
88	67	
89	66	
90	65	
91	64	
92	69	
93	70	
94	71	
95	73	
96	52	
97	51	
98	50	
99	47	
100	48	
101	49	
102	50	
103	26	
104	27	
105	28	
106		
107		
108		
109		
110		
111		
9395		

(2)

Marquette and Munroville

Irving	Rominger	Don Hise
4102	6242	6637
03	6316	40
05-	6353-	41
08		43
09		49
11		57
12		70
14		78
17		79
20		80
22		84
50		94
52		6702
87		03✓
89		06
93		10✓
96		12✓
98		14✓
99		16✓
4200✓		
16-		
17		
18		
19		
20		
21		
22		
24		
38		
39		
40		
71		
43		
63		
69		
70		
73		
81		
85-		
92		
91		

Mesabi Range and Confluent

Chambers	Irving	Merriam
6097✓	6772✓	10163
6100✓	74✓	65-
02✓	75✓	57
03✓	76✓	58
046✓	83✓	59
15✓	6860✓	60
6134	61✓	61
38✓	62✓	62
42✓	6787✓	64
44✓	89	66
87	78	68
7003	1675✓	69
04✓	28✓	70
07✓	81	72
08✓	82	8599
09✓		98
11✓		996
12✓		99
13		94
29✓		93
7118✓		
23✓		
20✓		
21✓		
22✓		
24✓		
7052✓		

see appendix

(3)

Babbro Iron Rocks

Chauvenet

6015
2016
18
21
22
24
36
38
40
44
45
51
48

7052

46
49
50
53
18
61
59
60

7115

Merriam

8728
81
82
8868
67
8900

Vermillion Lake

Chester

3103
10
13
24
27
38
41
42
54
59
62
68

Partly Merriam

Irving

8565
66
98
8600
02
40
41
14
15
16
17
20
21
22
23
24
25
26

8747
28
29
30
31
32
33
34
35
36
9737
39
57
8611
8574
9768
70
8601

Merriam

10009
11
29
19
10354
10144
45
8751
10339
41
42

Inguette's Memoir. in notes - p. 157

H. S. Memoir. In Notes - 171

Notes of H. S. Memoir. Chaumont 199

White Quartzites, Cherts and Limestones
and rocks intermediate between the above
and the Chloritic and Siliceous Slates.

9418

Cherty Conglomerate.

9419

C. R. Van Hise.

Macroscopic Description.

Both 2250.

75 W. N. 1/4 S. fine grained, dark green material, resembling a Sec. 14, T. 47, chloritic or mica schist. In this matrix are buried R. 45 1/2, Mich very plentiful rounded fragments of translucent opaline. Chert in sizes varying from three-fourths of an inch in diameter to those so small as to be lost in the matrix.

Microscopic Description.

The matrix is a siliceous slate. It is mostly composed of a mixture of rather small clastic particles of quartz and feldspar, there being but little of the latter, mingled with a somewhat plentiful interstitial material. Quite a good many of the clastic quartz grains are finely complex and are then of the same composition as the pebbles, only they are of less magnitude. The quartz grains as usual are enlarged. Scattered through the section are plentiful small flakes of white mica, muscovite, or sericite.

The interstitial substances are chiefly cherty and amorphous silica and chlorite, both being very plentiful. Mingled with these materials are quite a quantity of limonite and a little kaolin. The quantity of purely amorphous silica is greater than in any section previously described. In some cases quite large areas of this silica including more or less fine brown ferrite, grains of quartz and flinty silica, are seen. Incipient crystallization shows itself in a few faint specks and flakes which transmit light with crossed nicols. Grains of quartz included in this silica are often widely enlarged. The pebbles seen macroscopically are simply pure crypto-crystalline silica, of variety flint.

9390

7557a ✓

9390 from

Sec. 17-47-44N.

Mich.

Microscopic Description.

7557a from

13-47-46N, Mich.

There rocks in thin sections are exactly alike. 7557A is briefly described in Book IV, p. 71. The coarser parts comprise, besides quartz and plagioclase, orthoclase. In 9390 the quantity of fragmental quartz which is finely complex or cherty, is considerably greater than in 7557a. Flakes of sericite are also seen in it. The interstitial material of the two slides is chiefly cherty quartz, chlorite and ferrite, kaolin not being plentifully present.

9388

Chloritic Schist.

C. R. Van Hise, 1885.

17-47-44N, Mich.

Macroscopic Description.

The hand specimen varies from a finely laminated, green lustrous schist to a purple or black compact rock approaching a quartzite.

Microscopic Description.

In the thin section fragmental grains of quartz compose two thirds of the mass of the rock. These fragments are small angular and frequently enlarged. Many of them, perhaps one-fourth, are finely complex, i. e. fragments of flint. Aside from these very finely complex grains there are a few coarsely complex ones. A few of the flint fragments are very large, and in many cases the flint is intimately mingled with an aggregate of chlorite. The chlorite is at times so plentiful as, in plain light, to give these entire areas the appearance of an aggregate of chlorite. The large quantity of interstitial material is an intimate mixture of chlorite and flinty silica mingled with ferrite.

9411

Flinty Ferruginous Quartzite or Greywacke.

C. R. Van Hise. 1885.

17-47-44 N,

Mich.

Macroscopic Description

The specimen is a compact, medium grained, dark gray rock with sub-conchoidal fractures.

Microscopic Description.

Fragmental quartz and feldspar make up the mass of the rock. The grains of quartz are widely enlarged and consequently they fit closely or inter-lock. This section differs from any previously described in the quantity of cherty fragmental material, at least a third of it being finely crystalline quartz mingled with much chlorite. Much of the feldspar is quite fresh. Upon the other hand a considerable quantity is partly or wholly altered to chlorite and replaced by quartz. Brown ferrite is plentiful as broad lines between the clastic cores and their enlargements and with chlorite in the interstices.

The peculiar relation of the flinty quartz and chlorite spoken of in 9389 also occurs in this rock and such areas, as there explained were probably occupied by feldspars.

9389

Flinty Ferruginous Quartzite or Schist.

C. R. Van Hise. 1885.

17-47-44 N,

Mich.

Macroscopic Description.

The rock is rather finely laminated, very ferruginous black one, showing in spots a reddish cast. Although black the specimen contains no magnetite.

Microscopic Description.

Fully two-thirds of the fragmental grains of quartz are finely complex. Many of these finely complex grains have a large quantity of chlorite mingled with the minute quartz individuals. This occurrence suggests the possibility that these areas were once those of feldspar and that this mineral has been decomposed and mostly leached out leaving

9389 (con.) only chlorite behind, the vacant space being occupied by infiltrated silica, which has separated out as flinty quartz. Other areas contain, mingled with the quartz and chlorite, a considerable quantity of kaolin, which still farther suggests the above alteration. There are also areas which are yet partly feldspar which are also partly composed of kaolin, chlorite, and quartz. There are present quite a number of grains of quite fresh fragmental feldspar. The simple grains of quartz are all distinctly and some of them widely enlarged.

In the interstices is very plentiful brown oxide of iron with a small quantity of fine quartz, chlorite and kaolin.

9410
17-47-44 N.,
Mich.

Flinty Ferruginous Quartzite.

C. R. Van Hise, 1885.

Macroscopic Description.

This rock is of a coarse uniform grain, vitreous, contains many grains of jaspery quartz and is colored black by iron oxide.

Microscopic Description

This rock is much coarser grained than 9389 and 9411 but is essentially like them. The simple quartz grains are enlarged. The pure complex ones are in part jasper fragments. There are also present many fragments which are intimate mixtures of chlorite, fine quartz, ferrite and sometimes plentiful kaolin; and these, as in 9389 and 9411 were probably clastic feldspar areas. Brown ferrite is very plentiful and some hematite is included in the jasper fragments.

9471Quartzite.

C. R. Van Hise. 1885.

14-47-45 N.

Macroscopic Description

Mich.

The rock is a rather coarse grained, strong, vitreous quartzite of a pinkish gray color. The matrix fractures somewhat easier than the quartz grains and as a result the broken surface is botryoidal. Scattered through the specimen are a few individuals of flinty quartz, one of them being a third of an inch in diameter.

Microscopic Description.

Coarse well rounded grains of quartz are buried in a fine interstitial material. These quartzes are mostly simple although some of them are coarsely and a few finely complex. Many of them are slightly enlarged and some of them beautifully show a very gradual merging into the fine matrix. The abundant filling material is chiefly finely crystalline and amorphous silica, but with it is a large quantity of kaolin, chlorite and limonite.

7502Clay Slates or Clay Shales.

C. R. Van Hise. 1885.

75037504Macroscopic Descriptions7504 a7505 a93919412

The specimens of 9391 and 9412 are fine grained and finely laminated. 9412 is gray in color while 9391 is reddish purple. Upon cleavage surfaces each shows the sheen of mica.

7502, 3, 4, 4a, 5a,

10-47-45 N,

Mich.

Microscopic Description.

9391 and 9412

17-47-44 N.

Mich.

The sections of 7502, 7503, 7504, 7504 a, and 7505 a are described in Book IV and 9391 and 9412 differ but little from them. They all contain small clastic particles of quartz and feldspar, the former of which are nearly always enlarged and the latter of which comprise the species orthoclase, oligoclase, and microcline. In no case, however, do these minerals compose more than half of the

7502 (con.) mass of the rocks, while in most cases they do not com-
7503 pose more than a third or a fourth of their mass.
7504 They are buried in exceedingly fine grained ground
7504a masses which are composed of finely crystalline or
7505a partly amorphous silica, of kaolin, of chlorite and
9391 of ferrite with quite plentiful flakes of sericite. The
9412 proportions of these substances vary, but generally
 all are plentifully present. In several of the sections
 the minerals of these clayey ground masses are a con-
 fused mixture, while in other cases each mineral or min-
 eral aggregate is well defined. In 7505a the aggre-
 gates of kaolin and areas of flinty quartz are distinct.

In those rocks which are strongly laminated,
 the coarser fragmental particles of quartz and feld-
 spar are largely concentrated in layers which in
 section are shown as bands.

7505 Described in Book IV.

4520

Sl. 1110

Quartzites.

C. R. Van Hise, 1885.

4534

Sl. 1465

Microscopic Description.

These slides have been re-examined and in
 4520 is from, them no proof of quartz enlargements found. Upon the
 14-44-3 W, contrary they both appear to be entirely originally crys-
 talline. What is said in reference to sericite in the
 4534 is from description of 9533 also applies to 4534, although not
 Mt. Whittelsey to so great a degree for the flakes of this mineral
 17-44-2 W, Wis. are less numerous and smaller in size than in that rock.

9054

Sl. 2920

Quartzites.

C. R. Van Hise. 1885.

9082

Sl. 2780

Macroscopic Descriptions

9013

Sl. 2767

These rocks are coarse grained, vitreous quartzites, stained a pale pink color by ferrite.

9054 is from

26-46-2 E. Wis.

9082 is from

19-45-1 E. Wis.

9013 is from

24-46-2 E. Wis.

Microscopic Description.

Beautifully enlarged interlocking grains of quartz compose the mass of the rocks. A few crystal outlined enlarged grains are seen. Films of ferrite are found between the cores and their enlargements. In 9054 there are a few small grains of magnetite.

9153

Sl. 2803

Ferruginous Quartzite.

C. R. Van Hise. 1885.

9154

Sl. 2804

Macroscopic Description.

Specimen 9154 differs from 9054 and 9082 in being more ferruginous. 9153 is finer grained than the preceding and is stained a dark brown color by ferrite.

Microscopic Description.

These rocks differ from 9054 and 9082 only in being finer grained and more ferruginous.

9152

Sl. 3104

Felspathic Quartzite.

C. R. Van Hise. 1885.

Macroscopic Description.

The rock is a medium grained, gray, massive one with a strong clayey odor.

Microscopic Description.

Rather small, rounded, enlarged grains of quartz compose the greater portion of the rock. Mingled with this quartz is quite a quantity of feldspar, both orthoclase and plagioclase. Mixed with the rather plentiful ferrite between the grains are flakes of kaolin.

9145

Al. 2800

6-45-26, Wis.

Chloritic Quartzite.

C. R. Van Hise, 1885.

Macroscopic Description.

The rock is a rather fine grained, greenish gray, completely vitreous quartzite.

Microscopic Description.

Rather small, widely enlarged, and deeply interlocking grains of quartz compose the mass of the rock. Chlorite is plentifully found in the interstices of the grains. But little ferrite is present.

9045

Located as per

p. 16, note book 35.

Feldspathic and Ferruginous Quartzite.

C. R. Van Hise, 1885.

Macroscopic Description.

The specimen is of a uniform medium grain, vitreous with conchoidal fracture and is stained reddish brown by ferrite.

Microscopic Description.

Rather small, originally well rounded fragmentary quartzes compose the greater part of the rock. These quartz grains are now mostly more or less enlarged and interlocking. Mingled with the quartz is a considerable quantity of orthoclase and plagioclase, both quite fresh. In the interstices of the quartz and feldspar are quite plentiful films and areas of deep brown limonite. Cutting through the section is a vein which contains a considerable quantity of finely crystalline quartz.

9046

9014

Ferruginous Quartzites.

C. R. Van Hise, 1885.

Macroscopic Description

Coarse grained, vitreous, mottled reddish-brown and white quartzites.

9046 see note book

35, p. 16.

9014 is from

24-46-26, Wis.

Hanging Wall.

9001

22-47-47 N, Mich.

Indurated Ferruginous Sandstone.

C. R. Van Hise. 1885.

Macroscopic Description.

The rock is a coarse grained, deep reddish brown, indurated sandstone, or semi-vitreous quartzite.

Microscopic Description.

Quartz grains of uniform size, originally well rounded but now enlarged, with abundant brown ferrite in the interstices make up the rock.

9002

22-47-47 N,

Mich.

Indurated Ferruginous Sandstone.

C. R. Van Hise. 1885.

Macroscopic Description.

Like 9001.

76037611 ✓

7603 is from

18-47-46 N,

Mich.

7611 is from

24-47-47 N,

Mich.Ferruginous Quartzites.

C. R. Van Hise. 1885.

Microscopic Description.

Both rocks are composed of much enlarged grains of quartz containing in the interstices plentiful brown iron oxide. 7611 is considerably coarser than 7603 and finely shows the division lines between the cores and the borders.

7556 ✓

Fine-grained Flinty Quartzites.

7557 ✓

C. R. Van Dine. 1885.

9415 ✓

Macroscopic Description

9423 ✓

Specimens 9415, 9423, and 9424 are very much alike. They are fine grained, yet not aphanitic, with a sugary look and a conchoidal fracture, and 9430 are of a pale pink or purplish pink color.

9434 ✓

7556, 7557 fm

13-47-46W,

Microscopic DescriptionMich.

9415 from

17-47-44W,

Mich.

9423 & 9424,

9430 and 9434 fm

14-47-45W

Mich.

The sections of these rocks are composed essentially of an intricately interlocking mass of quartz individuals. In all the sections large parts of the areas are very finely-grained while in all also portions are found which are moderately coarse-grained. The proportion of coarse-grained material is very considerable in one of the slides of 9424. But whether coarse or fine grained, there is absolutely no trace of any clastic material. Evidently the quartz is an original chemical constituent and the rock a completely crystalline one. In many cases the coarser parts of the sections are in bits or veins in the fine portions while also in many cases these parts are in irregular areas which gradually change to the parts which are composed of minute individuals. In all the sections and all parts of each section are seen, as inclusions in the quartz, very numerous minute particles of brown ferrite. In 7557, described in Book IV. p. 81, the ferrite is unusually plentiful, and in places compact areas of ferrite exclude the quartz.

9413 ✓9414 ✓Flinty Quartzites.

C. R. Van Hise. 1885.

Macroscopic Description.

17-47-44 W.

Mich.

These rocks resemble closely 9415, - 23, and 24, the chief difference being that they are almost aphanitic and more flint-like in appearance.

Microscopic Description

The original interlocking quartz individuals are finer grained than in 9415, 9423, and 9424 but otherwise these rocks are in every respect like them. As to oxide of iron inclusions the rocks are also the same. The one difference of importance between the two sets of rocks is that in 9413 and 9414 large fragmental grains of quartz are found, in 9414 abundantly. These fragmental grains are always enlarged and in 9414 the enlargements are unusually plain and relatively very wide. These enlargements extend far out into the finely crystalline material most often merging into it, and sometimes very gradually. 9414 is a good section to figure.

9445Ferruginous Flint.

C. R. Van Hise. 1885.

Macroscopic Description.

10-47-45 W.

Mich.

The specimen is very nearly like 9424, 9430, and 9434, the chief difference being that it contains dark brown bands.

Microscopic Description.

Under the microscope the brown bands are seen to be due to numerous ferrite inclusions in the quartz. Otherwise the rock is precisely like 9415, 9424, 9430, and 9434.

9676

Fine-grained Quartzite.

C. R. Van Hise. 1885.

22-44-54,

Wis.

Macroscopic Description.

The rock is very finely granular, has a sugary appearance, is very friable, and in places is almost milky white in color. In the sunlight innumerable glittering crystal facets are seen.

Microscopic Description.

The section upon both surfaces is badly obscured by emery dirt. It is, however, composed of a minutely crystalline mass of very pure quartz grains. These quartz individuals are for the most part crystals which fit each other perfectly, face to face in straight lines with little ^{or no} interlocking. There are usually apparently no vacant spaces between the crystal outlines and the rock is thus very nearly as completely a solid as in quartzites in which the grains deeply interlock. The weakness of the rock is explained by its crystal-grained composition. It is perfectly crystalline, no trace of amorphous silica being present. Also no trace of the enlargements of the quartz grains are seen. The quartz is, however, so very pure that these enlargements may have taken place and left no trace behind. But the possibility and perhaps probability is that the entire rock is an original crystalline one. If this is the case, perhaps in the siliceous magma ~~as~~ many crystals formed without being so numerous as to interfere with each other particularly. They thus would be crystal outlined. Then, as other individuals formed in the interspaces they conformed to the shape of the spaces left and thus were bounded by the limiting planes of the earlier crystals. It does not seem more difficult to conceive that the whole mass is an original crystallization, than it does to conceive it as a clastic rock in which the grains owe their crystal outlines to enlargement since the entire space is occupied. The question why the enlargements did not interfere and interlock, considering the rock a clastic one, is just as pertinent as the one why the original crystal individ-

9676 (com.) uals did not. In both cases there is close contact, in other words, interference, and a theory devised to explain why the enlarged clastic grains did not interlock will equally well apply to the rock if it were derived from an original siliceous magma in which crystallization had begun.

9533

Fine-grained Quartzite

C. R. Van Hise, 1885.

14-44-3H,

Wis.

Macroscopic Description.

This rock is much like 9676, only that it is somewhat coarser grained and less friable.

Microscopic Description

Fine grains of quartz, very pure, with the exception of quite plentiful minute flakes of sericite, compose the rock. These quartz individuals are coarser than those in 9676. While crystal outlines are often seen, the greater number of grains while they do not interlock to any great extent form junctions in lines which are more or less curved. The sparkling in the sunlight and the outlines in the thin section, however, show that the crystal outlined or partly crystal outlined grains are very numerous. Included in the grains of quartz, as mentioned above, are very plentiful minute flakes of what is taken to be sericite. This sericite is equally distributed through the grains, occurring as plentifully in the extreme borders of the grains as in their centers, and often a single flake of the sericite is included in two or more grains of quartz. No enlargements are seen. One would not expect this uniform distribution of the sericite if the rock were a fragmental one in which the quartz grains had received enlargement. If enlargements are present in those grains which have crystal outlines they must frequently be very wide, for flakes of sericite

q533(con) extend often in these grains from their exteriors or beyond it far toward the center of the grains. Upon the whole it seems much more probable that the whole is an original crystallization. A few of the largest of the grains of quartz are quite free from sericite and these grains may be fragmental.

q422

Flint.

C. R. Van Hise. Feb. 10. 1886.

14-47-45N,

Mich.

Macroscopic Description.

This rock is very like q413 and q414, the differences being that it is entirely aphanitic and flinty in appearance and is cut in places by brown and in others by green specks or bands.

Microscopic Description.

The section includes a portion of the green band. It is mostly made up of exceedingly finely crystallized and amorphous silica in about equal quantities. The green color is concentrated in bands and irregular areas and is caused by aggregates of chlorite mingled with a little brown iron oxide.

q420.

Chert Conglomerate.

C. R. Van Hise. Feb. 10. 1886.

14-47-45N,

Mich.

Macroscopic Description.

This rock differs considerably from q418 and q419 found at the same locality. While they resemble conglomeratic mica schists, the matrix of q420 appears to be a chloritic and ferruginous flint or chert, being green in some places and brown in others. The pebbles are pure milky flint.

Microscopic Description.

The pebbles and matrix differ from each other only in purity. The pebbles are pure, half-crystallized, flinty silica, while the matrix contains, with silica

9440 of the same sort much ferrite and some chlorite. The section is evidently cut from the brown ferriferous portion of the rock. In the matrix there are also present a few small grains of fragmental quartz. These grains are generally more or less enlarged.

9449

Flint Conglomerate.

C. R. Van Hise, Feb. 10. 1885.

10-47-45 W,

Macroscopic Description.

Mich.

The specimen varies from a red sandstone to a white sandstone and then gradually to a flint conglomerate. The pebbles are mostly pure milky flint. With them are mingled a few pebbles of black hornstone.

Microscopic Description.

The section is cut at the place where the rock varies from the white sandstone to the conglomerate. The pebbles are half-amorphous flinty silica for the most part. However, there are present a few yellowish green ones which are totally amorphous. These are taken to be amorphous silica mingled with chlorite and ferrite. The matrix is like others of the siliceous slates subsequently described. Fragmental grains of quartz, more or less enlarged, with a little feldspar and abundant filling material of silica, partly amorphous and kaolin, with a little ferrite, make up the rock.

9531.

Dolomitic Limestone.

C. R. Van Hise.

1885.

14-44-324

Macroscopic Description.

