

Diabase.]

mer of 1876, and the face of the rock shows perpendicularly about eighteen feet. It probably exists as a dike." It cuts No. 201.

Ref. Annual Report, ix, page 52; Proceedings American Association for the Advancement of Science, vol. xxx, page 163; Bulletin ii, page 113.

Meg. A medium-grained, dark diabase showing lustre-mottling. Cracks and seams are slickensided, coated with chlorite, or with thin sheets of metallic copper. One hand specimen, marked 200, is a mass of dark-green chloritic material, evidently from one of the layers mentioned above. Along the centre of the specimen are narrow seams of a soft red mineral, perhaps laumontite.

Mic. The rock is composed of *plagioclase* laths, *augite*, which is frequently in plates of large size, *olivine*, now largely altered to a substance which is black, yellowish and brown, and is perhaps *bowlingite*, *magnetite*, *hematite*, *chlorite* and a small amount of metallic *copper*. The olivines in some instances have part of their outlines conditioned by the surrounding feldspar, thus showing that some of the feldspar is older than some of the olivine.

Two sections.

Age. Probably a part of the great Beaver Bay diabase sheet.

U. S. G.

NO. 200A. DIABASE (*with thomsonite and copper*).

Fall River mine, N. W. $\frac{1}{4}$ sec. 24, T. 61-1 W.; a short distance up Fall river. Near the lake shore.

Ref. Annual Report, ix, page 52; Annual Report, x, page 139; Bulletin ii, page iii; American Association for the Advancement of Science, vol. xxx, page 163.

Meg. Inclusions or concretionary masses, apparently within No. 200, of a different color and structure from No. 200 itself.

Mic. Following is Wadsworth's description: "In the least altered and most coarsely crystalline portions the rock is composed of pinkish, divergent, lath-shaped *feldspars*, with interstitial dark material. Irregularly intermingled with this are dark-brown to black or yellowish-brown masses and streaks of decomposed and softened rock with a hardness of about 3. In the coarsely crystalline portions occur segregations of *chalcedony*, *epidote*, *zeolites*, etc.

"The least altered portions of the sections are composed of *augite*, *magnetite* and *feldspar*, with various secondary products. The *augite* is but little changed to *viridite*, and is of a clear, pale yellow or yellowish brown color. The *feldspar*, however, has suffered much, being kaolinized, and contains *viridite*. Along the fissures, and in the patches of *kaolin* and *ferrite* occurs considerable native *copper*, as a secondary product, or else as an infiltration. It was not observed in connection with the *augite*, and but rarely near the *magnetite*, although one might naturally expect to find it in connection with that mineral. The *copper*, indeed, appears mainly in the interior of the *feldspars* during that condition of their alteration in which they are brownish gray, from the dissemination of kaolin with subordinate

ferrite, but the copper disappears when the alteration is carried still further, as it often is in the section. The feldspar here is largely replaced by viridite and chalcedonic patches. In the sections of the more highly altered portions of this rock, the augite is changed, for the most part, to a dirty green viridite and chlorite, which show oftentimes a spherulitic structure. In the more highly altered parts many *apatite* needles occur.

"In the portions of the rock which are most altered, the chalcedony forms beautifully polarizing radiating concretions, and the general appearance of the rock is that of granite instead of that which it really is—an altered, coarse-grained diabase."

A Boricky test of the pinkish feldspar gave only lime and soda, the former being in large crystallites of monoclinic form, and the latter as small hexagonal rods. No signs of potash were observed, and the feldspar may hence be assigned to the prevalent category, viz., *labradorite*.

The mineral, however, which seems to be that called chalcedony, since it is radiated in structure and polarizes in brilliant radiating colors, is certainly a biaxial mineral, and hence cannot be any form of quartz. Quartz, when of the same thickness, would show the same color in all positions and directions when its axis is parallel to the section as in the radiating fibres, and also when parallel to either nicol it would simply be dark. A single test in convergent light confirms this, since the interference figure is either a single optic axis or a curved black bar of a biaxial hyperbola, or occasionally a bisectrix (n_e). The fibres which are cut perpendicular to their longer dimensions show sometimes rectangular shapes. Such forms are found when the centre of a spherule or a radiated mass is cut, and in such case the highest colors of double refraction are found; and such sections show the figure of the optic normal (n_m) in convergent light, indicating the axial plane is transverse to the longer dimensions of the fibres. In other words, the mineral is orthorhombic or tetragonal and has a high double refraction, and its elongation is perpendicular to the axial plane. Further, when the fibres are cut parallel to their elongation, they extinguish parallel. The bisectrix n_e is in the acute angle of the optic axes. Measured in air by the axial goniometer of Lacroix (American Geologist, February, 1896) this angle is found to be about 50° .

These characters, combined as they are, can only be found in *thomsonite*, which is not a very uncommon mineral in the coarse traps of the region, though generally in amygdules of much larger size. This radiated mineral being excluded from that category, there seems to be no free quartz in the sections examined.

Four sections examined, three being the same as examined by Dr. Wadsworth.
Age. Cabotian.

Remark. There is now no doubt, judging from an examination of numerous instances of contacting red rock and the basic eruptives, that the peculiar characters of this rock are the result of small masses of the red-rock series being included in No. 200 at the time of the intrusion, and after complete or partial fusion the dissemination of the elements into the basic rock.

The rock has evidently suffered a great change since its intrusion, giving rise to the zeolites, the "chalcedony" and the copper, and carrying forward the alteration of the feldspars, but a considerable portion of the alteration was probably accomplished before the cooling of the mass. The three sections examined by Wadsworth all contain particles of *metallic copper*. Two others made since show the same. The amount is not sufficient, here, to warrant any economic exploitation. It only shows that the circulating waters at the time of its deposition had access to considerable copper-bearing rock masses, and it is not unlikely that such sources may yet be found in the vicinity. The original source is more likely to be in connection with the reddish-brown felsyte which this basic eruptive cuts than in the eruptive itself—or in some associated detrital rocks.

In further examination of these radiating spheruliths two sections were made by M. Marchand of a thickness as low as 0.015 millimeters. In these the augite shows, between crossed nicols, a light yellow tint, the feldspars are neutral, and the spheruliths, when cut properly, have a yellow color. Some part of the thomsonite shows no color, or only a gray tint, but darkening when parallel with the threads; and some beautiful, perfect, radiated spheruliths, having a negative elongation, have, intermediate between the centre and the periphery, a sharply defined concentric band of fibres parallel with those on either side of the band which are of positive elongation. On the introduction of the quartz plate of the sensitive tint the quadrants are contrastedly colored, and those in this narrow band are contrasted in an opposite direction from those outside and inside of the band.

Some *calcite* also has formed in association with this thomsonite. N. H. W.

NO. 201. APORHYOLYTE?

From the mine at Fall river. It is cut by No. 200.

Ref. Annual Report, ix, page 54; Annual Report, x, page 141; Proceedings American Association for the Advancement of Science, vol. xxx, page 164.

Meg. A very fine-grained, compact, hard, siliceous rock containing small, reddish feldspar phenocrysts. Quartz phenocrysts are very rare, only two or three being shown on the hand specimen. No section.

Age. Cabotian; red-rock series.

Remarks. This rock seems to be of the same general character as the rock of the Great Palisades—*i. e.*, an acid surface lava—and it is also thought to be of the same age.

U. S. G.

NO. 202. DIABASE (*with olivine*).

"Green, coarse doleryte, round the east point of Grand Marais; a low exposure in the coast line; with concretions or inclusions of a finer grain. This terminates rather abruptly on the east, somewhat like a dike, when in contact with No. 203; but it is not basaltic, nor is the contact abrupt. Nos. 202 and 203 change colors gradually, and in fragments are mixed through a breccia of three or four feet wide."

Ref. Annual Report, ix, pages 52, 53.

Meg. A black, heavy, rather coarse diabase. There are a few large porphyritic feldspars, one of which is three-fourths of an inch across. The hand specimen also contains a few small areas, aphanitic, and of a dark-brown color. These areas are quite soft. They may be included fragments of a foreign rock or pseudamygdaloidal areas of some soft earthy mineral.

Mic. The section, which is a poor one, shows an ordinary diabase, considerably altered. There are some dirty yellowish areas which represent original olivines.

One section.

Age. Cabotian.

U. S. G.

NO. 203. APORHYOLYTE.

Outcropping in the beach east of Grand Marais. It is the rock that gives red color to the beach for many miles, by reason of the rapid formation of pebbles from the frequent cracks that intersect it. The pebbles also are very durable. They are also abundant in the drift clays of the region. The rock dips 5° to 15° toward the lake, and consequently in some instances, as viewed from the lake, appears horizontal by reason of the coincidence of the coast line.

Ref. Annual Report, ix, pages 53, 54, 55, 57; Annual Report, xiii, pages 100 (No. 162), 103; Bulletin viii, page xxxiii.

Meg. Very much like the Palisade rock (Nos. 138 and 139), and sometimes much resembles the siliceous, slaty, gray rhyolyte of Beaver bay (Nos. 127, 528).

Mic. The specimens bearing this number are rather more crystalline than the Palisade rock. The thin sections show translucent, sharp, rod-like areas, recalling an original feldspathic crystallization, and between them the angular spaces are reddish and sub-opaque; but the whole rock is permeated with silica, which embraces the rest of the undefined mineral contents in a coarse poikilitic nexus which darkens simultaneously over large areas.

Two sections.

Remark. The following analysis has been made of rock No. 203:

SiO ₂	-	-	-	-	-	-	-	-	-	73.58
Al ₂ O ₃	-	-	-	-	-	-	-	-	-	13.36
Fe ₂ O ₃	-	-	-	-	-	-	-	-	-	3.78
FeO	-	-	-	-	-	-	-	-	-	.69
CaO	-	-	-	-	-	-	-	-	-	.81
MgO	-	-	-	-	-	-	-	-	-	.18
K ₂ O	-	-	-	-	-	-	-	-	-	2.48
Na ₂ O	-	-	-	-	-	-	-	-	-	2.42
H ₂ O	-	-	-	-	-	-	-	-	-	1.14
Total	-	-	-	-	-	-	-	-	-	98.44

Age. Cabotian; red-rock series.

N. H. W.

Laumontite. Breccia. Diabase.]

NO. 203A. LAUMONTITE.

From a vein in No. 203. The specimen is in the form of crumbled powder, rather coarse, of a light-pink color.

Ref. Annual Report, ix, page 53.

N. H. W.

NO. 204. BRECCIA.

Nos. 204, 205 and 206 are transition rocks, in the order numbered, between Nos. 202 and 203.

Ref. Annual Report, ix, page 53.

Meg. A red, fine-grained, shaly rock, containing much laumontite. The hand sample contains a few apparent fragments of a rock very similar to the rest of the hand sample, but more compact, finer grained and not containing laumontite.

No section.

Age. Cabotian.

U. S. G.

NO. 205. DIABASE. (*Contacting.*)

A supposed transition rock between Nos. 202 and 203, as stated above.

Ref. Annual Report, ix, page 53.

Meg. Compact, fine-grained, brown or gray, with some reddish brown small crystalline angular areas, as if of a rusted feldspar.

Mic. There are remaining some feldspar forms, but they are filled with impurities. They can sometimes be distinguished as twinned triclinic crystals. Narrow, slender, greenish crystals, with feeble absorption, cut across the rock. These extinguish sometimes at a large angle, approximating 26° with the nicols, and have a conspicuous cleavage parallel with their elongation; also an irregular, coarse fracturing, simulating a cleavage, which is oblique to the other. At other times they extinguish nearly parallel to their elongation, but in this case the cleavage is not evident, and the section is obviously not parallel to the edge *m m*. This mineral also has a high refractive index. It is either *hornblende* or *augite*, and the last mentioned character points strongly to *augite*. The most of the rock is not distinctly crystalline, but poikilitic quartz areas spread through it.

One section.

Age. Cabotian.

N. H. W.

NO. 206. DIABASE.

See under No. 204.

Ref. Annual Report, ix, page 53.

Meg. A fine-grained, dark, diabasic rock. It contains a few small areas, apparently pseudamygdaloidal, of quartz; also of calcite, and along a seam some soft saponite-like material. The hand specimen also contains fragments, not always sharply separated from the rest of the rock, of a very fine-grained, brownish rock.