Wis.

The rock is finely granular, of a uniform texture, and of a light gray color. In places a slight greenish tint is seen. Also scattered through the specimen are quite numerous small grains and crystals of pyrite.

Microscopic Description.

Small closely fitting or interlocking particles of calcite and dolomite compose nearly the whole mass of the rock. Some of these grains show cleavage and twin lamination but the greater number show neither of these properties. Scattered through the section are quite a good many colorless brilliantly polarizing blades which with crossed nicols quite often grow dark when their cleavages and greatest directions are parallel to the nicol planes or nearly so. But some are found which do not become dark in this position and all are taken to be tremolite. Blades exactly like these occur more plentifully in 1421 Wis. and are described by Julien as tremolite. An occasional small grain of quartz is seen, also a few small crystals of pyrite and patches of ferrite.

9405

Dolomitic Limestone.

C. R. Van Hise.

1885

18-47-4424

Macroscopic Description.

Mich.

This rock is almost exactly like 9531, the only difference being that it is slightly lighter colored.

Microscopic Description.

Calcite and dolomite are again the only minerals of importance. Small grains of quartz and here and there narrow veins of the same mineral are found. Neither tremolite nor pyrite is present.

9563^sDolomitic Limestone

C. R. Van Hise, 1885.

14-44-3N,

Macroscopic Description.

Wis.

Like 9531.

Microscopic Description.

Finer grained than 9531. It contains no tremolite or pyrite. Otherwise like it.

9387

Chloritic and Dolomitic Limestone.

C. R. Van Hise, 1885.

17-47-44N,

Macroscopic Description.

Mich.

The rock differs from 9405 and 9531 in containing streaks of greenish material and in being of a pinkish gray color.

Microscopic Description

Interlocking grains of calcite and dolomite compose much the greater portion of the rock. However areas and bands of pale green chlorite aggregates, which act as a completely amorphous substance, are quite plentifully present. Quartz as in 9405 is also found. Small particles of reddish brown iron oxide are found as inclusions and these perhaps give the rock its pinkish color.

9408

Dolomitic Limestone.

C. R. Van Hise. 1885.

17-47-44N,

Macroscopic Description.

Mich.

This rock is coarser grained than any of the preceding limestones and of bright flesh color with greenish white spots and bands.

Microscopic Description.

This rock differs from 9531 chiefly in being somewhat coarser grained. Flakes of tremolite are here found as in 9531. The pink color seen macroscopically is due to ferrite which is a plentiful inclusion.

9677Tremolitic Limestone.9678

C. R. Van Hise, 1885.

Macroscopic Description.

22-44-5H,

Wis.

These rocks are uniformly granular, of a grayish white color and in general appearance are very close to marbles.

Microscopic Description.

Medium sized grains of very fine interlocking or closely fitting grains of calcite and dolomite compose the mass of the rock. Cleavage and twinning are often nicely shown in these minerals. Mingled with the calcite and rather plentiful dolomite are quite large blades of tremolite. These blades in many places are more or less altered, but the most of them, somewhere over their surfaces, show brilliant interference colors between crossed nicols.

9654Tremolitic and Dolomitic Limestone.

C. R. Van Hise, 1885.

Macroscopic Description

24-44-4H,

Wis.

This rock differs from 9677 and 9678 in that a portion of it is of a decidedly greenish color.

Microscopic Description.

This section differs from those of other limestones heretofore described in the abundance of tremolite, it being almost as plentiful as ^{the} calcite and dolomite together. The individuals of the various minerals are small. The calcite and dolomite are in grains and the tremolite in blades.

9404

Chloritic and Dolomitic Limestone.

C. R. Van Hise. 1885.

18-47-44W,

Mich.

Macroscopic Description.

This specimen differs from any of the preceding in being of a pale green color, except where cut by veins of pinkish coarsely crystalline ^{pure} calcite. ^{Microscopic Description.} The major portion of the section is, ~~however~~, composed of finely crystalline calcite and dolomite mingled with chlorite. The chlorite is in a few places found in narrow veins, here excluding the calcite and dolomite; but the greater portion of the mineral is mingled intimately and plentifully in minute aggregates with them. It is very pale in color and non-polarizing; so that much of it is difficult to discover. The veins seen in the hand specimen are composed of coarsely crystalline pure calcite.

9407

Dolomitic Limestone and Flint.

C. R. Van Hise. 1885.

18-47-44W,

Mich.

Macroscopic Description.

The specimen consists of interstratified bands of fine grained gray ^{limestone} and milky chert or flint.

Microscopic Description.

The section is cut at the junction of the flint and limestone, and thus includes a portion of both. The junction is for the most part quite sharp, the change from almost pure flint to pure calcite and dolomite taking place in a very short interval. The calcite and dolomite, so far as can be seen, are entirely free from silica in any form. They occur in small interlocking or closely fitting areas and their only inclusion is brown ferrite. Upon the other hand, the flint, which is about half amorphous, contains narrow belts and small areas of calcite and dolomite scattered throughout this part of the section.

9535

14-44-32

Wis.

C. R. Van Hise. 1885

Macroscopic Description.

A peculiar mottled white and green schistose rock, in which numerous large clear grains of quartz and fewer black patches of magnetite may be seen.

Microscopic Description.

The section consists of a ground-mass composed chiefly of grains of quartz of medium size and with them mingled much chlorite and a considerable quantity of magnetite and brown iron oxide. The iron oxides are quite frequently in large areas and the smaller grains of magnetite are often crystal outlined. The greatest lengths of the chlorite particles conform to each other and thus indicate the schistose direction. In this ground mass are numerous large well rounded quartz areas. These areas are so plentiful as to cover one-third the surface of the section. Perhaps one-half of them are simple quartz individuals while the remaining half are mostly coarsely complex quartzes. There are a few grains, however, which are finely complex and one or two which are largely amorphous. These large areas are so well rounded as to be certainly fragmental. Some few of these grains have received enlargements. Included in many of them are radial bunches of long, white needles, as well as numerous scattered ones, which are taken to be rutile. In some of the fragmental quartzes these inclusions are very plentiful. So far as can be made out most of the quartz in the ground mass is original, no enlarged grains being found.

9534

C. A. Van Hise, 1885

14-44-3N,

Wis.

Macroscopic Description.

Like 9535.

Microscopic Description.

Very like 9535. With the magnetite and brown iron oxide is a considerable quantity of pyrite, often in crystals, and here and there is a little hematite. Otherwise the sections are identical.

Specimens 9677, 9678, 9385, 9387, 9653, 9531, 9405, 9408, and 9654 all effervesce vigorously with very dilute, cold, hydrochloric acid. To complete the solution, or rather to carry it as far as possible, the dilute acid must be heated when a further continued vigorous effervescence takes place. However in all cases even with strong boiling HCl there is a considerable insoluble residue, except in 9385, and which, in the case of 9408, is at least twice as great as in 9677, 9653, 9531, and 9405, while in the case of 9654 not more than one-half of the rock dissolves.

In 9678, 9385, 9653, 9405, 9531, and 9387 after the HCl solution was neutralized with NH_4HO and the Ca. precipitated with $(\text{NH}_4)_2\text{CO}_3$ and $(\text{NH}_4)_2\text{C}_2\text{O}_4$, the filtrates gave when Na_2HPO_4 was added to them, heavy crystalline precipitates of ammonium magnesium phosphate. This taken in connection with the manner of solution leads one to the conclusion that all the above rocks are magnesian. The effervescence with very dilute acid shows that calcite is present and thus it becomes plain that in these rocks are both calcite and dolomite. The remainder of the rocks first mentioned were not tested for Mg. with Na_2HPO_4 .

9043

Coarse Siliceous or Greywacke Slate.

C. R. Van Hise. Oct. 1. 1885

See Note Book,

Macroscopic Description.

35, p. 16.

The specimen is coarse grained, greenish gray in color, of a uniform texture, and with sub-conchoidal fracture.

Microscopic Description.

About one-half the mass of the rock is composed of uniform medium sized grains of quartz and feldspar. These grains are mostly well rounded although quite a good many are angular and some of them sharply so. The quartzes are mostly enlarged, some of them to a considerable extent. Frequently the change from the enlargements to the matrix is a gradation. The feldspar is mostly orthoclase and microcline although a few particles of oligoclase are found. The interiors of these grains of feldspar are mostly fresh although upon their exteriors they are often altered to chlorite. These fragmental grains of quartz and feldspar are usually not in contact with each other but are buried in a fine complex ground-mass.

~~These fragmental grains of quartz and feldspar are usually not in contact with each other~~

In this ground-mass exceedingly finely crystallized, somewhat more coarse crystallized, somewhat more coarsely crystallized, and partly amorphous silica is the most plentiful constituent. The other constituents of the matrix are chlorite, kaolin, and oxide of iron all being present in a considerable quantity mingled ^{intimately} with the interstitial silica and with each other. Certain areas in this matrix are almost completely composed of finely crystalline silica or of silica mingled with ferrite. It is believed that in these cases the areas are complex clastic ones which so merge into the matrix as to make it difficult to separate them from it. This section is very like those of 7602, and 7621 described in Book IV, p. 83.

9083.

Banded Siliceous Slate.

C. R. Van Hise, Oct. 1885.

19-45-16,

Wis.

Macroscopic Description.

The coarser parts of this slate are like 9044. Inter-laminated with the coarse parts are some finer grained, darker colored banded parts.

Microscopic Description.

The constituents of this section are the same as those of 9094. The chief differences are as follows. The clastic grains of quartz are more plentiful and as a consequence their enlargements have often resulted in contacts or interlocking. In addition to the minerals found in the interstices in 9094, calcite is plentifully present. Chlorite is quite plentiful, and in parts of the section (doubtless those which correspond to the dark bands seen macroscopically), ferrite is also plentiful.

2058 No.Medium Grained Siliceous Slate.

C. R. Van Hise, Oct. 1885.

Microscopic Description.

Rather small clastic particles of quartz and feldspar compose a greater portion of the rock than do these minerals in 9043 and 9083. Also these particles are collected in clusters, and here often interlock quite deeply. The particles are mostly very angular. This angularity is frequently due to enlargements but in most cases the cores also are angular and often sharply so. The change from the clastic particles to fine matrix is often very gradual, the individuals slowly fading into the matrix. Finely crystalline and chalcedonic silica is the preponderating constituent of the matrix. Mingled with this matrix are quite plentiful small flakes of kaolin, and somewhat altered larger ones of biotite. Chlorite is also present.

9011

Coarse Siliceous Slates.

9151 ✓

C. R. Van Hise, Oct. 1885.

9011 is from

Macroscopic Description.

24-46-26.

These rocks are made up of pale pink to pinkish-

Wis.red colored bands interstratified with narrow bands of
9151 is from a dark green color. Upon cleavage surfaces both the
27-46-26, red and green bands show the sheen of numerousWis.

flakes of mica or hydromica.

Microscopic Description.

The elastic particles of quartz and feldspar are rather small and make up the bulk of the rock, the amount of interstitial material being rather small. These grains are angular and closely fitting or interlocking. The proportion of feldspar is quite large both plagioclase and orthoclase being present. The interstitial materials are finely crystallized quartz, limonite, and minute flakes of kaolin or sericite. The little flakes, the sheen of which is seen macroscopically, are difficult to perceive in the thin section.

9004

Siliceous Slate.

C. R. Van Hise, Oct. 1885.

27-47-47W,

Macroscopic Description.

Michr.

This rock is much like 9011 and 9151 except that the iron oxide is present in much greater quantity, giving it a brownish red color, and that the sheen of mica is also much stronger.

Microscopic Description.

In the thin section the constituents are the same as those in 9011 and 9151. The limonite in the interstices is very plentiful, excluding largely the interstitial quartz. The enlargements of the fragmental particles are mostly wanting or narrow. The mica, the sheen of which is so plain in the rock, is plentifully seen through the section and shows all the properties of sericite and muscovite, and is probably the former. As the section is transverse to the lamination of the rock, the mica show in small, long, narrow blades.

2083 Wis.

C. R. Van Hise, Oct. 1885.

Microscopic Description.

The section is poor and little can be made out of it. It is a fine grained rock containing crystals of magnetite and a considerable quantity of limonite.

9084Siliceous Slate or Greywacke Quartzite.

C. R. Van Hise, Oct. 1885.

19-45-1 E.

Wis.

Macroscopic Description.

The rock is a medium grained, uniform textured, greenish gray one.

Microscopic Description

The rather fine grained fragments of quartz and feldspar are for the most part closely fitting or interlocking. The proportion of feldspar is great and comprises the species orthoclase, microcline and oligoclase with perhaps plagioclase, and the feldspar is for the most part quite fresh. Quite a good many of the quartz fragments are finely complex. The small quantity of interstitial material is quartz, chlorite, kaolin, and ferrite. The chlorite is quite plentiful.

9171Chloritic Conglomerate.

C. R. Van Hise, Oct. 1885.

27-46-2 E.

Wis.

Macroscopic Description.

The specimen contains large pebbles of green schist. These pebbles are cemented by a dark green, uniform grained matrix, in which are seen imbedded numerous grains of quartz and feldspar, the latter exhibiting lustrous cleavage surfaces.

Microscopic Description.

The section is from the matrix. Fragmental particles of feldspar and quartz, of varying sizes and in about equal proportion make up three-fourths or

9101

Analysis by W. W. Daniells. 1886.

Si O₂ - - - - - 85.29Al₂O₃ + Fe₂O₃ - - - - - 10.67

Ca O - - - - - 0.35

Mg O - - - - - 0.40

9171 (con.) more of the mass of the section. These particles are, as a rule, quite angular although many grains are well rounded. The grains of quartz are most often enlarged to a greater or less extent. The feldspar is very plentiful and is, in about equal quantity, orthoclase and plagioclase a large proportion of the latter being microcline. Much of the feldspar is badly decomposed the resultant products being kaolin and chlorite.

Quite a good many of the fragmental quartz grains are finely complex. The interstitial material is chiefly chlorite, colored dark brown, with iron oxides. With this chlorite is a considerable quantity of finely crystalline quartz and kaolin.

9038

Sericitic Greywacke Slates.

9044

C. R. Van Hise. Oct. 1885.

9101

Macroscopic Descriptions.

9436

9435

9038 + 9044

see n. l. 35, pp. 154/6.

These rocks are fine grained, compact, of uniform texture and sub-conchoidal fracture. They are of a greenish to pinkish gray color. Upon cleavage surfaces they all show the sheen of hydromicas.

9101 from

19-45-1 E.,

Wis.

9436 + 9435

14-47-45 N.,

Mich.

Microscopic Description.

The slides of 9038 and 9044 are almost identical in appearance. Small fragmental particles of quartz and feldspar, angular and often closely fitting or interlocking, make up the great bulk of the rock. The quartz as to enlargement, and the feldspar as to species and decomposition are the same as in siliceous slates previously described. The flakes of white mica seen macroscopically are plentifully present in narrow, long, brilliantly polarizing flakes, and are probably sericite. The rather plentiful filling materials are chlorite, finely crystalline quartz, kaolin, and limonite. 9436 contains areas of hematite. The slide of 9101 differs from the two preceding in that the quartz and feldspar are coarser grained and in that the filling material is far more

9038 & plentiful and is composed entirely or nearly so of fine
(con) brilliantly polarizing flakes of Kaolin or hydromica.
This rock is a good one to test for magnesium in
order to show whether talc is present with the Kaolin.

9523

Sericitic Greywacke Slates.

9615

C. R. Van Hise. Oct. 1885

9523 from

Macroscopic Description.

16-47-4624,

These rocks are exactly like 9044.

Mich.Microscopic Description.

In no important respect are these rocks different
from 9044.

9089

Calcareous Greywackes.

9088

C. R. Van Hise. Oct. 1885.

9100

Macroscopic Description.

These rocks are but little different from 9038,
19-45-16, 9044, and 9101. 9088 is composed of two parts, one
Wis. of which is almost white in color while the other
is dark greenish gray.

Microscopic Description.

The sections of these rocks differ from those of
9038, 9044 and 9101 in that calcite is present. This
is particularly true of 9100, the two sections corres-
ponding in almost every particular aside from this.
9089 differs from the sections referred to in contain-
ing crystals of magnetite. 9088 contains in the inter-
stices a good deal of Kaolin.

9040

9035

Fine-grained Greywacke Slates.

C. R. Van Hise. Oct. 1885.

Macroscopic Description.

See note book

This rock differs from 9038 and 9044 only in being finer grained and of a purplish gray color.

Microscopic Description.

The sections differ from those of 9038 and 9044 in that the fine interstitial material is present in a much greater quantity. The interstitial material is chlorite, kaolin, finely crystallized quartz and limonite.

9442

9443

Fine-grained Greywackes.

C. R. Van Hise. Oct. 1885

Macroscopic Description.~~See note book~~

35, page 15

10-47-452,

Mich.

These rocks are very like 9038 and 9044. The sheen of hyaromica is less marked than in them.

Microscopic Description.

The clastic particles of quartz and feldspar are larger and more rounded than those in the sections of 9038 and 9044. The enlargements of the quartz grains in 9442 are broad and well marked. In other respects the quartz and feldspar are much as in 9038 and 9044. In 9442 chlorite is the greatly preponderant filling material but in 9443 this mineral is mingled with much cherty silica and kaolin.

9394

Chloritic Vitreous Quartzite

C. R. Van Hise, Oct. 1885.

Macroscopic Description.

17-47-442,

Mich.

The rock is a medium-grained greenish gray, completely vitreous quartzite, cut at intervals by white quartz grains.

Microscopic Description.

Well rounded and enlarged grains of quartz with films of chlorite and limonite in the interstices compose the rock. The veins are pure, very coarsely crystalline, and deeply interlocking quartz.

9440

Vitreous Quartzite.

C. R. Van Hise. Oct. 1885.

10-47-45N,

(Mich.)

Macroscopic Description.

A compact, coarse grained, gray quartzite, with conchoidal fracture.

Microscopic Description.

This rock is a beautiful illustration of the interlocking of well rounded grains of quartz by enlargements. The added borders are very wide and intricately interlocking. Films of chlorite and limonite between the cores and enlargements are wide and distinct. These minerals are also found in the interstices. No feldspar is present.

9463

Vitreous Quartzites.

C. R. Van Hise. Oct. 1885

9441

Macroscopic Description.

9463 from 9441 is a fine grained, pink vitreous quartzite.
13-47-46N, 9463 is a fine grained, light green vitreous quartzite.

(Mich.)

10-47-45N,

(Mich.)

Microscopic Description.

These rocks in the thin section differ from 9440 in being finer grained and having mingled with the quartz a good deal of feldspar. The enlargements of the quartzes are relatively wide and the interlockings deep. As in 9440 chlorite and limonite plainly mark the original cores of quartz and fill the interstices of the grains.

9005.Vitreous Quartzite.

C. R. Van Hise, 1885.

27-47-47^W

Mich.

Macroscopic Description.

The rock is a gray quartzite like 9440, the only difference being that 9005 is more glassy.

Microscopic Description.

In this section this rock differs from 9440 only in containing sparingly orthoclase, oligoclase, and microcline, these minerals being absent in 9440. These feldspars are dimmed by alteration. Nice instances of complex quartz enlargements are seen in the section.

9444Vitreous Quartzite.

C. R. Van Hise. Oct. 1885.

10-47-45^W

Mich.

Macroscopic Description

A pinkish and greenish white coarsely granular quartzite.

Microscopic Description

Enlarged quartz grains mingled with a considerable quantity of feldspar grains compose most of the rock mass. In the interstices is a considerable ferrite and chlorite with kaolin and fine quartz.

9432Fine grained Clayey Quartzite.

C. R. Van Hise. 1885.

14-47-45^W

Mich.

Macroscopic Description.

The rock consists of two parts, a white colored one and a deep brownish^{red} colored one, this latter color being due to iron oxide stains. The junction between these parts is most irregular.

Microscopic Description.

The section is from the white portion. The small quartz grains deeply interlock by enlargement. The feldspar fragments are rather sparse and usually much decomposed, and often

Analyses by W. W. Daniell 1886.
9453 Si Or { 78.3 } 78.26.

9409 Si Or 74.55.

7019 Ti Or ~ None

9432 (con.) completely so. In these cases the areas formerly occupied by the feldspars are now taken up by chlorite, kaolin, and finely crystalline quartz. In the interstices is a considerable quantity of these same minerals mingled with a little limonite.

9453

Coarse Siliceous or Greywacke Slate.

9460

C. R. Van Hise. 1885.

Macroscopic Description

9453 from 10-47-45N Mich. The hand specimens each have a broad band of dark greenish gray, coarse material interstratified with fine bands of a reddish brown color.

9460 from

13-47-46N,

Mich.

Microscopic Description.

The larger portions of both thin sections are from the coarse portions spoken of above. In each coarse well rounded grains of quartz scattered uniformly through the sections compose about one half of the rock. These quartz grains are sometimes enlarged and then quite often merge gradually into the surrounding materials. The greater part of the other half of the rocks consists of exceedingly finely ^{rounded} complex areas of about the same average magnitudes as the quartz grains. In the section of 9460 these rounded complex areas are almost entirely composed of half amorphous cherty silica. In the case of 9453 these areas happen to be composed of silica as in 9460 mingled with a large amount of rather brilliantly polarizing flakes which are taken to be kaolin but which might possibly be chalcedonic silica. If these flakes are kaolin as supposed the areas in which they are most plentifully found are altered elastic feldspar grains which have decomposed, their positions now being taken by alteration and replacing products. Between the elastic areas both simple and complex, as a filling material, is a rather small quantity of ^{chlorite} ~~ferrite~~ and brown ferrite. These rocks are somewhat different from any heretofore described. 9453 to have silica determined.

9512
13-47-462k,
Mich.

Sandstone.

C. A. Van Hise. 1885.

Macroscopic Description.

This rock is a fine grained, almost white sandstone, in which pale green laminae show the plane of sedimentation.

Microscopic Description.