Mic. The section shows a fine-grained diabase, with *plagioclase* laths, *augite*, *magnetite*, *hematite* and large amounts of confused, dirty, greenish to brownish,

alteration products. Some secondary *quartz* is also present. At one edge of the slide is a small area which probably represents part of one of the fragments noticed in the hand specimen. It is composed of quartz, feldspathic material, augite, and confused alteration products. The quartz is in poikilitic areas.

One section.

Age. Cabotian.

U. S. G.

NO. 207. DIABASE (*with olivine*).

From a dike about 200 feet wide cutting the rock No. 203. There are six such dikes within the distance of a mile. They run E. 15° S.; a short distance east of Grand Marais.

Ref. Annual Report, ix, page 53.

Meg. Coarse, dark-gray diabase.

Mic. Similar to No. 199, of which it probably is a cotemporary. The large augites embrace the earlier feldspars in an ophitic manner.

One section.

Age. Cabotian; probably an apophysis of the great gabbro outbreak which exists in full force in the hills further north.

N. H. W.

NO. 208. DIABASE (*with olivine*).

East of Grand Marais; just beyond the mouth of the third little creek represented on the Lake Survey chart.

Ref. Annual Report, ix, pages 53, 54, 56.

Meg. Two rocks, or two forms of the same rock, are designated by this number. One is fine grained, brown and heavy, outwardly resembling the Two Harbor rock (compare Nos. 117 and 176), but the other is coarser and has a greenish-gray color. It is less heavy than the former.

Mic. These are both essentially olivine diabases, but the finer-grained one contains much more olivine than the other.

Two sections.

Remark. "This rock occurs much like a dike, at first, with perpendicular jointage, or basaltic structure in beds, but soon larger bedding, crossing these, cuts it and causes the rock to all appear bedded. This is fine grained and brown, and is about twenty-five rods from the last of the dikes already mentioned. This becomes a bedded rock like similar beds seen before, having sometimes the appearance of the Two Harbor rock. It slopes toward the water. Just beyond the mouth of the third little creek (on the Lake Survey chart) these beds become disturbed and brecciated, and even tipped in the other direction (southwest), and are crossed by a dike of doleryte, like No. 207, about eighteen feet wide. Previous to this (further west), they show patches amygdaloidal; but just on the east of this dike there is much amygdaloid with laumontite. Just before reaching the mouth of the fourth creek, another dike like No. 207 crosses these beds, running in the same direction as those

before seen, and throwing up the firm heavy beds of No. 208, at a high angle. This dike is basaltic perpendicular to these beds by being cooled by them. This last larger dike is only exposed near the water, and its exact contact with No. 208 is invisible. It is exposed about fifty feet." (Annual Report, ix, pages 53, 54.)

This description of the field appearances seems to show that these beds are older than a series of coarse diabase dikes which cut them, and which is presumably of the same date and origin as the sheet at Grand Marais. It is for that reason that these beds (No. 208) are put in the Cabotian along with the "red rock" of the region. The brown fine-grained rock having this number is allied to Nos. 217-219, but shows little or no glass.

If the foregoing parallelisms are correct, it is necessary to admit that before the Grand Marais diabase, there was a large series of surface eruptives, both basic and acid. If the Grand Marais diabase is the parallel of the Beaver Bay diabase, as believed, and that is the continuation of the Duluth gabbro, as believed, it is also necessary to allow an eruptive epoch which gave origin to basic surface flows at Duluth prior to the advent of the gabbro of that place as well as cotemporary with it.

N. H. W.

NO. 209. DIABASE (*with olivine*).

West of the mouth of Devil's Track river. Basaltic perpendicular to the tilted beds of No. 208. Runs nearly east and west.

Ref. Annual Report, ix, page 54.

Meg. A medium-grained diabase, dark gray in color. There are numerous small grains of a yellowish mineral (*olivine*) in the rock, and these give a yellowish tinge to the hand sample.

Mic. A medium-grained olivine diabase, the *olivine* being quite abundant. It is altered more or less to a brownish substance. The rock is comparatively fresh, but still has a number of dirty greenish areas and also areas of *chlorite* in radiating masses; perhaps these areas represent, in part at least, interstitial *unindividualized magma*.

One section.

Age. Cabotian (?)

U. S. G.

NO. 210. DIABASE.

Southeast corner of sec. 8, T. 61-2 E. It forms a low exposure and is a firm, smooth-weathering rock.

Ref. Annual Report, ix, pages 54, 55.

Meg. A rather fine-grained, brown, diabolic rock. It is permeated by small areas of a soft greenish mineral.

Mic. The section shows a fine-grained diabase, with large quantities of *hematite*. The hematite is in large part secondary, filling in the areas between the feldspars and replacing the augite; it also occurs in transparent films in numerous cracks.

Magnetite is present, but is not nearly as abundant as the hematite. The brown color of the rock in hand specimens is due to the abundance of hematite.

One section.

Age. Cabotian(?)

U. S. G.

NO. 211. DIABASE. (*Lustre-mottled.*)

Cow's Tongue point, the point next west of Kimball's creek, S. E. $\frac{1}{4}$ sec. 9, T. 61-2 E.
Ref. Annual Report, ix, pages 54, 55; Annual Report, x, page 43.

Meg. Similar to No. 210. The hand sample shows a water-worn surface which is blotched with lighter areas.

Mic. Essentially identical with No. 210, but the augite is in larger plates, and the *magnetite* is more abundant, but *hematite* is present in large quantities.

One section.

Age. Cabotian.

U. S. G.

NO. 212. APORHYOLYTE.

In the bay next east of Cow's Tongue point, after a short pebbly beach, this rock forms a low outcrop.
Ref. Annual Report, ix, page 54; Annual Report, x, page 43.

Meg. A red or brownish red rock with scattered porphyritic crystals of some glassy feldspar, but no quartzes.

Mic. This rock much resembles the Palisade rock (No. 139), but in the absence of original quartzes it is probably less acid. It is also the same rock as No. 203.

One section.

Age. Cabotian.

N. H. W.

NO. 213. PORPHYRYTE.

From the extremity of Fish Hook point, near the centre of sec. 6, T. 61-3 E.; eleven miles from Grand Marais. Lies as an overflow, and is visible under the water toward the west for some distance, cut by dikes.
Ref. Annual Report, ix, page 54; Annual Report, x, page 43.

Meg. Dark brown, easily splitting rock, which has scattered, light-colored feldspars in a fine matrix. This rock is fissile, horizontally, or obliquely to the main structure, which dips toward the lake. Nos. 213, 214 and 215 may be included in one general description, since they occur on the same general expanse of beach extending from the point westward for nearly half a mile. It is firm against the hammer and against the weather, but is filled with old cracks and joints that make it almost impossible to get a fresh break. It has a red color outwardly, near the water, except in the joints which are iron-shot (so called by Norwood) and blue black. It is finely porphyritic with stellar spangles of feldspar and with isolated crystals that weather nearly white.

Mic. A few *olivines*, numerous *feldspar* microliths and minute *augites* (?) were generated in this rock before the consolidation. There remained, however, a large amount of undifferentiated magma, which now renders the slide dark and obscure

Porphyryte. Diabase.]

between the nicols. This magmatic base is brownish with disseminated *hematite* and surrounds the small microliths. The olivines are probably the oldest crystals in the slide, as they are the largest, but they are wholly altered and are either opaque with ferruginous matter or light green and nearly isotropic with the usual product of such alteration. The plagioclases are small, blurred, apparently broken and so indefinite as to render their specific determination almost impossible. The minute brightly colored points which are presumed to be augite are scattered promiscuously through the slide, but seem to cluster most numerous in the vicinity of the altered olivines, a fact which casts doubt on their supposed augitic nature, but they resemble, except for being much finer, the fine augites that appear in several other fine-grained basic rocks of the region. One section.

Age. Cabotian.

N. H. W.

No. 214. PORPHYRYTE. (*Quartziferous.*)

Forms a low inconspicuous outcrop, runs along two or three hundred feet, dipping a little south of east, about one-fourth of a mile west of Fish Hook point.

Ref. Annual Report, ix, pages 54, 55.

Meg. More firm and siliceous than No. 213, and showing a few quartz phenocrysts.

Mic. More completely crystalline, with a little pegmatitic *quartz*; also *calcite* and *epidote*. One section.

Age. Cabotian.

Remark. This rock seems to approach very near the rocks Nos. 127 and 129, at Beaver bay, and perhaps has the same origin and date. The occurrence in the lake, off shore, opposite rocks Nos. 214 and 215, of a basaltic intrusive, may have some bearing on the date and origin of this intermediate rock.

N. H. W.

No. 215. PORPHYRYTE. (*Quartziferous.*)

Near No. 214, at Fish Hook point.

Ref. Annual Report, ix, pages 54, 55.

This is also an intermediate rock, there being more or less secondary silica diffused through it, due probably to deep-seated contact with acid rocks.

Age. Cabotian.

N. H. W.

No. 216. DIABASE.

"It is a greenish-brown rock with curling internal structure, containing quartz and amethystine nests, from the westerly of the two little points west of Brulé river, and before reaching either island, where a little stream enters the lake. It is a short outcrop rising about five feet in the midst of a red beach. This is an igneous rock; and the next point is of the same, also the little island off it, which is in the line of bearing."

Ref. Annual Report, ix, page 55.

Meg. The hand sample shows a rather fine-grained diabasic rock holding a few small areas of chalcidony or of chalcidony and quartz. Along joints a small amount of saponite is present.

Mic. A fine diabase with plates of *augite* which include a number of feldspar laths. The spaces between the augite plates, which are roughly circular in form, is occupied by *feldspar* laths in a dark confused mass composed of *magnetite*, *hematite* and greenish alteration products. No olivine is now present, but there may have been some original olivine. This dark material between the augite plates perhaps represents an original glassy matrix. Some of the augite plates are comparatively free of feldspar laths. The general structure of the rock is similar to that represented on plate IX of the "Copper-Bearing Rocks of Lake Superior" (U. S. Geol. Survey, Mon. v).

One section.

Age. Cabotian.

U. S. G.

NO. 217. BASALT. (*Amygdaloidal.*)

In the midst of a red beach, extending eastward from the easterly of the two little points west of Brulé river, are occasional exposures of this rock which resembles the Two Harbor rock. The specimen collected is from a conspicuous outcrop within the bay between two streams.

Ref. Annual Report, ix, page 55.

Meg. A very fine-grained, brownish-red rock which has irregular streaks and blotches of a greenish color. There are a few rounded amygdules of quartz and chalcedony, and also some of a soft, green chloritic material.

Mic. The section shows plagioclase microliths in a background composed of confused greenish alteration products, *magnetite* and an opaque brown substance. This brown substance, which is bright red in reflected light, makes up the main mass of the rock; it is supposed to represent original *glassy* material. Throughout the section are more transparent areas where this brown substance is lacking. These are, evidently, the greenish blotches seen in the hand specimen. They contain, besides the *plagioclase* microliths, *magnetite* and greenish alteration products, small, brightly-polarizing grains which are probably *augite*.

One section.

Age. Cabotian.

U. S. G.

NO. 218. BASALT (*with olivine*).

From the point near Brulé river off which lie the principal islands.

Ref. Annual Report, ix, pages 55, 56.

Meg. Brown, conchoidally fracturing rock, very fine grained, with small quartz-lined geodes, weathering rough-angular, and black when not under friction. Back from the beach friction, but on the beach, old weathered surfaces are brick red. Similar to No. 217 and to No. 176.

Mic. A fine-grained basalt. The *feldspars* are lath shaped, and sometimes grouped in a radial manner, each consisting usually of two or three albite twins. They do not conspicuously cut any of the other minerals, in the manner of a typical

Basalt.]

ophitic structure, but occasionally they are seen to interfere with the outlines of the small augites.

The *augite*, though in small grains, can easily be distinguished. Its grains are larger than the olivine grains, and they have a yellowish color, and less refractive power than the olivines. They are comparatively scarce.

Olivine is in very small grains, scattered abundantly throughout the slide, sometimes embraced in the augites and sometimes in the feldspars. It is well preserved considering the minuteness of the grains.