The section is mostly composed of medium-sized grains of quartz and feldspar. The grains of quartz are often enlarged and, as a result, frequently interlock. The rather plentiful filling materials are finely crystallized quartz, kaolin, chlorite, and limonite.

9462
1347-462k,
Mich.

Ferruginous Siliceous Slate.

C. A. Van Hise, 1885.

Macroscopic Description.

A medium grained, banded, dark greenish or almost black colored rock.

Microscopic Description

In the thin section this rock is little different from 9512.

The Chloritic^{ms} Siliceous Slates East of Mount Whittlesey.

C. R. Van Hise. 1885.

These rocks under the microscope include a completely crystallized interlocking-grained quartzite, with but little feldspar and no interstitial material; a rock with equally coarse grains one-half or more of these grains being feldspar with a finer filling material; excessively fine-grained chloritic, kaolinic, and hydro-micaceous slates and every gradation between the three.

x+x

For the most part a glance at a section divides it into two parts, a coarser plainly fragmental one and a fine interstitial material which quite often becomes so plentiful as to be properly called a matrix.

The distinctly fragmental material always comprises both quartz and plagioclase. Probably much of the coarser-grained mica is also fragmental although the outlines of the particles of this mineral do not prove this to be the case as with quartz and feldspar. These plainly fragmental grains vary greatly in size. Even in the coarsest grained sections, when filling material is ~~present~~ plentiful, mingled with the larger grains are most often those that are much smaller, these smaller ones decreasing in size to those so small as to be lost in the fine interstitial material.

The clastic quartz occurs in grains which are for the most part simple although quite frequently the clastic particles of this mineral are finely complex, chalcedonic or flinty. The grains are often well rounded especially in the coarser rocks, although here many of them are angular. In the finer grained sections the grains of quartz are more angular and in some sections they are very irregular and angular. The grains of quartz are everywhere enlarged to a greater or less degree. These enlargements are frequently so wide as to make them closely fitting and in some cases quite deeply interlocking. The enlargement of the quartz grains has taken place to the smallest extent in those sections containing a considerable quantity of ferrite in the interstices. The films of inclusions between the clastic cores and added borders of the enlarged grains are generally gas cavities.

and particles of brown ferrite. In a few cases mingled with the ferrite, and at times almost excluding it, are films of chlorite.

The clastic feldspar is of the three species orthoclase, microcline, and oligoclase. It is possible that more basic feldspar may be present in some cases but none was found the extinction angles of which were large enough to warrant this conclusion. In all the sections the feldspar is present in considerable quantity and in some of them is fully as plentiful as the quartz, and perhaps exceeds it in quantity. Often the feldspars are as fresh as if in a fresh granite or mica ~~Schist~~ ^{Schist} while often too, many of the particles are much altered or decomposed. The most plentiful decomposition products of these feldspars are kaolin and chlorite. Often the kaolin is found in ^{numerous} little flakes over the entire surfaces of the grains of feldspar, the original feldspar grain then becoming a kaolin aggregate. The chlorite is generally found as borders to the altering feldspars, although at times the change has penetrated the interiors of the grains.

The large grains of white mica are taken to be fragmental and are probably hydrous and therefore sericite. These are abundantly present in many of the sections and in the hand specimens give a silvery sheen to the rock when cleared along the plane of lamination.

The interstitial material which may be ^{in the clay shales & shales as to} almost ^{or} ^{very} plentiful, is composed of silica both crystallized and partly amorphous, kaolin, sericite, chlorite, and limonite. The proportions of these minerals vary widely in different sections, yet, in nearly every case, all of them are found, with the exception of sericite. All of these minerals are ones which result from the alteration of feldspar and mica, and, in these sections, are all formed in connection with the feldspars with the exception of quartz and sericite as decomposition products. It is very probable that the sericite is altered muscovite and all the chlorite, kaolin, and limonite, with perhaps the silica, in part at least, result from

the disintegration of the feldspar.

The interstitial silica is often very plentiful, is sometimes completely crystallized, sometimes semi-crystallized, and rarely almost completely amorphous. The kaolin is usually in small brilliantly polarizing flakes and when plentiful is usually in intimate mixture with the interstitial silica. Sometimes it becomes so plentiful as to almost entirely exclude the silica. The chlorite occurs in pale green aggregates both in the interstices and as films between the cores of quartz and their enlargements. The limonite in brown patches is sometimes one of the most plentiful of the filling constituents and in other cases the quantity is very small.

Sericite ordinarily occurs in individuals of greater size than the other constituents of the filling materials and ought, perhaps, more properly to be classed with the large clastic grains of quartz and feldspar.

9646

Biotitic Chlorite Schist.

C. R. Van Hise, 1885.

19-44-32k,
Wis.

Macroscopic Description.

The rock is a finely granular, dark gray, uniform textured one of almost quartzitic compactness and massiveness. Its schistose structure is only shown by a readier fracture in this plane.

Microscopic Description.

Small grains of quartz of uniform size constitute the ground-mass and compose about two-thirds of the rock. These grains of quartz while, as to general shape, they are roundish or oval are minutely angular and often interlocking. In the majority of cases no proof of enlargement is found, but in many grains distinct enlargements have occurred, the division lines being particles of chlorite and biotite instead of iron oxide as is ordinarily the case. It is however believed that all these grains are fragmental and that the irregular exteriors as now seen are due to enlargement.

9646 (con.)

Scattered through this ground mass and composing the greater part of the remaining third of the rock are small flakes of chlorite and biotite in about equal quantity. These minerals are confusedly intermingled ~~with~~ in complex masses and in narrow bands between the grains of quartz. The folia of each of these minerals are, although small, well defined and those of chlorite act as crystallographic units and probably belong to the species ripidolite. With the quartz a few grains of orthoclase and plagioclase are associated. A few small crystals of magnetite are also seen.

This rock differs from the chloritic and siliceous slates heretofore described in many important particulars. The almost total absence of feldspar, the absence of kaolin, the presence of plentiful biotite, and the more completely crystalline appearance of the sections all make it lithologically widely different from them.

9563.

Biotite Schist

C. R. Van Hise, 1885.

14-44-3 N,

Wis.

Macroscopic Description.

This rock in its more massive positions is exactly like 9646. It, however, contains thin laminae, which are colored black by minute flakes of biotite.

Microscopic Description.

In its general character this rock is very like 9646. It contains a fragmental quartz ground-mass exactly like that rock. Biotite occurs as in 9646, but also almost entirely takes the place of chlorite, being as plentiful as chlorite and biotite together in 9646. A few grains of muscovite are also found.

Magnetite is quite plentiful in large octahedral crystals. In one place a little epidote was seen.

9644

Biotite Schist.

C. R. Van Hise Oct. 1885.

17-44-3N,

Wis.

Macroscopic Description

The rock is mostly finely laminated, but contains occasional bands of greater width and coarser grain. It is of a greenish gray color and shows strongly the sheen of mica.

Microscopic Description.

The ground mass is mostly very fine grained and is composed of quartz. This quartz is small and so intimately mingled with the mica, which is about equally plentiful, that it is difficult to determine whether they are enlarged or not. However, running through the section is a band which contains many comparatively large grains of quartz and these are always distinctly and often widely enlarged. The division lines between the cores and enlargements are most plainly shown by small flakes of included mica.

Brown biotite in quite large flakes is so abundant as to compose about one half of the mass of the rock. Chlorite is also present but in much smaller quantity. However, the flakes of chlorite are often much larger than any of those of biotite, and they always act as single uniaxial individuals and are taken to be ripidolite.

Like 9646 and 9563 feldspar is absent or so sparsely present as not to be discovered. There is no kaolin and the rock has a very crystalline appearance.

9565

Chloritic Biotite Schist

C. R. Van Hise Oct. 1885.

14-44-3W,

Wis.

Macroscopic Description.

The rock is very fine grained and finely laminar, of an entirely uniform texture, cleaves readily along the plane of lamination and is of a greenish gray color. The sheen of mica is upon the cleavage surfaces.

Microscopic Description.

The rock has a quartzose, fine ground mass, the grains being of nearly equal size and fitting closely or interlocking. However, proof of enlargement from fragmental grains is in very many of the grains plain and has doubtless occurred in all.

Biotite occurs as in 9646 and with it is mingled epidolite in considerable quantity. Flakes of white mica (sericite) are quite plentifully present and also areas of kaolinic material. In these points this rock differs from 9646, 9563, and 9644 and somewhat approaches the chloritic and siliceous slates.

9564

Sericitic Chlorite Schist.

9562

Biotite Chlorite Schist.

C. R. Van Hise Oct. 1885.

14-44-3W,

Wis.

Macroscopic Description.

The rocks are fine grained and finely laminated, yet they do not cleave readily in the direction of lamination. They break with a sub-conchoidal fracture across the plane of lamination. They are greenish gray in color and their cleavage surfaces show strongly the sheen of mica.

Microscopic Description.

In both rocks a ground mass of quartz composes two thirds of the bulk of the rock. In 9564 sericite and chlorite and in 9562 chlorite and biotite mingled with some sericite are the more important remaining minerals. In 9564 quite a good many crystals and grains of magnetite are found while very little is present in 9562. In 9562 a few crystals of pyrite are seen.

9645

Chloritic Biotite Schist.

C. R. Van Hise. Oct. 1885.

19-44-32K

Wis.

Macroscopic Description.

The rock is like 9644.

Microscopic Description.

The ground-mass as in the preceding mica schists is largely a quartzose one. It, however, differs from any of the others in that, mingled with the quartz, is a large quantity of kaolin, this material being as plentiful over large areas as quartz. The ground mass is then about the same in composition as are the chloritic and siliceous schists. The larger quartz grains are distinctly rounded and fragmental and are often enlarged.

The biotite is mostly concentrated in belts and in these belts it is the ^{most} abundant mineral of the section. It is here as aggregates of very numerous small brown flakes. Chlorite is also quite plentifully present associated with the biotite.

9647 ✓

Chloritic Quartzites.

9648 ✓

C. R. Van Hise. Oct. 1885.

9643

Macroscopic Description.

The rocks are medium grained, massive, semi-vitreous. 9647, 9648 from ones. They are regularly and peculiarly mottled gray 19-44-32K, ish white and green.

9643 from

16-44-32K

Wis.

Microscopic Description.

Clear grains of pure quartz compose three fourths or more of the mass of the rock. In a portion of the section of 9647 these grains are much coarser than in the remainder and in 9648. They are usually separated from each other by chlorite and are distinctly rounded and probably clastic. In 9648 and the other part of 9647 the grains are very closely fitting or interlocking. As no division lines of enlargement are seen it is difficult to say from this portion of the section whether the quartz is originally crystalline or not, but studied in connection with the coarser part of 9647 it appears probable that the grains of this mineral are clastic. Between the grains of quartz, frequently in large patches are aggregates of pale green chlorite. Films of this chlorite are also found between the quartz grains even when most closely fitting. Mingled with the chlorite is a little brown ferrite.

9556

Sl. 3147

14-44-32

Wis.

Actinolitic and Magnetitic Quartzite.

C. R. Van Hise Nov 1885.

Macroscopic Description.

The larger part of the rock is finely mottled white and black, the white portions being quartz, and the black portions magnetite. In one or two places ~~the~~ green actinolite is preponderant, although the eye detects none of this mineral in the greater part of the rock.

Microscopic Description.

Quartz and magnetite are about equally plentiful and they together compose the mass of the rock. Actinolite is the only other mineral of importance present. The quartz is in grains of small and approximately equal size. They closely fit or interlock. Quite often the smaller ones are partly crystal outlined. They nowhere show traces of enlargement or fragmental origin. The greater quantity of the magnetite occurs in large most irregular ramifying areas, often including many complex ones of quartz and less frequently blades of actinolite. Small grains are also plentifully present and these are sometimes crystal outlined. Finally the magnetite is found as very numerous minute black specks included almost everywhere in the quartz. In some places these particles are so numerous and minute as to give the quartz a very dark hazy appearance in natural light, but in polarized light the individuals of the complex areas of quartz are made out.

The greater quantity of actinolite occurs in colorless or pale green feebly dichroic blades which often include several or many grains of quartz and magnetite. Numerous smaller blades of the actinolite are included in the quartz. Often these blades are so small as to be included by a single quartz grain and again they are so long as to cut through two or more grains of quartz. It appears that each of the three minerals present in this rock includes considerable quantities of both the others, a condition of things which is apparently explicable only upon the supposition of simultaneous crystallization.

9557

Actinolite and Magnetite Schist.

C. R. Van Duse, Nov. 1885.

14-44-32

Wis.
MistMacroscopic Description.

This specimen is much like 9556. It differs from it in containing bands of almost pure magnetite and in that, in the mottled black and white portions, actinolite appears to be more plentiful, giving the specimen a greenish cast.

Microscopic Descriptions.

The several minerals and their relations are precisely the same as in 9556, the only differences being in magnitude of individuals and of variation of proportions.

The section is cut in one of the less ferruginous portions of the rock and consequently does not contain a very large quantity of magnetite. Actinolite is very abundant, composing more than half the section. Large blades and complex areas are seen, as well as long slender needles which everywhere are included in the quartz. The grains of quartz are often much larger than in 9556, but show no trace of fragmental origin being cut, as mentioned above, by needles of actinolite.

9558

Actinolite Magnetite Schist.

C. R. Van Duse, Nov. 1885

14-44-32

Wis.

Macroscopic Description

The specimen is reddish black, fine grained, almost aphanitic, tough, finely banded, with conchoidal fracture and very heavy with magnetite.

Microscopic Description.

This rock in its constituents is like 9556 and 9557. It is, however, finer grained and the magnetite has a more or less distinct banded arrangement i.e. it is concentrated to a certain degree in belts and is here preponderant although including quartz and actinolite. The actinolite is only a little less plentiful than the magnetite while the quartz is subordinate in quantity. The individuals of both quartz and actinolite are of smaller average size than in 9556 and 9557.

9566 The section ^{shows to the naked eye} ~~as seen microscopically~~ consists of a
 95197. reticulating mass of brownish materials with
 contains roundish spots of a lighter color. ~~Each~~
 Most of these spots contains a core with a black
 tint surrounded by a nearly colorless border.
~~As the section is examined by the microscope~~
~~shows that the reticulating mass~~ and the lighter
 spots ^{seen} ~~on~~ ^{not} ~~the~~ sharply defined from ^{one another} ~~each other~~, i.e.
~~both in the mass the same~~ all the
 minerals which are found in the section are
 found in both of these parts. ~~The constituent~~
~~minerals~~ are quartz, actinolite, biotite, magnetite
 and a mineral ~~the nature of which is not certain~~
 The background of the ~~reticulating mass~~ ^{section} is composed
 of small flakes of biotite, ~~quartz and magnetite~~
 and magnetite, the biotite being the most plentiful.
 Scattered through ~~the background~~ all parts of this
 background are quite large blocks of actinolite,
 and of the undetermined mineral. The actinolite
 is in rather large individuals which in transverse
 sections nearly ~~always~~ show the rhombic form
 of the unit prism, but which in longitudinal sections
 have ~~irregular ragged terminations~~ ^{fibres} ar-
 ranged in fan like forms which have ~~irregular~~
 ragged terminations. They include ^[here copy from parentheses]
 p 83, Book VI. ^{concentrated - combined with the smaller}
 The mineral ^{which when present in} ~~which in the lighter colored spots~~ ^{proportion of biotite} ~~which~~
 separates the light spots from the remainder
 of the section contains such a large amount
 of the remaining other minerals that it is difficult
 to determine certainly what it is. However it is
 remarkably like the fragmental feldspar so
 abundant in the ordinary black slate, and
 which have a precisely similar appearance

due to partial attraction to biotite with the
 simultaneous separation of quartz, and in the
 case of this section, we have besides the minerals
 so common in the upper slate, actinolite and mag-
 netite, which however may ~~might~~ penetrate the
 feldspar by attraction processes, plentiful actinolite
 and magnetite.

The major portion of the quartz is finely crystalline
 and interlocking, but in here and there through it
 are larger roundish fragments grains which have
 a strong fragmental appearance. The magnetite
 besides being found in the actinolite abundantly,
 is found in small grains throughout the section.

This rock appears to be intermediate between
 the actinolite magnetite schists and the altered
 fragmental black slate. If fragments of feldspar
 and quartz were included in material a chemical
 sediment from matrix, it would explain the
 combination of the characters of the two classes
 of rocks mentioned above.

sp. 97
= 3.46
Buyer 1887
9566.

Magnetitic Biotite Actinolite Schist.

C. R. Van Hise. Nov. 1885.

14-44-3W.

Wis.

Macroscopic Description.

The rock is dense, finely schistose, and black in color. It is studded with small black lustrous needles of actinolite which appear to compose half the mass of the rock.

Microscopic Description.

The ground mass is composed of small flakes of biotite, grains of quartz and particles of magnetite, the biotite being the most plentiful. Scattered thickly through this ground mass are quite large blades of actinolite. The actinolite blades have irregular ragged terminations and the parts often have a fan like arrangement. (They include very numerous minute particles of magnetite, so numerous as to give the actinolite in places an almost black color. In many places they are altered to flakes of biotite. In this alteration part of a blade of actinolite has changed to many flakes of biotite. It is very possible that all the biotite is thus secondary to actinolite. This idea is favored by the fact that the great mass of the biotite occurs in small flakes which have the exact appearance of those which are certainly secondary to the actinolite.) The quartz is ~~often~~, in certain parts of the section, nearly excluded, but in other parts is quite plentiful, finely crystalline and interlocking. The magnetite besides being found in the actinolite is scattered in small grains throughout the section.

9567

Magnetitic Actinolite Schist.

C. R. Van Hise, Nov. 1885

14-44-3W.

Wis.

Macroscopic Description.

The rock is very fine grained, and quite massive yet showing a coarse band of a greenish gray between layers of a blackish gray color. The greenish gray band seems less ferruginous and more actinolitic than the other parts.

Microscopic Description.

The ground mass is composed of finely ^{crystalline} interlocking

9567(con) quartz, with no trace of enlargements. In this ground mass are thickly scattered individuals and bunches of actinolite blades many of which are arranged in fan-like forms. In abundance this mineral is about equal to the quartz. It is very fresh, colorless, and feebly dichroic. Very numerous small particles of magnetite are everywhere scattered through the section being included in about equal quantity in both the quartz and actinolites.

9561

Gray Quartzite.

C. A. Van Hise, Nov. 1885.

14-41-37,

Wis.

Macroscopic Description.

The rock is fine grained, ~~dark~~ gray in color, with sub-conchoidal fracture.

Microscopic Description.

Quartz is the most plentiful constituent, it composing three-fourths of the mass of the rock. Between these grains of quartz is plentiful sericite, chlorite, and perhaps some actinolite. Neither magnetite nor hematite are present. The quartz grains are rather small and while many of them are closely fitting or interlocking, they have a decided fragmental appearance. That they are all fragmental is rendered more probable from the fact that quite a good many are very distinctly enlarged there being broad well marked lines of division between cores and enlargements. Green chlorite, and colorless brilliantly polarizing sericite occur mingled together in the most irregular manner in patches of considerable size and as narrow fibris between the quartz grains. Included in the chlorite and sericite is a little limonite. This rock is much closer allied to the siliceous slates than to the iron belt rocks.

9560

Gray Quartzite.

C. R. Van Hise. Nov. 1885.

14-44-3W,

Wis.

Macroscopic Description.

This rock is like 9561 except that it is somewhat coarser grained and lighter gray in color.

Microscopic Description.

This rock is essentially the same as 9561. The quartz grains are larger, more plentiful and more rounded and consequently less interlocking. The interstitial materials are the same as in 9561 with the addition of flakes of biotite. The chlorite biotite and sericite are mingled with each other and in the same relation to the quartz as in 9560. This rock is but a biotitic "siliceous slate."

9555

Sl. 3190

Magnetitic Actinolite Schist.

C. R. Van Hise. Nov. 1885.

11-44-3W,

Wis.

Macroscopic Description.

The rock is fine grained, composed of bands which vary in color from light gray to a very dark gray, depending upon the amount of actinolite and magnetite contained. It is very much like 9567.

Microscopic Description.

This rock is closely like 9567 the chief differences being in the relative proportions of the minerals and the absence of fan like shapes in the actinolite blades. Quartz is plentiful in the ground mass, and is entirely originally crystalline, occurring in rather small grains of nearly equal magnitude. Actinolite blades are everywhere through the section and often concentrated in masses which have the greatest lengths running in all directions and everywhere penetrating and cutting through the grains of quartz. The magnetite is more plentiful and in larger grains than in 9567 and often concentrated so as to be the most abundant mineral in that part of the section. Very numerous small grains are also included by the quartz and actinolite.

Dec. 1887.

A careful reexamination of the section of this rock makes the relation of the garnet and actinolite contained less definite than stated upon the opposite page. There is no evidence that all of the actinolite of the section is secondary. The actinolite of the garnet is essentially like the actinolite of the matrix, although it seems to have a somewhat lighter color. The arrangement of the actinolite in the garnets is the same as about them. It commonly has divergent sheaf like forms, or radiates from centers. When a garnet is in contact with one of these sheaves, the divergent blades of actinolite often penetrate the garnet just as if the garnet were absent. Also at times garnets and radial bunches of actinolite have common centers, and then at times the actinolite blades continue beyond the crystal outlined garnets. Both of these relations suggest that the actinolite was prior to the garnet in crystallization. However, what is known of the power of one mineral to grow into another by processes of alteration makes it possible that this penetration of the garnet may be an alteration phenomenon. This probability is greatly increased by the fact that oftentimes, when wide blades of actinolite come in contact with a garnet, a portion of these blades only continue, and penetrate the garnet, the sharp outlines of that mineral apparently serving as a barrier against which the greater part of the actinolite blades abruptly terminate. This fact taken in connection with the fact that the manner of the inclusion of the actinolite can be explained by alteration makes it probable that a portion or all of the actinolite contained in the garnet is secondary to it. Also many blades of actinolite abut against individuals of garnet

9553

X 3188

11-44-3W,

(Wis.)