Glass is less common than in No. 176 or in No. 217, but still occurs sufficiently to warrant the designation basalt. It surrounds all the other crystals. It is not so much ferrated as in No. 217.

Occasional *magnetite*, even having its rectangular outline, is also to be observed. One section.

Age. Cabotian.

N. H. W.

NO. 219. BASALT.

"A little beyond [east of] the last locality [a point near the Brulé river, off which lies the principal islands], and just as the rock disappears again, it suddenly becomes slaty or closely jointed and laminated, dipping S. 10° E., and more enduring. In this condition it forms some of the islands near the beach, and also rises fifty or more feet near the coast back from the water."

Ref. Annual Report, ix, pages 55, 66.

Meg. A very fine-grained, hard, compact, brown rock. It is of the same general character as Nos. 216 and 217.

Mic. Microliths of *plagioclase* are the most noticeable feature of the section, but between these, and not sharply separated from them in size and shape, are other plagioclases; thus nearly the whole section is composed of feldspar. There are also small, more or less angular grains of *augite*, also *magnetite*, and some alteration products. In structure and composition the rock resembles No. 218.

One poor section.

Age. Cabotian.

U. S. G.

Remark. Nos. 217, 218 and 219 seem to be a repetition of Nos. 213, 214 and 215 outwardly, but the latter trio is more acid. It may be that structurally they are nearly related. No. 176 belongs with Nos. 217, 218 and 219.

These beds (Nos. 217-219) seem to have been disturbed by some upheaval, and appear in nearly all respects like those of No. 208 (fine grained), though not so conspicuously exposed.

N. H. W.

NO. 220. BASALT.

Mouth of Brulé river, forming a dull point.

Ref. Annual Report, ix, page 56; Annual Report, x, page 43.

Meg. A dark-gray, diabasic rock, of fine grain. It contains numerous small black blotches. (Compare No. 539.)

Mic. *Plagioclase* laths are seen distributed in a background which is composed of *augite* in small grains, *magnetite*, chloritic alteration product, and dirty, faintly brownish areas. These areas (which are abundant), except for small bright points, show no effect on polarized light, and they are thus referred to an originally *glassy* condition of the rock. The large amount of this glassy material is noticeable. The black blotches noticed on the hand sample are seen to be pseudamygdaloidal aggregations of the chloritic material.

One thick section.

Age. Cabotian.

U. S. G.

Remark. In the field this dark-gray rock is seen to be partly brown, and in some places it is about half brown. It is thus shown to have outwardly, as it has microscopically, a close relation to the rocks Nos. 217-219, in association with which it appears along the beach.

N. H. W.

NO. 221. DIABASE. (*Coarse.*)

At a distance of about twenty rods east of the mouth of Brulé river.

Ref. Annual Report, ix, page 56; Annual Report, x, pages 43, 140; Bulletin ii, pages 76, 100, 101; American Association for the Advancement of Science, vol. xxx, page 163.

Meg. A coarse rock, rather dark colored and easily rusting. Evidently one of the most recent eruptives of the region, judging by its contents and from the general structural relations. The crystals are all fresh and of large sizes.

Mic. The feldspar is twinned, both on the pericline and albite plans, the lamellæ crossing at varying angles, as cut by the plane of the section. It is very fresh and includes fine needles, apparently of *apatite*. The highest extinction angles on 010 range from 25° to $27\frac{1}{2}^{\circ}$, indicating *labradorite*. Several sections show a single optic axis in convergent light, the figure consisting of a single straight bar, which rotates in a direction the reverse of that of the rotating stage. Such sections are neither dark nor colored, but show a dim light, and are thus readily recognized in a thick section like the one examined, whose thickness, judging from the colors of the *labradorite*, compared with Michel Lévy's colored scale (*Détermination des Feldspaths*, plate), is about .07 millimeters. The colored fringes on the *augites* indicate the same thickness. When the albite and pericline bands are at or near right angles, as happens sometimes when the crystal is cut in the zone 001:100, the narrow sharp pericline striæ maintain their integrity through the albite bands. The section also shows Carlsbad twinning, the twins themselves being also twinned.

Wadsworth mentions orthoclase and quartz in this preparation, but we can find no orthoclase. There is a little quartz in the altered magmatic remnants.

The *augite* is well preserved, the thickness of the section not producing any dimness in the colors or in the transparency. It is coarsely fissured, but does not seem to pass into diallage. It exhibits a colored striation or banding, occasionally

Diabase.]

similar to that of the plagioclases, except that the striations are confined to the central portions of the grain. These manifesta kind of multiple twinning sometimes possessed by augite. According to Rosenbusch these twin striations are parallel to 100.

Magnetite is common in large angular grains, apparently of original generation.

Apatite is abundant in the feldspar, in fine needles. These needles are frequently abundant along a side which lies adjacent to the original magma unindividualized as if they projected from the magma into the feldspars. They can also be seen in the unindividualized magma, independent of the feldspars, sometimes forming a loose network. The augite is entirely free from them. This seems to indicate that they were the earliest of the generations from the magma, and that their formation ceased before the augite was generated, or that the augite had a special facility for rejecting them.

If any olivine be present it is in very small amount, and is in such obscured relations to the opaque remnants of the magma that it cannot be distinguished as such. Dr. Wadsworth calls attention to the similarity of this rock to the ovifak basalt of Greenland.

One section.

Age. Cabotian.

Remark. This rock resembles the rocks Nos. 133, 126, 114, 107, 106, etc., and is presumed to occupy a similar relation to earlier eruptives, if not a cotemporary in time with those. It rises back of Sickle and Double bays, and forms an important constituent in the topography as well as in the origin of the Sawteeth hills, both at the eastern and the western extremities of that range. (Compare No. 540; also, Nos. 1813 and 1815.)

It seems to be necessary to trace the outcrop of the basal conglomerate of the Potsdam, seen at Grand Portage bay and in Puckwunge valley, southwestwardly, in order to determine its stratigraphic relation to the great diabase, Nos. 221, 222, 540, and hence to the Beaver Bay and Duluth equivalents of the same, *i. e.*, to ascertain the possible later date of this diabase than that of mount Josephine, etc. N. H. W.

NO. 222. DIABASE. (*Coarse.*)

Underlies and apparently forms a part of No. 221, the two rising in a bluff about fifteen feet, and forming two or three little points within a mile east of the Brulé. The intervening bays are occupied by large rounded boulders of the same (*i. e.* of No. 221), with little rock exposure.

Ref. Annual Report, ix, pages 56, 57; Bulletin ii, page 77, figure 2, plate VI.

Meg. This is coarse and similar to No. 221. It weathers into a light green, and sparkles all over with what at a distance appears to be mica, but which is, in part at least, due to the glittering cleavages of feldspar, and of pyroxene slightly iron-stained.

Mic. The feldspar shows a curious alteration from one species to another. The original feldspar is altered by the entrance of many kaolinic microliths, and in some

instances the twinning lamellæ are obliterated. This has extinction on the brachypinacoid at 64° , indicating *bytownite, near anorthyte*. Intimately ingrown, in irregular areas in this feldspar, is another which is clear and glassy, and which extinguishes not in unison with the other. These areas ramify singularly, like the spreading growth of a mineral that is produced at the expense of another. In some cases the secondary feldspar has wholly replaced the original, so far as seen in the section, and the area appears like quartz.* This secondary feldspar is *andesine*, as indicated by the extinction on n_x at 9° . In another section, the acute bisectrix being n_p , the angle of extinction is 3° on the edge 100:010, indicating *andesine-oligoclase*. In the centre of the same crystal, which is fresh and set off from the border as from a peripheral zone; extinction is 8° , and the acute angle contains n_x , indicating again *andesine*. Thus it appears that this feldspar changes, with the optic angle, from anorthite to andesine and to andesine-oligoclase.

The pyroxene is *diallage*, having a secondary cleavage parallel to 100, characteristic of that species. The grains are not altogether thus affected. It was cotemporary with or slightly preceded the feldspar (*i. e.*, the original feldspar). There are also later pyroxenes that are better preserved and sustain ophitic relations with the feldspars.

Three sections.

Age. Cabotian; Beaver Bay diabase(?)

Remark. No. 222 differs remarkably from 221, although they are in contact, and must be considered the older rock. According to the field description No. 221 is basaltic, further east, and rises into the crests of the hill range which passes inland at Sickle bay.

N. H. W.

NO. 223. GABBRO(?)

Four miles east of the mouth of the Brulé river. Rises in a bluff facing Sickle bay toward the east, thirty feet high, and having nearly vertical basaltic structure. Evidently the same rock mass as No. 221. (See No. 540.)

Ref. Annual Report, ix, page 57; Bulletin ii, page 101.

Meg. This rock is much fresher than No. 222. In the sun-light are many reflecting cleavage surfaces of feldspar, but the rock is in general coarse, dark and heavy.

Mic. The feldspars are not earlier than the pyroxene, but these minerals seem to have formed simultaneously. In the large slide examined not an instance of ophitic structure is discernible, but in rare instances the *augite* is entirely enveloped by the *feldspar*. The *augite* has a small optic angle. Considerable amounts of the unindividualized magma were still in the rock when it solidified, but these are now altered to a green and isotropic substance, in the midst of which is rarely seen a little

*Some such small areas were mistaken for quartz, in his description and illustration, by Dr. Wadsworth. *Bulletin ii*, plate VI, figure 2, Minnesota Survey. These areas all give a curved black bar in convergent light.

Aporhyolyte. Gabbro.]

quartz. No olivine is visible. The augite but rarely shows any tendency to become diallagic. The following extinctions were measured on the feldspar, indicating a *labradorite*: Extinction on n_p , 56° ; extinction on n_p , 55° ; angle on n_p , between the pericline and albite bands, 81° (Fouqué, Bulletin de la Société de Minéralogie de France, vol. xvii, page 428).

Two sections.

Age. Cabotian; Beaver Bay diabase (?). It is at present impossible to affirm either the Cabotian or the Manitou age of this rock. For the sake of consistence, with what precedes, this is classed Cabotian; but it may be later than the basal conglomerate of the Potsdam. More field work is needed to determine this point.

N. H. W.

NO. 224. APORHYOLYTE (?)

From the rocky point which divides Double bay into two parts; N. E. $\frac{1}{4}$ S. E. $\frac{1}{4}$ sec. 10, T. 62-4 E. This rock is somewhat basaltic like trap, and also rudely bedded.

Ref. Annual Report, ix, page 57.

Meg. A fine-grained, brown rock, very indistinctly mottled with a darker color. Under the lens the rock appears granular, but the only mineral distinguishable is feldspar.

Mic. The section, which is quite fine grained, is made up of *feldspar*, *quartz*, green *hornblende*, *hematite*, *magnetite*, *chlorite* and *augite* (?). The feldspars are more or less cloudy, are mostly untwinned, and are frequently in short, stout crystals, although many of the grains are allotriomorphic. The quartz is in small grains and sometimes in small poikilitic areas. The hornblende is in small plates, and is evidently secondary. The grains, which are perhaps augite, are minute, greenish to colorless, and polarize brightly. In a few places there is a little greenish to brownish interstitial matter which, under crossed nicols, is dark, except for a few light points. It probably represents *glass*. Other areas, which appear similar to this interstitial material in ordinary light, under polarized light are seen to be largely feldspathic. The rock as a whole is considerably altered.

One section.

Age. Cabotian.

Remarks. See under No. 226.

U. S. G.

NO. 225. GABBRO (*with orthoclase*).

From the most easterly point of Double bay. (See Nos. 5, 263.)

Ref. Annual Report, ix, page 57; Bulletin ii, page 81.

Meg. A coarsely crystalline "orthoclase gabbro" (apparently), as defined by Irving, comparable to that form of the gabbro at Duluth, which is represented by No. 5 of this series.

Mic. The *feldspar* in the sections examined is very much impregnated by quartz and clouded by other alterations, so much so that it is sometimes impossible to state its specific relations. Some of it is certainly triclinic, having yet remnants of the characteristic twinning of the albite type. There are some large plages, however, having more nearly a square outline that are more abundantly supplied with the pegmatitic *quartz*, which may be *orthoclase*. Such acid feldspar, however, cannot be considered an original integral portion of the rock, but only as accessory, and due to the proximity of contact on the elastics. This fact, *i. e.*, the contact with the sedimentaries, manifests itself in many places in a silicification of the other (original) elements of the basic eruptives and in the appearance of *orthoclase*.