Magnetitic Garnetiferous Actinolite Rock

C. R. Van Hise. Nov. 1885.

Macroscopic Description.

This rock resembles closely 9555 and 9567 the chief difference being that in 9553 in the lighter colored belts there are very numerous small crystals (dodecahedrons) of garnet.

Microscopic Description.

Garnet, magnetite, and actinolite with its alteration products compose almost the entire mass of the rock. The garnets are rather small, but very numerous and of a very pale pink tint. In natural light many of them are seen to be crystal outlined. This is not so evident in the polarized light as they have so altered as to give the black parts irregular outlines. All of the garnets are cut by needles of actinolite. As the outer borders of the grains are approached more and more of the material is actinolite. This actinolite contained in the garnet and that surrounding them is unquestionably an alteration product of the garnet. If the gradation of one mineral into the other were not sufficient to prove this, the fact that crystal outlined garnets as seen in natural light are really in their outer portions not garnet but actinolite, that is, the complex needles of actinolite in many cases together make pseudomorphs after garnet and contain cores of that mineral. Every stage of the alteration is seen from that in which the garnets are mostly unaffected until only a small core remains, which is penetrated by actinolite needles. The alteration as mentioned above has taken place by many radiating or intersecting needles of actinolite being formed from a single garnet. It is very possible and indeed probable that all the actinolite has resulted from the alteration of garnet. The actinolite occurs, as described above, and also in intersecting needles between the garnet crystals, being by far the most plentiful mineral at present in the section. The actinolite has altered to quite a large extent to biotite. This alteration has made a further diminution in the sizes of the individuals forming the

without penetrating them at all. The contrast between this sort of termination and the divergent ragged terminations of the unobstructed actinolite blades is very striking
C. R. N.

1404a Dec. 1887. The relations of the actinolite and garnet wis: on the same as in 9553. This rock however contains a good deal of magnetite and this mineral is indiscriminately included in garnet and actinolite in such a manner as to leave no doubt that it was prior to them both in crystallization.

1444a The actinolite included in the garnet and that wis in the matrix are exactly alike even to the brown iron stains which are upon both. The relation of the two minerals are however as in 9553 and 1704.

9552 Included in all the garnet crystals are
823187 all the constituents remaining i.e. quartz,
9554 biotite and feldspar. In the main the garnets
823189 are not crystal-outlined, but in places they are, and here often biotite blades abut sharply against ^{the garnet} and abruptly terminate.

9553 con. rock as many minute flakes of biotite result from a single individual of actinolite. Small particles of magnetite some of them crystal outlined are scattered uniformly through all parts of the sections and included in all the other minerals.

1404 a is very like the above. Some of the garnets are less altered and consequently more often preserve their crystal outlines.

1444 a differs from 9553 and 1404 a in that all the actinolite is stained a deep reddish brown by oxide of iron. Also many of the garnets possess very perfect crystal outlines, being but little altered.

9552

Garnetiferous Biotite Schists.

Sl. 3187

C. R. Van Hise, Nov. 1885

9554

Macroscopic Description.

Sl. 3189

These rocks are aphanitic, finely laminated, readily cleaved along the plane of lamination, of a reddish or greenish black color, and soft. The cleavage surfaces are lustrous and covered with many small protuberances which are taken to be due to contained garnets.

Microscopic Description.

The rocks are mostly composed of small flakes of biotite with particles of a black substance set in a fine quartzose ground mass. The quartz is fine-grained and closely fitting. Whether any of it is fragmental it is difficult to say. A few grains are found which are larger than the great quantity of the mineral and these are roundish and appear to be clastic. Biotite in very small flakes with the greatest diameters ordinarily in a common direction compose fully one half the mass of the rock. Mingled with this biotite and giving the rock its black color are large quantities in very small particles of the black or very dark brown material spoken of above.

9552)
9554)

This is not magnetite, but appears to be a very dark colored ferrite or such ferrite mingled with carbonaceous material. In each section there chances to be but ^{one or two} single crystal of garnet. These garnets include many of the black specks above mentioned and in streaks through them incipient alteration has begun. These rocks belong rather to the black slates than to the iron group. The finely-crystalline quartz is not more non-fragmental in appearance than the quartz in the fine-grained black slates. The non-fragmental appearance of these rocks is explained by feldspathic alteration.

9642.

Sl. 3152

Magnetitic Schist.

C. R. Van Hise. Nov. 1885.

Macroscopic Description.

16-44-3W,

Wis.

The specimen is composed of two portions which are quite different, one being a layer of almost pure magnetite and the other being dense, fine-grained, massive, mottled white and black.

Microscopic Description.

The section is from the mottled portion and is composed mostly of quartz and magnetite. The quartz makes up two-thirds or more of the mass of the section, is rather fine-grained closely fitting or interlocking, and shows no trace of enlargement. Quite a good many of the smaller grains are crystal outlined. The magnetite is included everywhere in the quartz, mostly in very small grains and crystals. Blades of actinolite heavily stained with brown iron oxide and considerably altered are scattered somewhat sparsely through the section.

9680

Actinolitic Magnetitic Schist.

C. R. Van Hise. Nov. 1885.

20-44-5W.

Wis.

Macroscopic Description.

The rock is little different from 9642.

Microscopic Description.

The section is quite like that of 9642, yet there are some differences. Quartz is the most plentiful constituent as in 9642, but many of the individuals are of quite large size and often these

9680 (con.) have partial or perfect crystal outlines with no trace of fragmental origin. The magnetite ^{which} is ~~not~~ more plentiful than in 9642, occurs in large grains and often the particles are arranged in spheroidal concretions. In this section as in 9642 the magnetite is included in the quartz, but in these concretions the long circular lines of individuals of magnetite show complete independence of the quartz grains cutting through and included in many individuals of the latter mineral. The quantity of actinolite is considerable, in very fresh blades cutting in all directions through the quartz and included in and by the magnetite.

9649

Sl. 3159

Actinolitic Magnetite Schist.

C. R. Van Hise. 1886.

Macroscopic Description.

19-44-3W,
(Wis.)

Like 9642 and 9680.

Microscopic Description.

This section differs from that of 9680 only in being finer grained.

9641

Sl. 3151

Actinolitic Magnetite Slate.

C. R. Van Hise, Nov. 1885.

Macroscopic Description.

16-44-3W,
Wis.

The rock is very fine grained, dark gray to black in color, finely banded, and breaks most readily along the bands.

Microscopic Descriptions.

The section which is very fine grained shows no magnetic concretions but is very magnetitic, magnetite composing half of the rock. In other respects the section is not different from those of 9680 and 9649.

9692
Sl. 3169

Chloritic and Actinolitic Magnetite Schist.

C. R. Van Hise, Nov. 1885.

Macroscopic Description.

16-44-5 Wis. The rock is very massive, yet coarsely banded,
Wis. breaks with a conchoidal fracture and is dark gray to black in color and strongly magnetic.

Microscopic Description.

The sections contain a finely crystalline ^{quartz} ground mass. The abundant magnetite is in large irregular and often ramifying areas as well as in small particles. Actinolite and chlorite are very plentiful, the latter more so than the former, but as an alteration product of the actinolite.

9696
Sl. 3170

Magnetitic Actinolite Schist.

C. R. Van Hise, Nov. 1885.

Macroscopic Description.

26-44-6 Wis. The rock is more schistose than 9692 but otherwise like it.

Microscopic Description.

The section contains relatively little little magnetite, that present being in minute particles. Actinolite is the most plentiful constituent. A quartz-^{or} ground mass not different from that in the preceding rocks is present.

9679 ✓
Sl. 3166

Chloritic Actinolite Rocks.

C. R. Van Hise, Nov. 1885.

9684
Sl. 3168

Macroscopic Description.

9698 ✓ These rocks are of a uniform fine grained, quite massive in appearance, with sub-conchoidal fracture although showing in places something of a banded appearance. They are dark greenish gray in color and in their coarser parts are seen to be composed mainly of small needles of actinolite.

9679, Sec. 29
9684 Sec. 20
T. 44, R. 5 N., Wis.
9698 from
26-44-6 Wis.

Microscopic Description.

A mass of somewhat altered intersecting needles

9679 (con.) and blades of actinolite compose the mass of the rock. In all three rocks the actinolite is more or less altered to chlorite giving the sections a green color. In 9679 the actinolite has also altered to biotite to some extent. In all three a small quantity of magnetite is found.

9617

Sl. 3100

Magnetitic Quartz Schist.

C. R. Van Hise, Nov. 1885.

Macroscopic Description.

The rock is a mottled black and white, fine grained one, quite massive in the hand specimen. In the fine, white, sugary looking quartz are roundish areas of magnetite and red hematite.

Microscopic Description.

Completely crystalline fine quartz is the ground mass of the rock. The individuals interlock and there is no trace of fragmental origin. There are also quite a number of veins and irregular areas which are composed of large interlocking quartzes, but here also there is no clastic appearance. Small particles of magnetite are included everywhere in the quartz. Besides these small particles there are numerous large irregular or oval magnetite areas. These are often but a shell of magnetite containing quartz. Even when solid magnetite, the roundish forms show the effects of concretionary action. Sometimes the magnetite is arranged in narrow concentric belts each one cutting through numerous grains of quartz and arranging itself in entire independence of that mineral. In parts of the section brown ferrite is also included in the quartz.

9620
Sl. 3147

Actinolitic and Magnetitic Quartz Schist.

C. A. Van Hise, Nov. 1885.

Macroscopic Description.

This specimen consists of two parts, ^{one of which is} light colored ~~one~~ like 9617. These light colored portions include black bands of nearly pure magnetite.

Microscopic Descriptions.

The section is from the light colored part and resembles the section of 9617 except that it is actinolitic. The quartz occurs exactly as in 9617. The magnetite also is as in 9617 except that less of it is found in concretionary forms. The actinolite is plentiful, sometimes in quite large areas, but the needles are always of minute size. They are included alike in the quartz and magnetite although plentifully in the former mineral.

9618

Jaspery and Magnetic Schist.

C. A. Van Hise, Nov. 1885.

Macroscopic Description.

This rock differs from others obtained at Tyler's Fork in being composed very largely of jasper. There is no section of the rock.

9623
Sl. 3148

Hematitic Magnetite Quartz Schist.

C. A. Van Hise, Nov. 1885.

Macroscopic Description.

The rock is a mottled white and black one, here consisting of quartz and magnetite and is cut by belts of almost pure magnetite. Scattered through the rock are quite plentiful roundish or oval areas of deep brilliant red jasper.

Microscopic Description.

The ground mass as in 9617 and 9620 is completely crystalline, non fragmental quartz. Through this there is scattered much magnetite and hematite, the first ^{being} more plentiful. Some of this magnetite is in small particles included in the quartz and more

9623 (cm.) of it in larger individuals which are often arranged in concretionary forms. The very numerous concretions are most commonly built up of both hematite and magnetite although often those are found which contain only one of these minerals. This is the case with the blood red areas spoken of macroscopically, the iron oxider here of course being hematite. A very little of some carbonate appears to be present.

9624

Sl. 3149

Actinolitic and Magnetitic Quartz Schist.

C. R. Van Hise, Nov. 1885.

Macroscopic Description.

The rock is somewhat mottled but with a more uniform dark greenish gray color than any of the preceding rocks from Tyler's Fork. It is fine grained and in the hand specimen appears massive.

Microscopic Description.

As heretofore the quartz ground mass is completely crystalline and unfragmental. The magnetite is mostly concentrated in grains of considerable size, sometimes, although not ordinarily, arranged in the forms of concretions. The actinolite occurs in abundant very delicate, perfectly fresh long needles. These needles are scattered quite uniformly through the quartz ground mass penetrating it in every direction and most of the actinolite needles cut through two or more quartz individuals. These needles ^{which} are at times concentrated into aggregates in sheaf-like forms, are often included in the magnetite and often again concentrated by concretionary action about the areas of magnetite; at other times by concretionary action surrounded by the magnetite.

9625

Sl. 3150

Magnetitic Flint

C. R. Van Hise, Nov. 1885.

Macroscopic Description.

The specimen is composed of belts of black and of grayish black material. It is very compact and fine grained and breaks with perfect conchoidal fracture.

Microscopic Description.

The quartz ground mass is much finer grained than in any of the preceding ferruginous rocks from Tyler's Fork. In fact a portion of it may be partly amorphous. In this ground-mass the magnetite is very plentiful, mostly in small particles very often crystals and is ordinarily arranged in concretionary forms.

908119-45-1 E.,
Wis.Magnetitic Schist

C. R. Van Hise, Nov. 1885.

Macroscopic Description.

This rock is a very magnetic black schist, mottled in places by white quartz.

910419-45-1 E.,
Wis.Magnetitic Quartzite

C. R. Van Hise, Nov. 1885.

Macroscopic Description.

The rock is mostly chalk white in color, mottled with black particles and narrow bands of magnetite.

9187

Sl. 3105

Quartzitic Hematite and Limonite.

C. R. Van Hise, Nov. 1885.

Macroscopic Description.

12-45-1 E.

Wis.

The rock is a fine grained one composed of regular bands of different colors varying from a rich reddish brown to black. It cleaves very evenly along these bands.

Microscopic Description.

Ferrite (hematite and limonite) massed together compose the bulk of the rock. Scattered through this ferrite is a little finely crystalline quartz and here and there are narrow veins which are almost wholly composed of this material.

9189

Sl. 2930

Ferruginous Quartzite.

C. R. Van Hise, Nov. 1885.

Macroscopic Description.

12-45-1 E.,

Wis.

The hand specimen is composed of a belt of finely crystalline quartz stained yellow with limonite, and a reddish brown belt composed almost entirely of ferrite.

Microscopic Description.

The section is cut from the quartzose portion. It is composed almost entirely of finely crystalline interlocking quartz, sometimes so fine as to approach a flinty character. Scattered through the quartz are the films of limonite. Oftentimes this limonite is arranged in concretionary forms and in such cases, as described heretofore, the lines of ferrite are quite independent of the individuals of quartz.

9144

Sl. 2799

Flint or Chalcedony.

C. R. Van Hise, Nov. 1885.

Macroscopic Description.

6-45-2 E.,

Wis.

The specimen is translucent milky to black flint.

Microscopic Description.

The section is composed of exceedingly finely crystallized and amorphous silica. Here and there are dark clouds of minute ferrite inclusions in irregular contorted bands.

9191, Ash 1886, contains largely of non-protecar-
bonate; result of test of sample by R.D. Irving,
Washington Ash 1886

9191 This rock was analyzed at Washington, Apr. 13/86
by R.B. Riggs under F.W. Clarke, Chief Chemist.

Si O ₂	15.62%	
Al ₂ O ₃	4.27	
* { Fe ₂ O ₃	8.14(?)	Partial analysis.
{ Fe O	32.85(?)	* Content of Fe O. —
Mn O	5.06	Lack of material.
Ca O	.81	
Mg O	2.66	
Co ₂	30.32	
H ₂ O	.68)	
	(100.41)	

The following is the mineralogical composition as
calculated from the analysis by C.A. Van Hise.

<u>Clay.</u> 2 H ₂ O, Al ₂ O ₃ , 2 Si O ₂			
Al ₂ O ₃	4.27		
H ₂ O	1.51		
Si O ₂	5.02		10.80
<u>Ca CO₃</u>			
Ca O	.81		
C O ₂	.64	1.45	
<u>Mg CO₃</u>			
Mg O	2.66	2.66	
C O ₂	2.92	5.58	
<u>Mn CO₃</u>			
Mn O	5.06		
C O ₂	3.13	8.19	
<u>Fe CO₃</u>			
CO ₂	23.69		
Fe O	38.76	62.45	77.67
Si O ₂			10.60

9190

Sl. 7931

Ferruginous Quartzite.

C. R. Van Hise, Nov. 1885.

Macroscopic Description.

6-45-2 E.

Wis.

The rock is mostly composed of opaque white quartz often stained and cut by bands of brown or black ferrite. A leaching process has taken out much of the quartz and ferrite leaving numerous cavities in the rock.

Microscopic Description.

Crystalline, interlocking, fine grained and sometimes flinty or chalcedonic quartz compose the greater part of the section. The yellow or dark brown ferrite is scattered in clouds of minute particles through the section or arranged in concretions. The cavities seen macroscopically show as irregularly outlined holes in the section. Their exteriors are heavily stained with ferrite.

9191

Sl. 7996

Magnetitic Ferro-Dolomite.

C. R. Van Hise, Nov. 1885

Macroscopic Description.

6-45-2 E.

Wis.

The hand specimen is fine grained and shows beautiful regular bands of light and dark gray color. Some of the dark gray to black seams are so heavily magnetic as to give fragments a third of an inch across which are raised by an ordinary magnet.
Sp. gr. 3.50 (See opposite page for analysis.)

Microscopic Description.

The section is small and cut from one of the light gray bands. Interlocking minute particles of ferro-dolomite compose its mass. Scattered through this ferro-dolomite ground mass are quite numerous small crystals and particles of magnetite.

9193.

33-46-2 E.

Wis.

This rock differs macroscopically from 9191 in that with the magnetite there is a good deal of red iron oxide.

9047

Sl. 2775

Ferruginous Quartzite (non frag.)

C. R. Van Hise. Nov. 1885

Macroscopic Description.

Note book 35

page 16.

The rock is a massive fine grained one, of mottled dirty white and dark brown colors.

Microscopic Description.

Finely crystalline, interlocking, non fragmental quartz composes two thirds to three fourths the mass of this rock. The individuals of quartz vary in size from medium ones to those of minute size and places are seen in which a portion of the silica is amorphous. The ferrite is dark brown in color and much of it is present in large irregular ramifying areas, often including grains of quartz. A portion of it is also arranged in concretionary forms including cores of complex quartz. Sometimes the individuals of quartz thus included are considerably larger than the surrounding grains of this mineral. In other cases a film of oval ferrite cuts directly through quartz individuals, as heretofore described, or even at times a complete concretion within a single grain of quartz occurs. In cases when the quartz individuals thus surround the ferrite it seems as though the former must have crystallized later than the latter.

9048

Limonitic Flint.

C. R. Van Hise. Nov. 1885.

Note book 35

page 16.

Macroscopic Description.

The rock is a translucent mottled white and yellow brittle flint.

Microscopic Description.

Exceedingly finely crystallized and amorphous silica stained with patches and minute particles of yellow ochre make up the rock. Through the section are very numerous beautiful concretions, each consisting of many concentric belts of ochre mingled with and cutting through grains of quartz. The quartz grains do not seem to have been much affected by

9048 (con.) the concretionary action except that the larger ones are bunched in oval or circular areas through which the ochre is arranged in concentric rings as described above. In one case two perfect concretions of the sort mentioned with a portion of the finely crystalline and amorphous silica are together the nucleus which is surrounded by concentric belts of ochre with more coarsely crystalline quartz.

9015

Ferruginous Flint.

C. R. Van Hise, Nov. 1885.

24-46-2 E.

Macroscopic Description

Wis.

The specimen is fine grained, of a gray color, and contains quite numerous small cavities. Upon one side is a belt of almost pure iron oxide.

Microscopic Description.

This rock is much like 9048, the only difference of importance being that there are but few rather faintly marked concretions.

9007

Ferruginous Ferro. Dolomite and Flint.

Sl. 7916

C. R. Van Hise, Nov. 1885.

9009

Macroscopic Description.

Sl. 7965

21-47-47 N.

Mich.

This rock consists of alternate bands of black flint and gray, tolerably coarse grained calcite and ferro-dolomite mingled with flint. In many places these coarser bands are heavily charged with yellow iron oxide which here replaces the calcite and ferro-dolomite.

Microscopic Description.

Exceedingly finely crystallized silica including numerous minute black particles of ferrite (magnetite?) or carbonaceous material, and in places green ones of chlorite constitute the black bands seen macroscopically, and in the gray bands or yellow patches composes the rather sparse ground mass. In the gray belts are very plentiful large areas of calcite and ferro-dolomite mingled with a considerable quantity of chlorite. Numerous, quite large, perfect rhombohedra of ferro-dolomite

9007 }
9009 } (con.)

are seen often massed together. Some irregular areas show cleavage in two directions. These are probably calcite.

The chlorite is often in oval forms as if it were the alteration product of a fragmental grain of some previous mineral or had been controlled by concretionary action. Each of these oval areas is composed of numerous fan like aggregates of chlorite. The red hematite and brown limonite are present as replacing products of the ferro-dolomite and is pseud-amorphous after it. All stages of the process, from faintly stained ferro-dolomite to that in which no trace of that mineral remains, are seen. The ferrite is pseud-amorphous after the ferro-dolomite. There are quite a number of areas of coarse quartz, some of them complex. These complex areas interlock intricately and the single ones are very angular. Whether these grains are fragmental or not it is difficult to say.

7622

Concretionary Ferro-Dolomitic Flint

C. R. Van Hise, Nov. 1885

Lit. Secs 22527

Microscopic Description.

47-47W, Mich.

The section is quite different from 9007 and 9009, which are from the same locality. It is composed of numerous concretions with narrow passages between them, these passages and intervening areas being composed of comparatively pure flinty and chalcedonic silica, mingled in places with a little ferro-dolomite which is often in perfect rhombohedra. Some of the concretions are $\frac{1}{8}$ " across, many half that diameter. They are composed of flinty or chalcedonic silica of ferro-dolomite, and included in these, very numerous minute black particles of opaque material (magnetite or carbonaceous matter?). Sometimes the concretions are composed of the quartz and sometimes of the ferro-dolomite, and again of both but always with the opacite inclusions. Quite frequently the quartz in the concretion is coarser crystalline than in the connecting silica. These concretions suggest that the forms of the chlorite areas in the previous sections are also due to concretionary action.

7619

Sl. 2308

27-47-47W,

Mich.

Ferruginous Flint.

C. R. Van Hise. Nov. 1885.

Microscopic Description.