The *augite* seems to have begun its formation from the magma contemporaneously with the feldspar, its form in some cases being independent of the feldspar, and even being embraced in a certain manner by the feldspars whose outlines give way before it. Yet, in other places, there seems to have been a later generation of *augite*, which now is seen to fit itself into the interstices between the feldspars. In all cases it is much altered.

The *quartz* is so arranged in the feldspars as to form a microscopic pegmatitic structure, numerous small areas extinguishing at the same moment, each small section sometimes being triangular and aligned with others as if their location had been determined by the cleavage of the feldspar, although, at present, there is no remaining trace of such cleavage. Quartz also appears otherwise as independent, sizable grains.

Magnetite in the usual form and quantity is distributed throughout the section.

Two sections.

Age. Cabotian.

Remark. This is put in the Cabotian because of its obvious association with Nos. 221, 222 and 223, both petrographically and structurally. It is presumed to be a contact phase of the same. This is in keeping with the assignment of No. 5 at Duluth, which is put in the Cabotian because, starting with the gabbro at Duluth as Cabotian, its contact apophyses would also be Cabotian, especially as there we find the upheaved Animikie and red rock associated with it. Still, there would be nothing unreasonable in expecting Manitou contact phenomena similar, if not identical, with those of the Cabotian.

N. H. W.

NO. 226. APORHYOLYTE(?)

From an isolated dike-like exposure on the beach in the next shallow bay east of Double bay; N. W. $\frac{1}{4}$ S. W. $\frac{1}{4}$ sec. 12, T. 62-4 E. This rock is closely jointed and basaltic.

Ref. Annual Report, ix, pages 57, 58, 59.

Meg. A fine-grained, reddish-brown rock, which is made up of small, reddish feldspars and a dark substance. It is porphyritic with small, reddish feldspars, and

Aporhyolyte. Diabase.]

also has a few porphyritic crystals which are fresher than the reddish phenocrysts, are gray and distinctly polysynthetically twinned.

Mic. None of the gray feldspar phenocrysts are cut by the section. There are, however, several of the smaller red phenocrysts. These are much altered and reddened, and show no twinning striae, but some of them are so much altered that traces of this twinning would probably not remain, even if it was once present. The rest of the section is composed of feldspar, quartz, hornblende, augite, magnetite, hematite and chlorite.

The *feldspar* is somewhat cloudy, is in small grains and stout crystals, and does not usually show twinning striae, although simple twins are seen. This feldspar is somewhat altered and reddened, is in such small grains, and does not show cleavage cracks, that no careful determination can be made. It, however, extinguishes approximately parallel to the long sides of the crystals, and also parallel to the twinning line, when one is present, and it is thought to be largely *orthoclase*.

The *quartz* is in small grains and is sometimes intergrown with the feldspar to form micropegmatyte, and is also in small poikilitic areas.

The *hornblende* is the usual green variety and is quite abundant. It occurs in small plates, pleochroic in shades of green and yellowish, and seems to be all of a secondary nature. In fact, in some places, it can be seen as an alteration from pyroxene.

The *augite* is greenish to colorless, and is usually in small grains, many of which are altered to hornblende. There are a few larger crystal of augite, partially idiomorphic, which are of about the same size as the red sub-porphyritic feldspars of the section.

The rock is considerably altered, and much of the quartz is probably secondary.

One section.

Age. Cabotian.

Remarks. This rock and No. 224 are evidently the same, petrographically, and in age, and are thought to be parts of the same mass. Their present condition does not clearly show their original nature, but it seems probable that they were originally of the nature of rhyolytes or trachytes. The small amount of quartz, much of which is secondary, would perhaps cause these rocks to be more accurately termed apotrachytes, but in accordance with the classification of the other rocks of a similar nature and age, they are here referred provisionally to the aporhyolytes. U. S. G.

NO. 227. DIABASE (?) (*Porphyritic.*)

Same locality as No. 226. A narrow dike-like form, not sharply separated from No. 226. "It is narrow and its line of bearing becomes confused, or blends with the rock No. 226, being perhaps a modified form only of No. 226, due to different influence in upheaval, or to unseen contact with accompanying igneous rock."

Ref. Annual Report, ix, page 57.

Meg. A fine-grained, compact, heavy, dark gray, almost black rock, looking like a fine-grained diabase. There are some porphyritic, gray to reddish feldspars, which are more common on one half of the hand specimen than on the other.

No section.

Age. Cabotian.

U. S. G.

NO. 228. DIABASE. (*Gabbroidal.*)

From the broad point just west of Cannon Ball bay; S. E. $\frac{1}{4}$ sec. 6, T. 62-5 E. "The east side of this bay is made of the same rock, also the east point, also the island east of it; the coast being rocky and low, or rising from six to ten feet, basaltic. The next island, and the coast along, especially the points of the coast, are of the same. It rises into basaltic beds in a sharp point [S. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$ sec. 34, T. 63-5 E.] on the west side of Red Rock bay."

Ref. Annual Report, ix, pages 57, 58; Annual Report, x, page 43; Bulletin ii, page 99.

Meg. A rather coarse-grained, heavy, black diabase. There are numerous yellowish grains, which might be taken for olivine, but the section shows no olivine.

Mic. A beautiful section of a rather coarse-grained, fresh diabase. Some of the *augite* has a tendency to an idiomorphic development, and is thus earlier than some of the feldspar, but most of the *augite* is later than most of the feldspar. There is a considerable amount of a brown alteration product (bowlingite) present. Dr. Wadsworth (Bulletin ii, page 99) regards this as an alteration product of an interstitial basaltic base. It is also apparent that some of it originated from the pyroxene.

One section.

Age. Cabotian.

Remarks. For further description, see under Nos. 222 and 223, which are evidently from the same mass as this specimen. (See, also, under Nos. 133 and 229.)

U. S. G.

NO. 229. DIABASE (*with olivine*).

From Red Rock bay; runs under the Eastern Palisades.*

Ref. Annual Report, ix, page 58; Annual Report, x, page 140; American Association for the Advancement of Science, xxx, page 163.