Finely crystalline, flinty silica composes nearly all the section. Scattered through this silica is a little hematite and limonite. These iron-oxides are sometimes in the form of a rhombus but whether pseudomorphs after ferro-dolomite or altered sections of octahedra it would be difficult to say.

7610.

Sl. 2306

Hematitic Flint.

C. R. Van Hise, Nov. 1885.

Microscopic Description.

24-47-47W,

Mich.

Like the preceding rocks flinty silica is the most plentiful constituent. However, the hematite is much more plentiful than in the majority of these rocks, almost solid belts being found. No crystal outlined grains are seen.

7606

Sl. 2305

Hematitic and Magnetitic Flint.

C. R. Van Hise, Nov. 1885.

Microscopic Description.

18-47-46W,

Mich.

Flinty and chalcedonic silica composes nearly all of one side of the section and is the ground mass in which the ferrite in the other half of the section is buried. While a portion of the quartz is very fine grained, vaguely outlined, and apparently mingled with amorphous silica, larger individuals of quartz are present than are ordinarily found in flints. They may possibly be fragmental although no indication of this is seen.

One half of the section contains very plentiful irregularly outlined and mingled hematite and magnetite which together here compose two-thirds or more of the section. The hematite shows beautifully the radial columnar structure often seen macroscopically.

7604 ✓

Magnetitic Flint.

Sl. 2304

C. R. Van Hise, Nov. 1885

7600

Microscopic Description.

Sl. 7009

Flinty silica is the most important constituent. Deep 7604 in Sec. 18 brown iron oxide with a little magnetite are the remaining minerals. These are scattered irregularly through T. 47, R. 46 W., the flint. The brown iron oxide is evidently altered magnetite. Mich.

7601 ✓

Magnetitic Flint.

Sl. 2307

C. R. Van Hise, Nov. 1885.

7596

Microscopic Description.

Sl. 2301

The flint ground mass is exceedingly fine grained, a considerable portion of it being apparently amorphous. 17-47-46 W. The iron oxide is, ^{mostly} in large irregular areas which are chiefly magnetite and the exteriors of which exhibit numerous crystals of this mineral. Hematite is found upon the borders of the magnetite areas as an alteration product of it and also included in numerous particles in the quartz, often as ^{concretions} concretions. Mich.

7565

Hematitic Flint.

C. R. Van Hise, Nov. 1885.

15-47-46 W.

Microscopic Description

(Mich.)

Rather coarse flinty quartz is the chief constituent. In this are included numerous particles of hematite mostly arranged in small concretions. Upon one side of the section a large irregular area of hematite is found.

7571 ✓

Hematitic Flint.

Sl. 1993

C. R. Van Hise, Nov. 1885.

7554

Microscopic Description.

Sl. 2298

The flinty ground mass is like that in 7601. 7571 Sec. 15 The hematite and limonite are not plentiful and 7554 Sec. 13 are scattered uniformly through the flint in minute red and brown particles. 47-46 W. Mich.

9500

Sl. 3182

Hematitic and Magnetitic Flint.

C. R. Van Hise. Nov. 1885.

Macroscopic Description.

13-47-46W

Mich.

The rock is a fine grained mottled one, being in spots white, red, or black, depending ^{upon} whether flint, hematite or magnetite, is sufficient plentiful to give color to the rock.

Microscopic Description.

A very fine grained flinty ground mass, with perhaps amorphous silica includes plentiful hematite and considerable magnetite. The hematite is mostly concentrated in numerous concretions as is also at times the magnetite. However, areas of the latter are more frequently crystals or aggregates of crystals, the outlining of many individuals being seen upon the exteriors of the areas. A few areas of martite with very distinct crystal outlines are seen.

The quartz is also affected by concretionary action and when thus affected, as often noted heretofore, the individuals are considerably larger than those of the surrounding matrix. This would seem to indicate that the concretionary areas were slow in formation thus giving more time for larger individualization.

9501

Sl. 3183

Hematitic and Magnetitic Flint.

C. R. Van Hise. Nov. 1885

9502

Sl. 3184

Macroscopic Description.

9503

Sl. 3185

13-47-46W

Mich.

9501 is a brick red, rather faintly banded, fine grained rock. 9502 is mostly of a deep brownish red color, cut by sharply outlined narrow bands of white material. 9503 is composed of alternate bands of a grayish white and brownish red colored material.

Microscopic Description.

Although the rocks are quite different macroscopically, under the microscope they differ only in the quantity of iron oxides which they contain. All the ground masses are uniform grained and exceedingly finely crystallized with the probable pres-

9501 (con.) cence of amorphous silica. In this fine ground mass
 9502 are a few grains of quartz which although small are
 9503 relatively much larger than the ground mass in which
 they are buried. In 9501 the oxide is mostly in
 small particles of hematite although a little magnetite is present. In 9502 the iron oxides are in greater quantity than the flint, in small uniform areas, hematite being the oxide of importance. Quite often pseudamorphs of hematite after magnetite, martite are found. In 9503 mingled with the hematite and magnetite is some brown ferrite.

9504

Sl. 3186

Ferruginous and Ferro-Dolomitic Flint.

C. R. Van Hise. Nov. 1885.

Macroscopic Description.

13-47-46W, Mich. The rock is fine grained and finely laminated and consists of alternate bands of dark brown and gray colored material.

Microscopic Description.

The section is cut from a part which does not contain any iron stained bands. It is composed of a rather sparse matrix of flint in which are bunches and individuals of dolomite, many of them being sections of rhombohedra. A little brown ferrite is present and this occurs as pseudamorphs after the ferro-dolomite. There is little doubt that all the iron of the brown bands is of this nature as shown in like rocks from a locality a little less than a mile east of 9504. A little chlorite is seen mingled with the flint.

7573

Sl. 1996

Ferro-Dolomitic and Ferruginous Flint or Chert.

C. R. Van Hise, Nov. 1885

Macroscopic Description.

14-47-46W, Mich. This section is exactly like that of 9504 except that about half of it is from a heavily ferruginous belt in which the brown ferrite is seen as beautiful pseudamorphs after ferro-dolomite. The description of 9474 answers perfectly for this section the only difference between the rocks being that 7573 is somewhat coarser grained.

7553

9505

9506

9507

Much Altered Greenstones.

9508

Sl. 2983

Lean Ore and Jasper.

C. R. Van Hise, Nov. 1885.

Macroscopic Description

13-47-462K, The specimen consists of a broad belt of bright red
Michx. jasper interlaminated with belts of lean siliceous ore.

Microscopic Description.

The section is cut from the jasper belt and consists mainly of finely crystalline silica and minute particles of red hematite. With these are found quite many crystals of magnetite, large numbers of which have partly and some wholly altered to martite.

9509

Sl. 3137

Ferruginous Flint or Quartzite.

C. R. Van Hise, Nov. 1885.

9510

Sl. 3087

Macroscopic Description

13-47-462K, The rocks are gray or grayish pink, fine grained
Michx. but distinctly crystalline, containing bands and
nodules of rich soft ore.

Microscopic Description.

The quartz is much coarser grained than in any of the rocks of the Black River section it being all very plainly completely crystallized. Through this quartz large areas of mingled hematite and brown ferrite are thickly scattered. In the quartz of one part of section 3087 are very plentiful large curved needles of rutile, a single rutile cutting through several grains of quartz.

9475- Mich 1886 - 9475 contains largely of iron prot-
carbonate
The same is true of 9474

9474^{4?}
Sl. 3082

Ferro-Dolomitic and Ferruginous Chert.

C. R. Van Hise, Nov. 1885.

Macroscopic Description.

13-47-46W Mich. The major portion of the rock is aphanitic, is composed of light and dark gray bands, and has a conchoidal fracture. Upon its weathered surface are layers a fourth of an inch thick which are of a deep reddish brown color.

Microscopic Description.

The light colored portion of the section is composed of chert and ferro-dolomite in about equal quantity. The chert which is amorphous and very finely crystalline serves as a ground mass in which the ferro-dolomite is buried. The ferro-dolomite occurs both in detached individuals in the cherty ground mass and as complex areas, the former comprising the greater portion. The detached grains of ferro-dolomite possess for the most part rhombohedral outlines, and very many of them are perfect rhombohedra. These grains are small of very uniform size and give somewhat brilliant polarization colors. The brown portion of the slide is composed of chert and limonite. The limonite takes exactly the same position with respect to the chert that the ferro-dolomite does in the other part of the section. It is plainly a secondary product pseudamorphous to the ferro-dolomite.

9473

Ferro-Dolomitic and Ferruginous Chert or Flint.

Sl. 3081

C. R. Van Hise, Nov. 1885.

9475

Macroscopic Description.

Sl. 3083

7548

Sl. 2061

These rocks are very much like 9474 the chief difference being that the ferruginous bands are as plentiful as the gray flinty parts.

9473 + 9475

13-47-46W,

Mich.

Microscopic Description.

7548 from same place.

The sections in mineral composition are exactly alike and in the arrangement of the minerals much the same as slide 3082. They have two parts, one transparent and the other of a dark brown color. The transparent parts are ferro-dolomite and flint, the brown parts ferrite and flint. There is a gradation

9473 (com.) from one phase to the other as in 3082, the ferrite re-
 9475 placing the ferro-dolomite in part at first and then
 7548 more and more until no ferro-dolomite is left. The ferrite
 then, as in 3082, is ^{much} amorphous after the ferro-dolomite.

There is this difference between the sections, that a much smaller portion of the ferro-dolomite is in the form of rhombohedra, although these are numerous. The ferrite however, imitates exactly the other forms of the ferro-dolomite as well as that of the rhombohedron and is all plainly a secondary pseudamorphous substance.

The proportion of ferro-dolomite in S. 3083 and S. 2061 is greater than in the other sections, it composing in places from three-fourths to nine-tenths of the mass of the sections. Hence also the ferruginous bands contain a very large percentage of ferrite.

9475 and 7548 differ from both 9473 and 9474 in containing with the ferro-dolomite and flinty quartz, some chlorite. Also in this specimen the ferrite is scattered to some extent through the gray portions of the section here replacing the ferro-dolomite.

9472

Sl. 3135

9482

Sl. 3178

Flinty and Chloritic Ferro-Dolomite.

C. R. Van Hise, Nov. 1885.

Macroscopic Description.

These specimens differ from 9474 chiefly in being coarser grained.

9472 Sec. 13

9482 Sec. 12

47-46 W,

Mich.

Microscopic Descriptions.

The sections are wholly from the gray parts. They are composed very largely of small granular particles of ferro-dolomite, at least four fifths and in places nine-tenths of the sections being of this mineral. The other minerals of importance are cherty silica and chlorite. In places where these minerals are preponderant and the particles of ferro-dolomite thus isolated the latter mineral takes the rhombohedral form. In slide 3178 ferrite is present only in small quantity in scattered patches. In ^{slide} 3135 minute particles of ferrite are mingled with the ferro-dolomite throughout the section. These rocks are almost exactly like 9473, 9474, and 9475 the only differences

9472 (con.) bring that the sections cut do not show the more ferruginous portions, and that ferro-dolomite is more plentiful.

9477

Sl. 3085

Siliceous Iron Ores.

C. R. Van Hise, Oct. 1886.

9476

Sl. 3084

Macroscopic Description.

Specimen 9476 is but a ferruginous band in the cherty ferro-dolomitic rocks just described. It is of a deep reddish brown color and still retains the distinct banding characteristic of the non ferruginous portion of the rock, and altered portion of which it doubtless is. 9477 is at first glance taken to be a massive piece of rich ore, but upon closer examination parallel bands like those found in the flinty ferro-dolomite rock, with which it is interstratified, are seen. Like 9476, it is taken to be an altered cherty dolomite.

Microscopic Description.

Brown iron oxides composes the great mass of the sections. Scattered through this iron oxide are areas of finely crystalline or flinty silica. The sections are then exactly like the most ferruginous portions of 9473.

9479

Sl. 3175

Flinty Ferro Dolomite.

C. R. Van Hise, Oct. 1885.

9480

Sl. 3176.

Macroscopic Description.

The rocks are grayish black in color, fine grained, and finely banded. 9479 upon its surface and in seams shows a lustrous, soft, greasy, black substance which is taken to be graphite.

Microscopic Description.

Finely granular ferro dolomite is by far the most abundant mineral. Mingled with this dolomite is a little flinty silica and, cutting slide 3175, are several veins which are chiefly quartz. More plentiful than the flinty silica is a black opaque substance which is scattered in specks and patches, the latter being aggregates of specks. These are taken to be carbonaceous material, probably graphite, although it is very probable that with this mineral iron oxides are mingled.

9481

Sl. 3177

C. R. Van Hise, Nov. 1885

Macroscopic Description.

12-47-4624,

Mich.

The rock is banded, these bands being aphanitic ^{coarse-grained} black, fine grained dark gray, and pinkish brown. Cutting through these coarser pinkish parts are narrow broken bands of the aphanitic material. Pyrite is also seen.

Microscopic Description.

The section consists of exceedingly finely crystallized silica, of ferro-dolomite, of chlorite, and of brown ferrite, all being plentiful. In the fine grained black bands flint is predominant, in the gray ones ferro-dolomite, and in the pinkish coarser parts also, although here chlorite and ferrite are also abundant.

9482

Sl. 3178

Ferruginous Flinty Ferro-Dolomite.

C. R. Van Hise, Nov. 1885

9483

Macroscopic Description.

The rocks are fine grained of a dark gray color and are cut by black belts of flint. Crystals of pyrite are seen.

Microscopic Description.

Ferro-dolomite composes at least nine-tenths of the section. The particles are of a uniform small size and many of them are sections of rhombohedra. A little very finely crystallized silica is interspersed through the ferro-dolomite and also a few narrow bands which are largely of this flint. Scattered uniformly through the section are small black aggregates which are taken to be patches of magnetite or partly decomposed pyrite.

9485.

Magnetitic and Hematitic Schist.

C. R. Van Hise Nov. 1885.

12-47-46N.

Mich.

Macroscopic Description.

The specimen is fine grained and of uniform texture and consists of alternate bands of reddish brown gaseous material and black bands of heavily magnetic material.

Microscopic Description.

The section is from the black portions. The abundant ground mass consists largely and probably wholly of chlorite and exceedingly finely divided or amorphous silica. Nearly the whole of this ground mass is totally non-polarizing. Through it there is very plentiful reddish brown iron oxide which probably consists of mingled hematite and magnetite and crystals of magnetite. The hematite and magnetite together make up a third or perhaps a half of the rock. Some of the flinty chlorite areas look as if they had been alteration and replacing products of some prior mineral, perhaps feldspar.

9486

Sl. 3180

Ferruginous and Chloritic Quartzites. (Blastic.)

C. R. Van Hise, Nov. 1885.

9487

Sl. 3181

Macroscopic Description.

The rocks are, although rather fine grained, much coarser than any of the rocks previously described from this locality upon the Black River. They have a distinctly quartzitic appearance. They are both cut by aphanitic flinty seams, the seam in 9486 being of a brownish red color and that in 9487 of a greenish black color. The only difference between the two specimens is one of a slight shade of color, 9486 being a dark brown while 9487 has mingled with the brown a greenish gray ^{colored} material.

Microscopic Description.

The sections of both rocks are at once seen to be fragmental. Rather small well rounded particles of quartz and feldspar in about equal quantity piled loosely together are the most plentiful minerals. The quartz grains are enlarged sometimes widely. The feldspar comprises both orthoclase and plagioclase, a portion of the latter being microcline. They are mostly tolerably fresh in their interiors although quite often a chloritic alter-

9486 (con.) ation has begun upon their exteriors. A few of the grains of
 9487 feldspar are also unmistakably enlarged. The large inter-
 spaces are filled chiefly with chlorite, magnetite, brown iron
 oxide, mingled with some flinty silica. The only difference
 between slides 3180 and 3181 is that the former contains a
 much greater quantity of the iron oxides, almost solid
 bands of hematite cutting it. A few colorless flakes are found
 with fibrous cleavage which give brilliant yellow polariz-
 ation colors and which extinguish when this cleavage is
 parallel to the cross-hair (mineral?). In places it has partly
 altered to chlorite. In 3181 quite a number of large irregular
 areas of dolomite or calcite are found. These areas
 are secondary ones and are sometimes so large as to
 replace several feldspar grains and the intervening
 spaces. All stages of this replacement of the feldspar
 are seen.

7534

Described Book IV, p. 73.

7535

9471

Magnetitic Jasper

M. 3173

C. R. Van Hise, Dec. 1885.

Macroscopic Description.

13-47-46 W.

Mich.

The specimen is a fine grained, bright red jasper,
 which includes reticulating filaments of black ^{lustrous} magnetite.

Microscopic Description

In composition this rock is essentially the same as
 9508. The matrix consists of flinty silica mingled with
 a considerable dolomite much of which is in rhombohedra.
 The red hematite is almost entirely arranged in concretions
 and is sometimes here mingled with chlorite. The magnetite
 is almost always crystal outlined, being either single crystals
 or aggregates of crystals. This mineral is scattered through
 the flint and included in the hematite.

9478

Sl. 3174

Ferruginous Flint.

C. R. Van Hise, Dec. 1885

Macroscopic Description.

13-47-46W.

A mottled white and brick red, fine grained rock.

Mich.

Microscopic Description.

The rock differs but little from 9500, the chief difference being the absence of magnetite. Martite is found, however. In one place an aggregate of hematite shows ? fibrous arrangement and from this area the ferrite lessens by imperceptible degrees, stretching far out into the fine silica and giving a very peculiar appearance.

7549

Sl. 2062

Sl. 2063

Ferro Dolomitic Chlorite and Flint.

C. R. Van Hise, Dec. 1885.

Microscopic Description.

13-47-46W.

Mich.

Exceedingly finely divided and amorphous silica mingled with chlorite the two together making up a substance which is almost dark between crossed nicols are the chief constituents. Through these materials numerous small detached, often crystal-outlined particles of ferro-dolomite are uniformly distributed. Dark bands ^{composed} of aggregates of minute black particles cut across the section. These are taken to be partly carbonaceous although they may be and probably are ferruginous.

7530.

Sl. 1964

Magnetitic Cherty Ferro-Dolomite.

C. R. Van Hise, Dec. 1885

Microscopic Description.

7-47-45W.

Mich.

This rock is described in Book IV, p. 195. The amount of crystal outlined magnetite is very considerable and the section is almost precisely like that of 9191.

7527

Sl. 2297

Ferruginous and Ferro Dolomitic Flint.

C. R. Van Hise, Dec. 1885.

Microscopic Description.

7-47-45W.

Mich.

The ground mass is a flinty one in which are thickly scattered concretions composed of hematite, ferro dolomite, flinty quartz and sometimes magnetite.

7524
Sl. 2796

Ferruginous Chlorite and Ferro-Dolomite Schist.

C. A. Van Hise, Dec. 1885.

Microscopic Description.

7-47-45W,
Mich.

The major portion of the section is almost wholly composed of chlorite (the fibres following the schistose plane) and ferro-dolomite. The two minerals are intimately mingled and contain a little hematite and a few crystals of magnetite. However, in another part of the section these substances become more and more heavily ferruginous until a belt is reached in which the hematite has almost entirely replaced the chlorite and ferro-dolomite, being evidently a secondary product.

7516
Sl. 2795

Ferruginous Ferro-Dolomite and Flint.

C. A. Van Hise, Dec. 1885.

Microscopic Description.

10-47-45W,
Mich.

Ferro-dolomite stained with brown ferrite and including crystals of magnetite make up the greater portion of the section. However, upon one side of it flint, in which ferro-dolomite and plentiful chlorite are included, is the preponderating constituent.

9381
Sl. 3769

Jasper and Magnetite Actinolite Schist.

C. A. Van Hise, Dec. 1885.

Macroscopic Description.

16-47-44W,
Mich.

The rock is mostly bright red jasper alternating with narrow black bands which are highly magnetitic.

Microscopic Description.

Actinolite and finely crystalline silica constitute the ground mass. The actinolite is considerably chloritized and heavily stained with red and yellow oxide of iron. Almost solid bands of red hematite with a little magnetite cut across the section. Between these bands of hematite the magnetite (often in crystals) is plentiful.

9382
Sl. 3039

Magnetitic Actinolite Rock.

Macroscopic Description

16-47-44W,
Mich.

The rock is a heavy, black and greenish black, banded rock.

Microscopic Description

Magnetite and actinolite, with its alteration products, make up almost the entire mass of the rock a little silica only appearing to be present. Most of the actinolite is much altered chlorite heavily stained with red and yellow iron oxide being the resultant product.

6774

Sl. 1331-32-33

Hematitic Flint - Jasper

C. R. Van Hise, Spring of 1888.

Finely crystalline and amorphous silica contains much iron oxide in small particles. Section also contains little siderite and apparently a few small crystals of magnetite.

6100

Sl. 1161-62

Actinolite Magnetite Quartz-Schist.

C. R. Van Hise, Spring of 1888.

Contains magnetite in forms oval or roundish. Also contains quite a quantity of siderite and some actinolite. Quartz completely individualized.

6102

Sl. 1163-64

Magnetite chief iron oxide. Largely in concretionary forms. Actinolite abundant. Remarkable association between actinolite and magnetite, the former surrounding the latter. In case the iron oxide is in form of single ring, the actinolite forms two rings, one inside and one outside of the magnetite. If the silification is later than the formation of the magnetite—as appears to be the case in the iron rocks—the formation of the actinolite, which requires silica, would naturally be expected to be later, and this corresponds also to observed facts. The association appears plainly to indicate that the magnetite furnished the iron oxide necessary for the formation of the actinolite, which must, however, have been formed before all the carbonates were removed, or during their process of removal. In 6100 both carbonate and actinolite are present; so that no difficulty there in such cases occurs in explaining the actinolite. Doubtless in 6102 the process has been the same, although nearly all of the carbonate has now disappeared. Quartz quite coarsely crystalline.

7012

Sl. 2081

Magnetite-Actinolite Quartz-Schist

C. R. Van Hise, Spring of 1888.

Three minerals about equally abundant. Quartz relatively coarsely crystallized. Magnetite and actinolite mostly arranged by concretionary action, the concretions being often composed mostly of these two minerals to the almost exclusion of the quartz. Usually a more or less broad belt of crystalline magnetite constitutes the outer border of the concretions, the interiors being composed of actinolite, or actinolite and quartz mingled with a little magnetite, or at times magnetite in large proportion.

7052

Sl. 2150

Quartz relatively coarsely crystallized. Magnetite arranged more or less in rounded areas, due to concretionary action, but as a whole is in lines giving banding to rock. Actinolite also at times in concretions, associated with and included in both quartz and magnetite.

7009

Sl. 2080

Quartz from almost amorphous to quite coarse in crystallization. Actinolite and magnetite with quartz arranged largely in concretionary forms. The actinolite and magnetite are largely concentrated in the concretions in the parts of the section where concretions are abundant, although here found in the interstitial silica also. Siderite, hematite and limonite accessory.

Mesabi Iron Rocks and Gunflint Beds.

6097

Sl. 1160

Jasper.

C. R. Van Hise, Dec. 1885.

6474

Sl. 1337

Microscopic Description.

The sections are those of typical banded jaspers. They are composed of very finely crystalline silica, flint, and hematite, with a little magnetite in small particles, 6097 is from some of them crystals. The banding is due to a varying amount of hematite, the light colored belts being chiefly flint free from hematite. 6474 is also flint free from hematite.

Gunflint Lake.

✓ 6100

Sl. 1161

Sl. 1162

Actinolitic Magnetite Schist.

C. R. Van Hise, Dec. 1885.

✓ 6102

Sl. 1163

Sl. 1164

Microscopic Description.

Magnetite and finely crystalline although perfectly individualized quartz, arranged largely in concretions, compose the greater mass of the rock. The magnetite as usual arranges itself in entire independence of the quartz. The slides of 6100 contain a little ferro-dolomite. Actinolite in small needles is sparingly present and is sometimes more or less chloritized.

Gunflint Lake, Can.

7009

Sl. 7080

Actinolite Magnetite Schists.

C. R. Van Hise, Dec. 1885.

7052

Sl. 7050

Macroscopic Description.

7052 is fine grained, finely banded, of black color, and appears to be largely magnetite.

7012

Sl. 7081

Microscopic Description.

These sections are all composed of actinolite, magnetite and quartz, the arrangement of the minerals being somewhat controlled by concretionary action. They differ from 6100 and 6102 in the much greater abundance of actinolite. 7012 is much coarser grained than 7009 and 7052, the quartz all being distinctly individualized and much of it in quite large particles. In 7009 and 7052

7009 + 7012 from

23-65-4 W,

Minn.

7052 is from

22-65-4 W

Minn.

7122

Sl. 3232

Magnetitic Actinolite Rock.

C. R. Van Hise, Spring of 1888

An interlocking background of iron-stained actinolite in small blades, includes many particles and crystals of magnetite.

7118

Sl. 2208

Magnetitic Actinolite Rock

C. R. Van Hise, Spring of 1888

Microscopic Description.

Actinolite chief constituent. Banding of rock indicated by concretions of magnetite. Between the concretions of magnetite the actinolite is in belts, the blades of actinolite running transverse to the belts, and therefore transverse to the lamination of the rock.

from Page

146

this time caused a cessation in the formation of magnetite and were favorable to the formation of actinolite. At any rate, included in the outer borders of the siderites is actinolite independent of magnetite. Exterior to the siderites, the relations of the magnetite and actinolite are the same as in the siderite, much of the actinolite surrounding the magnetite and much of it also being in independent radiating bunches. In some of the larger areas of magnetite actinolite is certainly included to some extent, and this inclusion may be more extensive than appears to be the case, so completely opaque is magnetite. The quartz is rather coarsely crystalline. There is some tendency shown by the magnetite and actinolite to arrangement in concretionary forms.

7009 (con.) much of the quartz is flinty in its character. Rocks
 7052 6100, 6102, and 7012 can be exactly duplicated by
 7012 the Penokee rocks.

7011

Actinolite Magnetite Rock.

Sl. 2194

C. R. Van Hise. Dec. 1885.

7123

Macroscopic Description

Sl. 2209

7122

7122 and 7123 consist of light gray to dark green
 bands of magnetite and actinolite.

Sl. 3232

Microscopic Description.

Actinolite and magnetite appear to be the only two
 7011 Sec. 23 minerals present. 7011 and 7122 are finer grained
 7122 & 7123, Sec. 24 than 7123. 7011 contains much more magnetite
 T. 65, R. 4 W, than the others but otherwise is the same. The magnetite
 Mimm. is in irregular areas along the schistose plane in 7011,
 little of it being in crystals, while in 7123 crystals of
 magnetite are plentiful. Similar to 9679, 9684, and 9698
 the actinolite in places is partly altered to chlorite and
 is exceedingly much stained with yellow ferrite.

7118

Magnetitic Actinolite Rock.

Sl. 2208

C. R. Van Hise, Dec. 1885

Macroscopic Description.

24-65-4 W,

Mimm.

This specimen is a banded, dark green to black rock,
 fine grained and composed of actinolite and magnetite.
 The actinolite when preponderant gives the green color.

Microscopic Description.

This section differs from that of 7123 only in being
 a little coarser grained and in that the actinolite is
 considerably altered to iron-stained yellow chlorite.
 The rock is almost identical in its nature with 9679,
 9684 and 9698.

6104B

Sl 1166

Flinty Siderite

C.R. Van Nise, Spring of 1888.

Section chiefly made of individuals and bands of individuals of siderite, mostly in very perfect rhombohedra of uniform small size. Contained between these rhombohedra is a small quantity of almost amorphous silica. Magnetite is present in many very small crystals, mostly contained within the siderite. A case typical of original silica as it seems to me. I can see no evidence that any of this silica is secondary.

6115

Sl 1169

Precisely like 6104B, except that the siderite is in larger individuals, and a smaller quantity of it is less perfectly crystalline. Silica again apparently original. The areas of siderite are largely in roundish areas which are precisely like areas of siderite in some of the Ohio carbonates of iron.

6861

Sl 1360-61

Chloritic Banded Iron Carbonate.

A mass of siderite composes most of the sections. Contained in the siderite, and giving the rock its banded appearance, are rows of black inclusions. Areas of green chlorite, and a few small particles of quartz also are contained.

6862

Sl 1362

Chloritic Siderite.

The minerals contained and their arrangement are the same as in 6861. However in 6862 all of the siderite is in small brilliantly polarizing individuals of uniform size, very many of them being perfect rhombohedra.

6772

Sl. 1330

Actinolitic Magnetitic and Quartzitic Siderite.

C.R. Van Nise, Spring of 1888.

Actinolite, magnetite, quartz and siderite are all plentifully present, the latter however being the most abundant. The siderite is mostly fresh and, so far as certainly altered, its product is limonite, the alterations occurring chiefly along cleavage planes. As a result of this alteration the outlines of several rhombohedra traced by limonite may be found in a single individual of siderite. Magnetite mostly occurs in crystals of moderate size, although there are some tolerably large areas. This magnetite is included in all the other minerals present, the siderite included. However, the magnetite in the siderite is usually but partially encircled by the siderite, most of it being concentrated around the irregular outer edges of the siderite areas. In some cases, in the section, the magnetite is wholly surrounded by siderite, but it is of course possible that in the rock this magnetite also was partly exterior to the siderite. This relation of the two minerals suggests strongly that a part or a whole of the siderite was prior to the magnetite, and it is quite probable that the magnetite is secondary to the siderite. However, there is nothing to prove this aside from the relation of the minerals mentioned. The outlines of the crystals of magnetite have no definite relation to those of the siderite; therefore, even if secondary the forms are their own. Many crystals of magnetite thus wholly or partly contained in the siderite is surrounded by a vein of radiating actinolite fibres. Here, as in previously described sections the appearance is strongly that the magnetite furnished the iron protoxide for the formation of the actinolite, although it is possible that changing conditions at

6104 b.

Sl. 1166

6115

Sl. 1169

6861

Sl. 1360

Sl. 1361

6862

Sl. 1362

Ferruginous and Flinty Ferro-Dolomites.

C. A. Van Hise Dec. 1885.

Microscopic Description

In all the sections ferro-dolomite is the chief constituent. In many cases beautiful rhombohedra of this mineral are abundant. Slides 1169 and 1362 show beautifully the brilliant polarizing of ferro-dolomite. Several of the sections contain crystals of magnetite while in others the magnetite has per-oxidized to some extent. The flint is exceedingly fine grained and apparently partly amorphous. From some of the sections it is entirely excluded while in others in parts it is plentiful enough to serve as a setting to the crystals of ferro-dolomite. In slides 1360, 1361, and 1362 quite a number of areas of aggregates of chlorite are contained.

6104 b + 6115

Gunflint Lake.

6861 + 6862

few miles from

Port Arthur.

6772

Sl. 1330

Actinolitic Ferro-Dolomite Magnetite Schist.

C. A. Van Hise. Dec. 1885

Microscopic Description.

Gunflint Lake.

Actinolite, ferro-dolomite, magnetite, and quartz are all very plentiful, the ferro-dolomite perhaps being equal in quantity to the other three principal ingredients. The actinolite is in small blades often in radial complex forms. It is mostly intimately mingled with the quartz although some portion of it is included in the magnetite and ferro-dolomite. The quartz is finely crystalline but plainly all individualized and as to its associations is the same as the actinolite. The magnetite is perfectly fresh occurring in small crystals and irregularly complex crystal aggregates and is distributed quite uniformly through the section, many crystals frequently being included by a single individual of ferro-dolomite. The ferro-dolomite gives particularly brilliant polarization colors. The individuals are often large and often considerable areas are free from inclusions of magnetite, quartz, and actinolite. The tendency of this mineral to form rhombohedra is beautifully shown. In a single individual often the perfect form of one or more rhombohedra are outlined by films of iron oxide. In these cases these crystals must have formed and an interruption taken place at which time their exteriors were stained with ferrite. A renewed growth has given them their present most irregular often complex forms.

6103

Sl. 1165

Actinolitic and Magnetitic Quartz Schist,

C. R. Van Hise, Spring of 1888.

Quartz completely individualized; varies from finely to coarsely crystalline. Hematite, magnetite and actinolite, mostly in smallness, many individuals of all of these minerals being frequently contained in a single quartz individual. In places affected by concretionary action. In one concretion the outer circle is about half a ring of magnetite, in several detached curved parts. The ring is completed by actinolite. Here apparently all of the iron oxide has been used in the formation of the actinolite. The interior of the concretion is mostly flint, which contains some actinolite.

6138

Sl. 1173

Sideritic Flint,

C. R. Van Hise, Spring of 1888. (Mar 9, 1888)

Silica partly very finely crystallized, but in good part chalcedony is the chief mineral of the section. Upon one side of the section, however, siderite in rhombohedra is a chief constituent. Here also we have some magnetite and hematite, and the magnetite as well as the hematite is pseudomorphous after the siderite. This is here the first time observed.

6144

Sl. 1176

Impure Flint and Chalcedony.

Mostly finely crystalline and amorphous flint. However contains beautiful chalcedony bands. In one part of the section are concretions of flint, magnetite, hematite, and somewhat altered actinolite. The relations of the actinolite and iron oxides are the same as in 6102, although in a less marked degree.

7007

Sl. 2079

Banded Magnetitic Siderite and Flint.

Flint and siderite in alternate bands are the chief constituents of the section, although magnetite is abundant. The bands of flint are much broader than those of siderite and are finer than the siderite bands of flint. Contained in both the flint and siderite are very numerous areas and crystals of magnetite. Only occasionally in the flint are the magnetite and flint in concretionary forms, although there are several very perfect concretions of this sort. However, in one belt of the siderite — other belts are not far from them — are very numerous concretions, the concentric rings of which are bands or belts of crystals of magnetite. The magnetite concretions are arranged in most parts without any reference to the individuals of the iron carbonate, several simple concretions, or a complex system, being contained frequently in a single continuous area of carbonate, which however is made of many individuals of siderite. In this belt in which a large number of concretions are present, the iron carbonate, — if it once existed — has been largely removed from between the concretions, and also in some of the concretions themselves. In these cases the iron carbonate is a core in the concretions being surrounded by belts of flint and magnetite.

6142

Sl. 1174-75

Chloritic Siderite and Flint.

C. R. Van Hise, Spring of 1888.

A background of exceedingly finely crystallized and amorphous silica contains much chlorite in minute areas. Some carbonate is also present in large areas, and this mineral includes the chlorite in just the same fashion as does the flint.

6103

Sl. 1165

Actinolitic and Magnetitic Flint.

C. R. Van Hise. Dec. 1885.

Microscopic Description.

Gunflint Lake.

A fine flinty ground mass composes the greater part of the rock. Through this matrix are scattered occasional crystals of magnetite, and many minute needles of actinolite, which are often more or less chloritized. Concretionary action has controlled the arrangement of the minerals in places.

6138

Sl. 1173

Ferro Dolomitic and Ferruginous Chalcedonynd Flint.

C. R. Van Hise. Dec. 1885

6144

Sl. 1176

Macroscopic Description

7007

Sl. 2079

7007 is a white and black mottled rock, apparently consisting of quartz and magnetite.

Microscopic Description.

6138 from north shore is found in all the sections. In 6138 included in this Gunflint Lake ground mass are in parts of the section numerous 6144 from south shore crystals of ferro-dolomite or small concretions of ferro-dolomite and flint, also some ferrite. In 6144 are of North Lake numerous small uniformly distributed particles of 7007 is from hematite. In 7007 is a good deal of magnetite (mostly crystals) and ferro-dolomite. Very numerous concretions are seen the filling usually being quartz coarser grained than the matrix with ferro-dolomite surrounded by particles of magnetite which often cut through the quartz and ferro-dolomite.

6142

Sl. 1174

Sl. 1175

Ferro Dolomitic and Chloritic Flintnd Chalcedony.

C. R. Van Hise, Dec. 1885.

North shore

Gunflint Lake.

Microscopic Description

The sections have a ground mass of flint and chalcedony which in quite a good many places is replaced by ferro dolomite, sometimes in quite large areas. Distributed almost everywhere through the sections are very numerous minute particles of green chlorite which in quantity is about equal to the ferro-dolomite and flint ground mass in which it is scattered.

6776

Sl. 1335

Ferruginous Quartz-Actinolite

C. R. Van Hise, Spring of 1888.

Minerals present, siderite, actinolite, hematite, limonite, magnetite and quartz, last three being the chief constituents. The most of the materials present are arranged in concretions of varying sizes. The small remainder of the section is mostly quartz quite coarsely crystallized. Some of the concretions are like those ordinarily occurring in the iron-bearing rocks. However, most of them are quite exceptional in their appearance, a single solid area of magnetite, or a ramifying area, containing a good deal of quartz or detached areas separated by quartz from the cores of these concretions. These cores, of more or less irregular shape, are surrounded by a perfect oval or spherical band of limonite, which mineral is also frequently mingled to a greater or less extent with the magnetite and quartz of the cores, as are also at times hematite and actinolite.

7004

Sl. 2077

Ferruginous Flint - Concretionary.

Background finely crystalline with perhaps some amorphous silica. Iron oxides comprise hematite, magnetite and limonite. These iron oxides, and much of the flint, are arranged in perfect concretionary forms, the magnetite, contrary to the usual condition of affairs, often forming the exterior belt of iron oxide in the concretion. Certain areas instead of being in oval or roundish concretions are in most irregular areas, the outlines of which are the reverse of the outlines of other areas adjacent to them; and not adjacent areas are of identical material and structure. In these cases there seems to be little doubt that these areas were once together and have been broken apart, although before this there may have been concretions formed as the other concretions were. The spaces between are filled with silica.

6783

Sl. 1337

Magnetitic Actinolite Rock

C. R. Van Hise, Spring of 1888.

A background of minute iron-stained fibres of actinolite composes three fourths or more of the section. Contained in this background are numerous crystals - many of them perfect - of magnetite.

6860

Sl. 1359

C. R. Van Hise, Spring of 1888.

Peculiar section, containing some fragmental material, and resembling in quite a good many respects the ferruginous rocks exposed upon the Montreal River between Wisconsin and Michigan in the Penokee-Goebie Range.

6776 ✓

Sl. 1335

7004 ✓

Sl. 2077

Concretionary Ferruginous Chalcedony^{and} Flint.

C. R. Van Hise, Dec. 1885.

Macroscopic Description.

6776 is a speckled white and brownish black mottled rock, showing a minute concretionary structure.

From Gunflint Lake. The white portion is quartz, the brown and black portion is hematite and magnetite.

Microscopic Description.

A ground mass of flint and chalcedony which contains much hematite and magnetite. The whole is arranged in the most complicated concretions, many small concretions being contained in a larger one. The iron oxides arrange themselves without the slightest reference to flint^{and} chalcedony.

6783 ✓

Sl. 1337

C. R. Van Hise, Dec. 1885.

Gunflint Lake

Microscopic Description.

This section is composed of numerous crystals and clusters of crystals of magnetite, which make up about half of the bulk of the section, set in a bright yellowish red aggregate of non-polarizing fibres and particles which are taken to be chlorite and flint heavily stained with ferrite.

6860 ✓

Sl. 1359

C. R. Van Hise, Dec. 1885.

A few miles

from Fort

Arthur, Can.

Macroscopic Description.

The specimen is badly calcined and is deeply stained with ferrite. The interior is of a greenish black color, finely banded, aphanitic. The black color is doubtless due to magnetite.

Microscopic Description.

An amorphous ground mass of chlorite and flint composes the greater part of the section. In some places the flint ~~xxx~~ is preponderant and in others the chlorite is. Over considerable areas ferro-dolomite replaces the above minerals. In this ground mass is plentiful magnetite often in concretionary almost always in non-crystal outlined forms which have often peroxidized. A few small grains of apparently fragmental quartz are seen.

6775

SL 1334

Actinolite - Magnetite - Quartz - Schist.

C. R. Van Hise, Spring of 1888

All three minerals very abundant, mostly finely crystallized, although quartz is wholly individualized. Magnetite mostly in very numerous small perfect crystals. Little siderite remains.

7008

SL 2147

Biotite Flint.

C. R. Van Hise, Spring of 1888.

Finely crystalline flint background composes most of the section. A considerable quantity of biotite and mingled iron oxide are included in this flint. There are also present quite numerous rounded and enlarged fragmental grains of quartz, some of which are complex. The remarkable thing about this section is the presence of a considerable quantity of biotite. The areas and blades of the areas are large in some cases, and the mineral is of the strongly absorptive kind showing all the characteristics of biotite. This is the first instance noted of the formation of biotite in these chemical sediments.

6775

Sl. 1334

Actinolite Magnetite Schist.

C. R. Van Hise, Dec. 1885

Microscopic Description.

Gunflint Lake.

This section differs from 7009 and 7052 in that the actinolite and magnetite crystals are more plentiful than in it and consequently the fine grained quartz is less so. Another point of difference is that much of the actinolite in this rock has altered to some extent to chlorite.

7029

Sl. 2095

Magnetitic Actinolite Flint.

C. R. Van Hise, Dec. 1885.

Microscopic Description.

18-65-4 W.

Minn.

A flinty, although apparently perfectly individual, ground mass which is in parts quite coarsely crystalline composes two thirds of the section. In this ground mass there is abundant fresh actinolite which sometimes is so concentrated as to almost exclude the quartz. The quantity of magnetite crystals is small. Cutting the quartz and included by it are indefinite numbers of minute curved reticulating needles of rutile which everywhere penetrate that mineral. The slides of 6775 and 7029 approach more nearly to the quartzose or silicified magnetitic greenstones than any of the sections heretofore described. Rock 7029 is also very similar to 6100 and 6102 but is much more actinolitic and non-concretionary.

7008

Sl. 2147

Actinolitic Flint containing Clastic Quartz.

C. R. Van Hise, Dec. 1885

Microscopic Description.

23-65-4 W.

Minn.

The section is composed of a flinty ground mass containing quite a number of medium sized clastic particles of quartz which have been enlarged. There are also present brownish yellow needles and bunches of needles which are taken to be considerably altered actinolite stained with ferrite.

7120

Sl. 3230

Magnetite Amphibole Rock.

C. R. Van Nieu, Spring of 1888

Two minerals in nearly equal quantity. Magnetite contained in the amphibole blades. The amphibole is about half actinolite and about half ordinary green hornblende with strong pleochroism. The term hornblende is used here because of the likeness of that mineral to the one contained. What difference there is in the composition of the pleochroic and non-pleochroic minerals is unknown.

7121

Sl. 3231

Magnetitic Siderite-Actinolite Rock.

C. R. Van Nieu, Spring of 1888.

Siderite and actinolite are the chief constituents. The siderite is a somewhat sparse background which is everywhere penetrated by the divergent blades of strongly pleochroic and brilliantly polarizing actinolite. In certain areas the actinolite is so abundant as to almost exclude siderite. Black particles of magnetite are included in both the siderite and actinolite. This rock has precisely the same relation to calcium-magnesium-bearing siderite that the strongly tremolitic phases of certain dolomites have to the original rock. In the one case actinolite has formed with the penetration of silica because iron is present. In the other case it is absent and we have tremolite. In appearance this section differs from strongly tremolitic phases of limestone only in that the amphibole is pleochroic and is therefore actinolite.

7124

Sl. 3233

Actinolitic Flint.C. R. Van Nieu, ~~Winter~~ Spring of 1888.

Background exceedingly finely divided one amorphous silica. Contained in this background are numerous blades and clusters of blades of actinolite, belts of black material (mingled ferrite and carbonaceous matter²), and quite numerous small particles of fragmental quartz.

7120

Sl. 3230

24-65-4W,

Minn.

Chloritic Actinolite Magnetite Rock

C. R. Van Hise, Dec. 1885

Macroscopic Description.

The specimen has a high specific gravity and apparently consists of magnetite and abundant blades of dark green actinolite.

Microscopic Description

Actinolite and magnetite appear to be the two original constituents and are about equal in quantity. The magnetite is in crystals and large most irregular areas. The actinolite has about half altered to green chlorite.

7121

24-65-4W,

Minn.

Magnetitic and Ferro Dolomitic Actinolite Rock.

C. R. Van Hise, Dec. 1885

Macroscopic Description.

The hand specimen is light greenish gray to dark gray or almost black in color, is banded and appears mostly to be composed of small needles of actinolite mingled with magnetite.

Microscopic Description.

Actinolite is the one important constituent occurring in reticulating sheaf like clusters of blades and needles. The magnetite is not chiefly in crystals, as in most of the actinolitic rocks, but in clusters of irregular particles. Parts of the actinolite in portions of the section are largely replaced by ferro-dolomite.

7124

24-65-4W,

Minn.

Actinolitic and Magnetitic Flint.

C. R. Van Hise, Dec. 1885.

Macroscopic Description.

The specimen is aphanitic, dark green to almost black in color, and breaks with a conchoidal fracture. It appears to be flint colored with foreign materials.

Microscopic Description.

A very fine grained, flinty and probably partly amorphous ground mass composes perhaps half of the rock. Numerous bunches of actinolite blades are present, which are now largely altered to green chlorite. The magnetite in small particles is aggregated along lines in the schistose direction. Scattered through the flinty ground mass are quite a good many small grains of unmistakably enlarged fragmental grains of quartz.

1678

Sl 454

Feruginous Flint.

C. R. Van Klee, Spring of 1888.

The section beautifully shows concretionary structure, and to some extent their formation. A few of the concretions contain a greater or less quantity of siderite, and some of them have a nucleus of fragmental quartz. In one such concretion the bands are as narrow and numerous as in any concretion that I remember to have seen.

1675

Sl. 453

Ferro-Dolomite and Flint

C. R. Van Hise, Dec. 1885

Head of

Thunder Bay.

Microscopic Description.

The slide is very fine grained and is composed almost wholly of ferro-dolomite and fine flinty and amorphous silica. In some parts of the section one is preponderant almost excluding the other and *vice versa*. The ferro-dolomite where sparse is frequently in rhombohedra.

1678

Sl. 454

Concretionary Ferruginous Ferro Dolomitic Flint & Chalcedony.

C. R. Van Hise, Dec. 1885.

Below mouth

of Blende

River, Thun-

der Bay.

Microscopic Description.

A ground mass of flint and chalcedony contains numerous concretions (in concentric rings) of iron oxide, limonite, hematite, and magnetite. The other ingredients of these concretions are flinty quartz or fine grained quartz, but occasionally these are absent and ferro-dolomite is present.

Marquette and Menomonic Iron Rocks.

4109

Sl. 910

Flint. - chert-schist

C. R. Van Hise, Dec. 1885.

Microscopic Description.

32-40-18 E.

Wis.

The section is composed of nearly pure finely crystallized, but completely individualized quartz. These particles interlock deeply and show no trace of enlargement.

4108

Sl. 1495

Hematitic Flints.

C. R. Van Hise, Dec. 1885

4199a

Sl. 1515

Microscopic Description.

These slides are composed mostly of completely individualized small interlocking grains of quartz in which is mingled a considerable quantity of hematite and, in 4199a, of magnetite as well. Also in 4199a the particles of quartz are enlarged in a common direction as though the rock had been subjected to great squeezing.

4108 is from

32-40-18 E, Wis.

4199 is from

5-40-29 W, Mich.

the magnetite as space allowed.

6707 is described in Book. II, p. 85

6714 " " " " " " 93.

4198

Sl. 1513

4247

Sl. 1528

5-40-29 W.

Mich.

4242 from

Old Home

Mine, Mich.

Jaspers.

C. R. Van Hise. Dec. 1885.

Microscopic Description.

Slide 1513 contains very finely crystallized quartz although all of it appears to be individualized. With the uniformly distributed red hematite there are present both magnetite and some hydrated ferrite. Slide 1528 is a typical red jasper, hematite being very plentiful, so much so, through large portions of the section, that no quartz is visible. In some parts of the section the quartz becomes preponderant and here the grains, although small, are distinctly individualized. In portions of the section also the quartz and hematite are arranged in concretionary forms.

4291

Sl. 1535

Hematitic and Magnetitic Chert.

C. R. Van Hise. Dec. 1885.

Microscopic Description.

1-47-27 W.

Mich.

The siliceous ground mass is in this section very largely amorphous. So far as crystallization has developed the material has a spotted flinty and radial fibrous chalcedonic appearance. The hematite and magnetite are mingled together composing solid masses in some places and in other places included in the partly amorphous base.

4199

Sl. 1514

4215

Sl. 1517

4224

Sl. 1523

4291

Sl. 1535

4292

Sl. 1536

6643

Sl. 1270

6702

Sl. 1315

6714

Sl. 1325

Banded Hematitic and Magnetitic Jaspers.

C. R. Van Hise. Dec. 1885.

Microscopic Description.

A fine grained, flinty, ground mass, which, however, in every case is completely individualized and in 6702 and 6714 coarser than in the others contains a large proportion of hematite and magnetite which are arranged in bands. The relative amounts of hematite and magnetite vary in different sections but in all both iron oxides are present. The hematite is generally uniformly distributed over the sections as inclusions in the quartz while the magnetite ordinarily occurs in solid complex crystal masses or as single crystals about which the quartz appears to have formed. It would seem that the magnetite had crystallized first and that subsequently the quartz, heavily charged with peroxide of iron, has crystallized around and through

(opposite page.)

4103

Sl. 1493

Magnetitic and Chloritic Flint.

C. R. Van Hise. Dec. 1885.

Microscopic Description.Commonwealth
Mine, Wis.

Fine grained flint almost wholly composes the greater part of the section, including a little chlorite and magnetite. Other parts contain with the flint much chlorite and magnetite in fine particles.

4120.

Sl. 1501

Flint and Ferrite.

C. R. Van Hise. Dec. 1885.

Microscopic Description.Youngstown Mine.
Mich.

One side of the section is composed of small perfectly individualized grains of quartz containing as inclusions a little ferrite in minute particles. The other side of the section is almost solid ferrite, apparently both hematite and limonite, in which is buried a little fine flinty silica.

4105

Commonwealth Mine.

Sl. 1494

Hematite and Magnetite.

C. R. Van Hise, Dec. 1885.

Microscopic Descriptions.

4112

Florence Mine.

Sl. 1498

4189

Vulcan Mine.

Sl. 1509

4239

New Stone Mine.

Sl. 1526

4273

Cambria Mine.

Sl. 1532

These sections are all almost solid, iron oxide, hematite, and magnetite being apparently the more plentiful minerals. Through these masses of iron oxide a few particles of quartz are seen. The amount of finely crystalline and amorphous silica is much greater in 4273 than in any of the others.

6678

Described in Book. II, p. 63

6706

" " " " " 89.

6678 from
Michigan
Mine, Mich.6706 is from
7-46-29 W,
Mich.

6641

28-48-31th Mich.
Sl. 1268Actinolite Magnetite Schists.

C. R. Van Hise. Dec. 1885.

6670

20-48-30th Mich.
Sl. 1269Microscopic Description.

6703

7-46-29th Mich.
Sl. 1316

6710

7-46-29th Mich.
Sl. 1322

6712

7-46-29th Mich.
Sl. 1323

These sections are all heavily actinolitic and magnetitic and contain also a little hematite. The actinolite is in fresh blades, abundant, intersecting, cutting through the quartz but ordinarily not through the magnetite. The magnetite is in irregular ramifying areas with many included spaces filled with quartz and actinolite. It is also in crystals. The order of crystallization appears to be magnetite, actinolite, quartz. These sections are in all essential points like the actinolite magnetite schists from the Tenakee Range. Each one is separately described in Book II.

6657

S. 1280

Altered Actinolite and Magnetite Schists.

C. R. Van Hise, Dec. 1885.

6679

Michigan Mine.
Sl. 1298

6684

Michigan Mine.
Sl. 1303

4111

Florence Mine.

Sl. 1497

Microscopic Description.

These sections differ from those of 6641, 6670, 6703, 6710, 6712 in that the actinolite is in places much altered, the resultant products being chlorite and biotite. They are all somewhat garnetiferous. Each is separately described in Book II.

4218

Goodrich Mine.

Sl. 1519

4220

Goodrich Mine.

Sl. 1521

4222

Goodrich Mine.

Sl. 1522

4281

Lake Superior Mine.

Sl. 994

6716

Apuite Mine.

Sl. 1326

Sericitic or Muscovitic Magnetite and Hematite Schists.

C. R. Van Hise. Dec. 1885

Microscopic Descriptions.

These sections are very like the actinolite magnetite schists 6641, 6670, 6703, 6710, and 6712 except that the actinolite is replaced by muscovite. The magnetite is very different in quantity in the different sections, but in all it frequently occurs in the form of crystals and is the first mineral to separate. The muscovite or sericite, probably the former, also varies greatly in quantity in the different sections and also greatly in the sizes of the flakes. However, in all cases it cuts through or is included in the quartz while it does not appear to be present in the magnetite. As in the actinolite schists, then, the quartz is the last mineral to crystallize. 6716 is described in Book II, page 95.

4114

Sl. 1499

Crystal Falls,
Mich.Ferro (?) Dolomitic Flint.

C. R. Van Hise, Dec. 1885

Microscopic Description.

Flint is the chief constituent of the section. It contains a good many grains and crystals of ferro-dolomite scattered uniformly through the section and also a little ferrite in minute specks as well as in streaks cutting across the section.

4117

Sl. 1500

Saint River Mine

Ferrite and Ferro Dolomite

C. R. Van Hise, Dec. 1885

Microscopic Description.

The section appears to consist of brown ferrite and ferro-dolomite intimately mingled over the greater part of the section, but one being preponderant in some parts, and the other in other parts.

4122

Sl. 1502

Railroad cut

20-43-32 N,

Mich.

Ferruginous Flint.

C. R. Van Hise, Dec. 1885.

Macroscopic Description.

Flint and the iron oxides, including considerable magnetite, are the most plentiful constituents. With these, however, there is ferro-dolomite and blades of a somewhat altered mineral which is taken to be actinolite. In this section there are together found flinty quartz, hematite, limonite, magnetite, ferro-dolomite and actinolite.

4193

Sl. 1511

Tulcan Mine
Mich.Ferruginous Ferro Dolomite and Flint.

C. R. Van Hise, Dec. 1885

Macroscopic Description.

This slide differs from that of 4122 in the absence of actinolite and its alteration products. Hematite, magnetite, ferro-dolomite, and flint are the four important constituents.

4151

Sl. 929

Sl. 1507

Ferro-Dolomitic and Magnetitic Quartz Schist.

C. R. Van Hise. Dec. 1885.

4152

Sl. 1508

Microscopic Description

The ground mass is composed of finely crystalline quartz mingled with ferro-dolomite. The quartz while fine-grained is completely individualized. The magnetite is scattered through the quartz and ferro-dolomite as inclusions 30-40-30 W, and also in parallel belts which cut across the sections.

Mich. The magnetite here seems to be independent of and prior to the quartz and ferro-dolomite in crystallization.

4219

Goodrich Mine.

Sl. 1520

Ferruginous Quartzites.

C. R. Van Hise. Dec. 1885.

4243 A

Sl. 973

Microscopic Description.

Very large, usually simple fragmental grains of quartz compose about one-half the areas of the sections. These grains have sometimes taken a second growth. The large amount of material through which these grains are loosely scattered, constituting the ground mass or matrix is composed mostly of finely crystalline silica and minute flakes of kaolin. In each section, included in the matrix, is more or less iron oxide. In 4243 A the iron oxides are limonite and hematite while in 4219 the iron oxides is more abundant and largely magnetite.

4243

Sl. 1529

Palmer Mine.

Strongly Magnetitic Quartzite.

C. R. Van Hise. Dec. 1885.

Microscopic Description.

Fragmental quartz is found as in 4219 and 4243 A. The matrix is however very largely magnetite this mineral being as great in quantity as the quartz. A little of this magnetite may be fragmental but the greater part of it appears to be secondary to the quartz as areas of it enclose or partly enclose many of the grains of quartz. With the magnetite in the matrix are quite large areas of mingled finely crystallized quartz and kaolin. With the magnetite there is also a little hematite.

4238

Sl. 1525

31-47-26 N.

Mich.

Magnetite Schist.

C. R. Van Hise Dec. 1885

Microscopic Description.

This section in mineral constituents and in their relations differs little from 4243. The fragmental grains of quartz are smaller and less plentiful, the magnetite is more abundant than in 4243 but otherwise there is little difference between the two rocks.

4240

New Hope Mine.
Sl. 1527

4285

Jackson Mine.
Sl. 1533Magnetite Schists.

C. R. Van Hise, Dec. 1885.

Microscopic Description.

Magnetite with hematite mingled with a little flinty quartz and kaolin make up the greater part of the rock. Buried in this magnetite is a little fragmental quartz.

4217

Sl. 1518

Godrich Mine.

Muscovitic Magnetite Schist.

C. R. Van Hise Dec. 1885.

Microscopic Description.

This section is much like that of 4238. It contains a ground mass of fine but completely crystallized quartz in which there is much magnetite. The large irregular almost solid areas of magnetite contain quite a good many grains of fragmental quartz some of which are enlarged. The muscovite or sericite scales and flakes associated with the quartz are mostly very small. This mineral occurs in larger flakes and complex areas associated with or included in the areas of magnetite and hematite.

4196

Saginaw Mine.

Hematitic and Magnetitic Quartzite.

C. R. Van Hise Dec. 1885.

Microscopic Description.

The quartz ground mass is quite coarsely individualized and most intricately interlocking. Scattered thickly and uniformly with this coarse interlocking ground mass is much hematite and magnetite the former in irregular patches and stains, the latter mostly in small crystals.

3

Note Mch 1886

Nos 10,159 and 10,160 on testing show a large content of iron-pyroxide, indication of side-site

The same is true of 10,163 and 10,157

The following is the result of the

analysis of
24.

no

Cl

situ

upro-
and Hise.

Mch. 1886 10,170 contains largely of iron-pyroxide

Note Mch 1886

Nos 10,159 and 10,160 on testing show a large content of iron-pyroxide, indicator of side-sile

The same is true of 10,163 and 10,157

The following is the result of the analysis of no. 10160 at Washington, by R. B. Riggs, under J. W. Clarke, April 17. 1886.

Si O ₂ -----	54.26 %	
Al ₂ O ₃ -----	2.57	
Fe ₂ O ₃ -----	3.62	
Fe O -----	19.63	
MnO -----	.19	
Ca. O -----	1.07	
Mg. O -----	2.93	
C O ₂ -----	14.93	
H ₂ O -----	1.20	
C -----	45	100.85

The following is the mineralogical composition as calculated from the analysis by C. R. Van Duse.

Mch.	<u>Clay</u> - 2 H ₂ O, Al ₂ O ₃ , 2 Si O ₂			
	H ₂ O -----	.91		
	Al ₂ O ₃ -----	2.57		
	Si O ₂ -----	3.02	6.50	
<u>Siderite</u>				
	Ca C O ₃			
	Ca O -----	1.07		
	C O ₂ -----	.84	1.91	
	Mg C O ₃			
	Mg O -----	2.93		
	C O ₂ -----	3.22	6.15	
	Mn C O ₃			
	Mn O -----	.19		
	C O ₂ -----	.12	.31	
	Fe C O ₃			
	C O ₂ -----	10.75		
	Fe O -----	17.59	28.34	36.71
	<u>Fe₃ O₄</u>			
	Fe O -----	2.04		
	Fe ₂ O ₃ -----	4.53	6.57	
	<u>Ferrite</u>			
	Fe ₂ O ₃ -----		-.91	
	<u>Organic Matter</u>			
	H ₂ O -----	.29		
	C -----	.45	.74	
	<u>Chalcedony</u>			
	Si O ₂ -----		51.24	
			100.85	

Iron Rocks of N. E. Minnesota.

10159

Ferro Dolomite and Flint

Sl. 3412

C. R. Van Rose Dec. 1885.

10160

Macroscopic Description.

Sl. 3413

10161

Sl. 3414

10162

Sl. 3416

10163

Sl. 3417

10169

Sl. 3420

These rocks are yellow and gray ferruginous ferro-dolomite and flint and are in general appearance like 9472 and 9481. Some of them, as 10162, contain broad bands of pure flint.

Microscopic Description.

Very finely crystalline ferro dolomite and amorphous and cherty silica compose almost the entire mass of the rocks. In most of the sections the gray ferro dolomite is preponderant although in one or two the chert is the more plentiful mineral. In areas and bands the ferro dolomite and flint contain a considerable quantity of dark opaque material which here gives the section an almost black color. The nature of this substance is not easy to determine, but it is probably mostly ferrite mingled perhaps with carbonaceous matter. In 10169 a few ^{small} areas of fragmental quartz are seen. (For analysis see opp. page.)

10170

Ferro Dolomite and Flint

Sl. 3421

C. R. Van Rose, Dec. 1885

10172

Macroscopic Description.

Sl. 3422

10170 is a coarse, light gray ferro dolomite. 10172 is a carbonaceous gray, finely laminated flint and ferro ^{dolomite}.

Microscopic Description.

These rocks differ from 10159, 10160, 10161, 10162, 10163, and 10169 in that the individuals of ferro dolomite instead of being minute, gray and non-polarizing are of a medium, uniform size and exhibit the characteristic brilliant polarization and rhombohedral habit of that mineral. Contained in the sections, but more abundantly in slide 3422, is opaque material like that in 10159, &c. This is doubtless, at least in part, carbonaceous matter. The silica present is largely chalcedonic.

10168

dl 3419

10169

dl 3420

Ferruginous and Chloritic Siderite and Flint

C. R. Van Hise, Spring of 1885.

These rocks are notable upon account of the large amount of fragmental material which they carry. They appear to be intermediate between the chemical and mechanical sediments - the sort of rock which one would expect to find near the top of the iron horizon. (Do they come from this horizon?) Although not exactly like, they have many points of resemblance to 7622, 9007 & 9009. The amount of fragmental material is greater. They are finer grained and a portion of the secondary iron oxide is black, however, in essential points they are exactly like. The formation of concretions from iron carbonate is almost as well shown in 10168 as in the rocks referred to.

10161 - see also nos. 3414-3417
Sl. 3415

Ferro Dolomite and Flint.

C. A. Van Hise. Dec. 1885.

Macroscopic Description.

The specimen consists of broad interstratified bands of apparently pure ferro-dolomite and flint.

Microscopic Description.

This section is from a flint band and consists of amorphous, chalcedonic, and very finely crystallized silica. Included in the silica and staining it somewhat is a little ferrite.

10168

Sl. 3419

Ferruginous and Chloritic Ferro Dolomite and Flint.

C. A. Van Hise, Dec. 1885.

Macroscopic Description.

A rather fine grained, banded, dark gray magnetic slate.

Microscopic Description.

As in 10170 and 10172 the ferro-dolomite is in relatively large individuals, but it is less pure, does not polarize so highly as in those rocks but as frequently has the rhombohedral form. The chert constitutes a matrix in which the ferro-dolomite and other minerals are set. In abundance it is about equal to the ferro-dolomite. In parts of the section quite a number of small areas of fragmental quartz are found. Chlorite, magnetite, and ferrite are all plentiful. They are mingled together and scattered through the ferro-dolomite and flint. A portion of the red and brown ferrite, and perhaps all of it, is an alteration of the ferro-dolomite, some of it being found as pseudomorphs after that mineral. The magnetite does not appear to be a secondary replacing product.

Flinty Siderite.10159

Sl. 3412

C. R. Van Hise, Spring of 1888.

10160

Sl. 3413

10161

Sl. 3414, 15

10162

Sl. 3416

10163

Sl. 3417

All the rocks are finely banded. The most abundant mineral in the sections is siderite, although some of them (10161, 10163) show in the section bands of nearly pure flint of considerable width. In 10162 the siderite is somewhat earthy. In the other slides, while the individuals are all small, most of the siderite is well crystallized, each of them being a rhombohedron, or a rhombohedron with curved outlines. The forms of these individuals are precisely like the large siderites of the Ohio Carbonates and the Bessemer Carbonate. Between the individuals of siderite is a greater or less quantity of silica which has in polarized light the very fine spotty appearance of half amorphous flint. In 10163, in the flinty part of the section, the siderites are particularly well formed and pure. In all the sections the siderite has altered to a greater or less extent, the product being black opaque ferrite. This ferrite is largely arranged in parallel bands. Several of the sections show nicely the formation of concretions - particularly 10160. The concretions in these sections bear exactly the same relations to the carbonate that they do in the Eogabic carbonates. The differences are that the iron oxide is black instead of brown or red, and that the concretions are all very small, the original carbonates themselves being minute.

10170

Sl. 3421

Siliceous Siderites

C. R. Van Hise, Spring of 1888.

10172

Sl. 3422

The secondary iron-oxide is largely black, magnetite. 10170 contains some large concretions which are composed of this black opaque ferrite and silica. The alteration of the rhombohedra of siderite to the black iron oxide is well shown in 10172. Some of the silica is flinty, some chalcedonic, and a good deal perfectly amorphous - opaline. (Do not remember before to have seen so completely amorphous silica in any of the rocks of the iron group.) A portion of the dark ferritic material is pyrite. How much of it is pyrite, how much magnetite, and how much hematite and limonite mingled with carbonaceous material, an analysis only can determine.

10164

²¹ Magnetitic Feldspathitic Chloritic Ferro-Dolomitic Flint

C. F. Van Hise, Dec. 1885.

Macroscopic Description.

Apparently the rock is a fine grained, massive, grayish drab flint.

Microscopic Description.

A flinty ground mass composing half the bulk of the rock contains numerous small crystals of magnetite, quite a number of tabular areas of feldspar, many small knots and aggregates of chlorite and here and there patches of ferro-dolomite. (???)

an altered fine grained greenstone R.D.

8598

Sl. 3354

Jaspers.

C. F. Van Hise, Dec. 1885.

8720

Sl. 3362

Macroscopic Description.

10029

Sl. 3409

8598 is a lean banded magnetitic and jaspery slate. 8720 is an interlaminated black magnetic and red jasper rock. 10029 is a reddish brown jasper containing large concretions of bright red jasper.

Microscopic Description.

The sections are cut from the jaspery portions of the rock. A large portion of slides 3409 and 3334 appear to be solid red hematite. However, this hematite doubtless includes silica. The other parts of these sections and slide 3362 consist of mingled minute particles of quartz and hematite. The silica all appears to be individualized although the grains are very small. In all the slides there are present crystals of magnetite.

8721Sl. 3364
Sl. 3365Magnetitic Jaspers

C. R. Van Hise, Dec. 1885.

8722

Sl. 3366

Macroscopic Description.10009

Sl. 3406

8722 is a coarse red jasper interlaminated with minute white layers. 10009 is a coarse red jasper interlaminated with magnetitic quartzite.

Microscopic Description.

The rocks all consist of completely crystallized minute interlocking grains of quartz mingled with and including abundant hematite and magnetite, the latter commonly in crystals. The quantity of iron oxides is greater in 8721 than in 8722 and 10009. The slides of 8722 and 10009 are evidently cut from jasper bands, while one of the slides of 8721 cuts a heavily magnetitic belt.

8717

Sl. 3361

Hematitic and Magnetitic Quartzites and Jaspers.

C. R. Van Hise, Dec. 1885

8730

Sl. 3371

Macroscopic Description.8732

Sl. 3373

8717 is an intricately brecciated, white and black rock. The white parts are fine, sugary quartz, the black parts, magnetitic quartz. 8730 is a brecciated jasper. 8732 is a strongly brecciated coarse white flint and red jasper.

Microscopic Description.

Finely but perfectly crystalline interlocking quartz composes the greater part of all the sections. Included in and mingled with this quartz is a considerable quantity of magnetite and hematite, the former mostly in small crystals, the latter in minute specks and irregular areas. These iron oxides are not so plentiful as to make the sections opaque, but abundant enough to give them a reddish or brownish tint.

8735

Sl. 3375

Magnetitic and Hematitic Quartz Schist.

C. R. Van Hise, Dec. 1885.

Macroscopic Description

Where not heavily charged with iron oxides, as mostly it is not, the rock is a white sugary flint or quartzite.

Microscopic Description.

The quartz individuals are much larger than in 8117, 8130, and 8132, they being of quite uniform moderate size. They are deeply interlocking and are generally longer in one direction than in the other, their greatest lengths being in a common direction. So far as can be made out the quartz is all originally crystalline. Most of the quartz is very free from iron oxides. In narrow bands, however, magnetite and hematite are preponderant.

10019

Sl. 3408

Magnetitic and Hematitic Quartz Schist.

C. R. Van Hise, Dec. 1885.

Macroscopic Description.

The rock is an interlaminated coarse flint, jasper, and magnetite.

Microscopic Description.

The section is cut from the pure flint portion and consists of grains of quartz which in size, origin, and arrangement are exactly like those in 8735.

10011

Sl. 3407

Magnetitic and Hematitic Quartzite (Non-Clastic.)

C. R. Van Hise, Dec. 1885.

Macroscopic Description.

The rock is an interlaminated white quartz and coarse red and brown jasper.

Microscopic Description.

The section is cut at the junction of the quartz and jasper. The only difference between the two parts is in the amount of magnetite and hematite present. The quartz is originally crystalline and mostly tolerably fine grained. Scattered through this quartz in about half of the section are abundant crystals of magnetite and areas of hematite. These are also present in the other half of the section. In one place in the section the quartz is coarsely crystalline, although here it appears also to be original. In this coarse quartz are a few roundish complex areas of chlorite, which seem to be aggregates of small units rather than fibres.

8714

Nearly Magnetic ^{Chert} Flints and Quartzites.

Sl. 3359

C. R. Van Hise, Dec. 1885.

8715

Macroscopic Description.

Sl. 3360

8715 is a white and black banded, coarse, flinty rock.

8724

Sl. 3428

8714 is a gray and black very finely banded, coarse flinty rock. 8724 is a black graphitic, banded rock, contain-

8736

Sl. 3376

ing quartz pebbles or concretions. 8736 is a brecciated coarse red jasper and black magnetic rock. 9737

9739

Sl. 3404

consists of interlaminated coarse red jasper, pinkish white coarse flint and black magnetic schist. 9739 is inter-

9737

Sl. 3430.

laminated and brecciated yellowish white chert and ^{black} flint.Microscopic Description.

The sections of these rocks are very similar. The base of all is a completely crystallized interlocking fine grained quartz, the different sections varying in fineness. Scattered abundantly through this base is magnetite in minute particles, in narrow or broad bands or in reticulating continuous areas. Sometimes this magnetite is in crystals, but more often not. It is also possible that associated with the magnetite, in some cases, there is more or less carbonaceous material. In 8736 a broad belt of hematite is seen. A considerable hematite, sometimes in crystals, is also present in some of the other sections. In 9737 an area of ferro-dolomite is found.

10343

Ferruginous Ferro Dolomite and Flint.

Sl. 3425

C. R. Van Hise, Dec. 1885.

10354

Macroscopic Description.

Sl. 3426

10343 is a coarse gray flint and ferro-dolomite interlaminated with reddish brown slate. 10354 is a fine grained and finely laminated gray ferruginous flint and ferro-dolomite.

Microscopic Description.

These sections are mostly composed of finely crystallized quartz and through the quartz are thickly scattered grains and clusters of grains of ferro-dolomite, many of them being rhombohedra. The ferrite which is quite plentiful is an alteration product of the ferro-dolomite, the sections showing many fine pseudomorphs after that mineral. A few crystals of pyrite are present.

10341

Sl. 3473

Magnetitic and Hematitic Flint.

C. R. Van Hise, Dec. 1885.

Macroscopic Description.

The rock is a brecciated white and gray, coarse, sometimes sugary, flint.

Microscopic Description.

Fine flinty, but completely crystallized quartz constitutes nine tenths of the rock. Through this quartz and included in it are small particles and crystals of magnetite and hematite. The exterior of the minute quartz grains are commonly stained a yellow color by limonite.

9737

Sl. 3403

Heavily Ferruginous Flint, Ferro Dolomite, and Quartzitic Magnetite.

C. R. Van Hise, Dec. 1885.

Macroscopic Description.

The rock is an interlaminated coarse red jasper, pinkish white coarse flint, and black magnetitic schist.

Microscopic Description.

One part of the section is like 10343 and 10354, except that the ferro-dolomite has been originally much more plentiful than in those rocks, composing with its replacing material, fully two thirds of this part of the section. The ferro-dolomite is now very largely replaced by red and brown ferrite. The part of the section described is abruptly separated from a very heavily magnetitic portion which besides the magnetite contains quartz and a little red ferrite.

8729

Sl. 3370

Ferruginous Ferro Dolomite and Flint.

C. R. Van Hise, Dec. 1885.

Macroscopic Description.

The rock is composed of belts of black flint, coarse pink flint, and ^{coarse white flint} ~~of ferro dolomite~~ the different belts merging into each other.

Microscopic Description.

As in 10354 the rock is mostly composed of ferro-dolomite and flint and of ferrite replacing the dolomite. It differs from them in that the quartz and ferro-dolomite are in larger areas and in that the quartz includes many minute particles of reddish brown ferrite and black material which may be a carbonaceous substance mingled with iron oxide.

8578²
9

number wrong

Sl. 3355

Ferro-Dolomitic and Magnetitic Flint and Quartzite.

C. R. Van Hise, Dec. 1885.

Microscopic Description.

This section is very much like those described upon page 181 (8714 &c.). A ground mass of interlocking quartz grains which include many minute particles of brown ferrite contains a good deal of magnetite and ferro-dolomite. The ferro-dolomite is quite largely replaced by red and brown ferrite.

8727

Sl. 3368

Ferruginous Chlorite Schists.

C. R. Van Hise, Dec. 1885

8728

Sl. 3369

Macroscopic Description.

The rocks are fine grained green schists, 8728 being speckled.

Microscopic Description.

The ground mass is finely crystalline interlocking quartz. This ground mass is rather sparse in 8728. Chlorite, often more or less stained by ferrite, is the most plentiful constituent in both sections. In 8727 the chlorite is in small blades with their greatest lengths mostly in a common direction. Here this chlorite might well be an alteration product of actinolite and the rock thus be an altered actinolite schist. In 8728 the chlorite is quite often in large irregular areas which, with the small areas of the same mineral, seem to have little definite arrangement, although the schistose direction can be made out. Both brown ferrite and magnetite are found in each section, the particles being small and numerous in 8727 and of greater size in 8728.

8600

Ferro-Dolomitic Chlorite Schists.

Sl. 3356

C. A. Van Hise, Dec. 1886.

8602

Macroscopic Description.

Sl. 3357

These rocks are fine grained green schists.

Microscopic Description.

In each section a finely crystalline rather sparse ground mass is present. In this ground mass ferro-dolomite and chlorite are plentifully present, the latter being more abundant than the former. These two minerals make up the greater part of the rocks. Much of the ferro-dolomite is in rhombohedra and included in the chlorite. The chlorite is so arranged as to clearly indicate the direction of schistosity. Black areas of magnetite are found in both sections but they are much larger and more abundant in 8602 than in 8600.

10145

Ferro-Dolomitic and Heavily Magnetitic Chlorite Schist.

Sl. 3411

C. A. Van Hise, Dec. 1885.

Macroscopic Description.

The rock is a dark gray, magnetitic, schistose, almost massive rock showing upon the broken surface many lustrous cleavage surfaces of ferro-dolomite.

Microscopic Description

The section consists of finely crystalline quartz, somewhat altered larger areas of feldspar, large areas of ferro-dolomite, numerous areas and crystals of magnetite and, more plentiful than any of the preceding minerals, aggregates of green chlorite. The magnetite is found included in all the other minerals present.

8565

Sl. 3352

Magnetitic Actinolite Schist.

C. R. Van Hise, Dec. 1885.

Macroscopic Description.

The rock is a black banded and ferruginous and flinty slate.

Microscopic Description.

The section has a ground mass of very finely crystalline but completely individualized quartz. Cutting through this quartz in every direction and, upon account of their abundance (composing a large part of the rock), are minute needles of actinolite. Magnetite in small crystals is ^{abundantly} present.

8574

Sl. 3353

Coarse Magnetite Actinolite Schist.

C. R. Van Hise Dec. 1885

Microscopic Description

The ground mass is coarsely crystalline ^{in large and small breaks} deeply interlocking quartz. Magnetite and actinolite are scattered everywhere through the quartz. The magnetite appears to have been the first, and the quartz the last mineral to crystallize. In places the magnetite has peroxidized. This rock approaches closely to the quartzose greenstones.

8726

Sl. 3367

Actinolitic and Ferro-Dolomitic Magnetite Schist.

C. R. Van Hise, Dec. 1885

Macroscopic Description.

The rock is a black and gray minutely banded one. In some layers the black portions in others the gray portions are preponderant.

Microscopic Description.

The section is mostly from the black part. Here it is composed of minutely crystalline quartz in which is scattered indefinite numbers of as minute particles of a black substance. This black material is arranged in bands and is doubtless mostly magnetite. Cutting the quartz both where including magnetite and where free from it are minute needles of actinolite. Upon one side of the section is a quite coarsely crystalline belt of quartz which contains as large crystals of magnetite.

10141

Sl. 3410

Chloritic Heavily Magnetitic Flint.

C. R. Van Hise, Dec. 1885.

Microscopic Description.

A fine grained flinty ground mass contains about an equal quantity of uniformly distributed, largely crystal outlined, rather small individuals of ~~quartz~~ magnetite. Chlorite is plentifully and ferro-dolomite sparsely scattered through the quartz ground mass.

8611

Sl. 3427

Magnetitic and Epidotic Chert.

C. R. Van Hise, Dec. 1885

Macroscopic Description.

The rock is a black banded, cherty and shaly one.

Microscopic Description.

A half amorphous cherty groundmass composes half the area of the section. Scattered through this groundmass in about equal abundance are small areas and crystals of magnetite and areas of irregularly outlined epidote. A little ferro-dolomite is contained.

8640

Sl. 3358

Magnetitic Flint and Opal.

C. R. Van Hise, Dec. 1885.

Macroscopic Description.

The rock is a peculiar black banded, magnetitic and cherty one containing layers of fine grained, flesh colored flinty^(?) material.

Microscopic Description.

The section is mostly composed in about equal quantities of fine grained flinty quartz and of a gray completely amorphous material which is taken to be opal. In certain narrow bands, besides the flint and opal magnetite is found.

8731

Sl. 3372

Hematitic and Magnetitic Quartzite.

C. R. Van Hise, Dec. 1885

Macroscopic Description.

The rock is a badly brecciated white flint, red jasper, and black flint or slate.

Microscopic Description.

Coarsely and finely crystalline deeply interlocking original quartz constitutes the ground mass and greater part of the section. Through this ground mass is a considerable quantity of hematite and magnetite. These iron oxides are sometimes in rod like forms and often radiate from a center, a single rod-like individual cutting through two or more large quartz grains.

8733

Sl. 3429

Hematitic and Magnetitic Quartzite.

C. R. Van Hise, Dec. 1885

Macroscopic Description.

The rock is a badly brecciated coarse white flint and ^{red} jasper.

Microscopic Description.

Most of the quartz in this section is plainly fragmental, the grains being more or less rounded, sometimes enlarged and containing between them films of iron oxide. These fragmental quartzes are sometimes finely complex. Parts of the section also appear to contain non-clastic quartz. The history may be that the rock has been a fragmental one, brecciation has taken place, and the spaces left have been healed by infiltrating and therefore interlocking quartz. Most of the dark brown ferrite also appears to be of fragmental or subsequent infiltrating material. It occurs in large irregular areas and scattered as an abundant binding material between the clastic grains of quartz.

10342

Sl. 3424

Quartzite.

C. R. Van Hise, Dec. 1885

Macroscopic Description.

The rock is a perfectly white, coarse, sugary flint.

Microscopic Description.

The section is composed of deeply interlocking, coarsely to finely crystalline original quartz. No trace of any fragmental appearance is seen.

9061

Sl. 3363

Ferro-Dolomitic and Feldspathic Quartzite.

C. R. Van Hise, Dec. 1885

Macroscopic Description.

Elastic quartz in rather small, well rounded grains, is the most plentiful constituent. Mingled with this is a considerable number of grains of about the same size as those of orthoclase and plagioclase. Ferro-dolomite is also plentiful, generally in quite large roundish areas. The feldspar is in places somewhat chloritized.

9757

M. 3405

Actinolitic and Heavily Magnetitic Quartzite.

C. R. Van Dike, Dec. 1885

Macroscopic Description.

The rock is an interlaminated ferruginous quartzite and green schist.

Microscopic Description.

The section is composed of two parts. The first is much like the actinolite magnetite schists before described. There is a finely crystalline quartz ground mass and through this are abundantly scattered grains and crystals of magnetite and minute needles and blades of actinolite. Contained in the above, as a sort of matrix, are exceedingly large, sometimes simple, sometimes complex areas quartz which have roundish outlines. These quartz grains, however, contain cutting them in every direction minute needles of actinolite. At times these needles are arranged in radial fibrous bunches throughout ^{the} ~~an~~ areas and again are scattered uniformly through them. Were it not for the actinolite inclusions these quartz grains would be taken to be clastic, although it is not probable that they are of this nature.

Rocks of N. E. Minnesota.

Collected by W. M. Chauvet.

6067Coarse Epidotic Biotite (?) Granite.

Orthoclase, plagioclase, quartz equally plentiful.
Much epidote and biotite.

6073Biotite Gneiss.

Quartz most plentiful mineral. Orthoclase, microcline, biotite and magnetite, latter often in crystals, somewhat sparingly present.

6082Granitell

Quartz, orthoclase, plagioclase, latter two much kaolinized, in about equal quantity. Ferrite stains.

6087Hornblende Schist.

Green hornblende composes two thirds of the mass of the rock.

6121Altered Uralitic Diabase.

Close to diorite. Cores of augite still remain.

6125Biotite Schist or Micaceous Greywacke.

C. R. Van Hise. Dec. 1885.

Biotite in small flakes. Quartz and feldspar very plainly fragmental, as well rounded often as in a sandstone.

6134Diabase.

Feldspar altered. Magnetite in rod-like forms.

6148Biotite Granite

Epidotic.

6154Quartz Porphyry.

Very large grains and crystals of quartz, orthoclase and plagioclase, buried in a very abundant exceedingly fine-grained ground mass, compose the rock. The feldspars are often largely altered to epidote. Chlorite and biotite important accessories.

6155Diabase.

Somewhat altered. Magnetite in rod-like forms.

6158Diabase.

Coarse, altered, and very magnetitic.

6170

Somewhat altered diabase. Very magnetitic. This mineral or its alteration products compose at least one-third the mass of the rock.

6175

Somewhat altered diabase.

6182

Coarse, fresh gabbro.

7037Magnetitic Quartzite or Quartzose Greenstone.

Quartz and magnetite, much of the latter in crystals and included in the quartz, about equal in quantity compose the bulk of the rock. The remaining mineral of importance is augite.

7039

Very fresh, coarse-grained olivine diabase. The plagioclases are very large. Olivines large and very fresh.

7059Quartzose Diabase.

Plagioclase and quartz about equal in quantity. The once very abundant augite is largely altered to hornblende and biotite. The hornblende is brown. The biotite fresh and in well defined blades. All stages of the alteration of the augite to each of these minerals are beautifully shown.

7060Quartzose Diabase.

Description of 7059 applies perfectly to 7060.

7093Hornblendic Fragmental Rock

Hornblendes beautifully enlarged, and so abundantly present as to compose two thirds of the mass of the rock.

7095Hornblendic Fragmental Rock

Fragments of hornblende and feldspar in about equal quantity, the latter much altered, compose the greater portion of the rock. The hornblendes are enlarged.

7096Hornblendic Fragmental Rock

Differs from the preceding two rocks in containing much less hornblende and much more altered feldspathic areas. There is also present a fine grained interstitial cement. Pyrite and magnetite are present, the latter most plentifully as inclusions in the hornblendes.

7098Dolomitic Flint.

Dolomite and finely crystalline and amorphous silica compose most of the rock. With these minerals are sparsely found fragments of quartz and feldspar of ^{greater} size.

7100Hornblendic Fragmental Rock

Feldspar fragments are most plentifully present. Quartz and hornblende fragments less plentifully seen. There is an abundant filling material which seems to be mainly, biotite, chlorite, and silica.

7101Feldspathic Fragmental Rock. (4)

Rounded grains of feldspar compose over half the mass of the rock. The growth of the feldspars has been an arrested one and the second growth has been a very large one. So great that it is perhaps doubtful whether they are cases of true enlargement. Hornblende and quartz in the interspaces of the feldspars are the other minerals of importance.

7102Granite Porphyry. (?)

Quartz evidently, in part at least, secondary. Hornblende and calcite in considerable quantity.

7103Hornblende Fragmental Rock.

Very like 7093 in the abundance and enlargement of the hornblende fragments. The interstitial material is largely finely crystallized quartz.

7106Granitic Porphyry.7112Feldspar Porphyry.

Large areas of feldspar compose three fourths of the mass of the rock. The cement is almost wholly finely crystalline quartz. In a few places these grains get to be of a considerable size. Hornblende and magnetite are accessory minerals.

7113Hornblende Decomposed Rock.

Hornblende very plentiful in grains of widely varying sizes. The matrix chiefly finely crystallized quartz. Quite numerous small grains of magnetite. At first glance ^{rock} appears to be hornblende schist.

7115Quartzose or Silicified Greenstone.

Quartz, feldspar and augite very plentiful. Magnetite less so. Augite in places altered in part to hornblende. Section might ^{easily} be called an augite schist or augite gneiss.

7120Tremolitic Magnetite.

Much of the tremolite altered to chlorite.

7121Magnetitic Tremolite Rock.

Most of the section composed of blades of tremolite. In places this mineral is altered to chlorite. Magnetite small in quantity.

7122Ferruginous Tremolite Rock.

Differs from 7121 in tremolite blades being smaller and in that red and brown oxides of iron are present as well as the magnetite.

7124Chloritic and Ferruginous Flint.

Chlorite in irregular areas and ferrite in long narrow bands are buried in half amorphous ^{flinty} silica. Branches of tremolite blades are found in places altered to chlorite. It is possible that all the chlorite is due to the alteration of tremolite. Scattered through the section are quite numerous rather small fragmental grains of quartz.

6130Very coarse, somewhat altered olivine gabbro.6167Coarse, considerably altered, very ferruginous diabase.

9385

9653

9400

9531

9387

8856 }
8871 }

Hornblende Conglomerates

Mar 1886 Mr Merriam finds that
digestion with potash takes from these
rocks (i.e. the matrices) a considerable
proportion of silica - indicating the
presence of amorphous silica.

12243
SL 5585

Garnetiferous Actinolite Magnetite Schist

Microscopic Description.

Chief constituents actinolite, magnetite, quartz and garnet. Actinolite is the most plentiful constituent in the rock; magnetite comes next in order, and quartz is not particularly plentiful. The relations of these three minerals are those common in rocks of this kind. The rather plentiful garnets are without crystal outlines and include actinolite, magnetite and quartz. All of these minerals are like the same minerals outside of the garnets, except that the included actinolite is stained with limonite. Often a single actinolite blade is partly included ⁱⁿ and partly exterior to a garnet. In the case of this rock there can be little doubt that the garnet was the latest mineral to form, and included the other minerals, just as augite often includes feldspar in ophitic diabases.

12245
SL 5587

Garnetiferous Actinolite Magnetite Schist.

This rock contains quite a quantity of garnet but the slide is so thick that nothing definite can be made out as to the relations of this mineral and the others of the rock.