Meg. This rock greatly resembles No. 228, but is finer grained.

Mic. An ophitic diabase with much fresh *olivine*. The rock is fresher than No. 228, both in respect of the *augite* and the possession of unchanged *olivine*. The *augite* appears chiefly in ophitic relation to the feldspar; but there is plainly an older *augite* which is not diallagic but filled with dark opaque particles scattered like dust throughout their mass. These have independent outlines like those of No. 228.

One section.

Age. Cabotian.

N. H. W.

NO. 230. APORHYOLYTE.

Red Rock bay; sec. 34, T. 63-5 E. The rock of the Eastern Palisades. (See No. 620.)

Ref. Annual Report, ix, pages 58, 59; Annual Report, x, page 59.

*The Eastern Palisades are N. W. $\frac{1}{4}$ S. E. $\frac{1}{4}$ sec. 34, T. 63-5 E.

Diabase. Basalt.]

Meg. A compact, hard, brownish red, siliceous, aphanitic rock, which holds porphyritic crystals of quartz and red feldspar.

Mic. The porphyritic *feldspars* are much decayed and reddened. The porphyritic *quartzes* are considerably rounded and are sometimes penetrated by little embayments from the groundmass. The groundmass is similar to that of most of the aporhyolytes already described, *i. e.*, a little *magnetite*, *hematite*, much minute cloudy feldspathic material, the whole section reddened, and all in a background of *quartz*, which is usually in poikilitic areas holding the other materials of the groundmass. The section shows some irregular areas of finely crystalline quartz from which most of the other materials of the groundmass are lacking. In ordinary light these areas are transparent and colorless.

One section.

Age. Cabotian; red-rock series.

U. S. G.

NO. 231. DIABASE.

From a dike of basaltic doleryte, cutting rock No. 230, a short distance east of the mouth of Red Rock creek, embracing patches of the red rock (No. 230). Compare No. 1818.

Ref. Annual Report, ix, page 58.

Meg. Very fine-grained, nearly black, with isolated nodules of pyrite.

Mic. The slide is too thick for such examination. The *feldspar* is in the form of lath-shaped crystals without distinct terminations. Much *magnetite* is visible as small roundish grains.

One section.

Age. Cabotian; probably an apophysis from the great gabbro mass. N. H. W.

NO. 232. BASALT. (*Amygdaloidal.*)

Is the first rock that appears in the pebbly beach east of the rock of the Red Rock point, probably in S. W. $\frac{1}{4}$ sec. 25, T. 63-5 E. Compare No. 1823.

Ref. Annual Report, ix, pages 58, 59; Annual Report, x, page 47.

Meg. A reddish brown, fine-grained, compact or amygdaloidal rock, the amygdules being white, coated with green or entirely green. Apparently underlies No. 230, and resembles some of the compact brown rock seen at Duluth and at many intermediate points.

Mic. The *feldspars* and all the other minerals are very much stained with ferric oxide, and penetrated by other impurities. The section between crossed nicols is nearly opaque.

There are remnants of *olivine*, and of *augite*, and a considerable quantity of *magnetite*, the last prevailing in the vicinity of the olivine, and enwrapping it. In general the *feldspars* are quite perfect in their outlines, the reddened substance which embraces them being probably the uncrystallized remnant of the magma. The old olivine grains, entirely altered, sometimes show nearly regular crystalline

outlines. The green substance prevailing in the amygdules is opaque between crossed nicols, or nearly opaque, owing to the confused polarization of the crowded, very fine fibres which may be of *thalite*, or of serpentine.

Two sections.

Age. Cabotian; perhaps pre-gabbro.

N. H. W.

No. 233. BASALT (*with olivine*).

From a dike twenty-one feet wide, near No. 232, horizontally columnar, running N. 15° E., projecting into the bay seventy-five to ninety feet.

Ref. Annual Report, ix, pages 58, 59.

Meg. Dark, medium-grained, diabasic.

Mic. This rock is not ophitic, but granitic, so far as concerns the relation of the augites to the feldspars. The *augites* are small and not much altered, considering their comparative date of generation. The *feldspars* are somewhat kaolinized. *Magnetite* rods, or skeleton crystals are disseminated abundantly, and at the same time magnetite is present in the form of angular and irregular masses, probably a replacement of olivine. There is an abundant remnant of a poorly differentiated *magma-glass*, through which the magnetite rods are scattered. In these areas are not only incipient minute crystals which are apparently of augite and of feldspar, but also small secretions of *quartz*, and an isotropic grayish green substance, which represents the final residuum from the glass.

One section.

Age. Manitou (?)

Remark. It is impossible to assign age to the dikes along this part of the shore with any positiveness, since the Manitou may or may not have shared in their production. Considering the fact that the field relation of this rock to No. 234 indicates that it is a part of the same mass as that, it exhibits an interesting variation, which requires different names for the two rocks. The glassy remnant seen in this, and the non-porphyrific structure, are contrasted with the holo-crystalline and porphyritic feldspars of the other.

N. H. W.

No. 234. PORPHYRYTE. (*Diabase*.)

"From a dike eighteen feet wide running east and west 'hading' a little to the south, cross-columnar, cotemporary and blending with the dike No. 233, the structure of the two running together; of a brownish-black color."

Ref. Annual Report, ix, page 59.

Meg. A rather fine-grained, apparently granular, dark, brownish-black rock, with porphyritic plagioclases of about the same color as the mass of the rock. Many of the phenocrysts seem to contain the older materials of the rock poikilitically.

Mic. The plagioclase phenocrysts shown in the sections are few and small. They are not poikilitic, as is indicated by the hand specimen, only one of them

Basalt.]

containing foreign material, *i. e.*, a grain of olivine. It is possible that other phenocrysts would in thin section show this feature more prominently. The groundmass is composed of *plagioclase*, *augite*, *olivine* and *magnetite* as original constituents. The rock, as a whole, has been considerably altered and fissured; the fissures are filled with *hematite* and a greenish yellow serpentine-like material, and these two substances, especially the latter, are developed throughout the rock, replacing the olivines and most of the augites, and also filling spaces which may possibly have been occupied by a glassy residuum; a little secondary *quartz* is also present. The rock is inclined to a hypidiomorphic structure, rather than to the ophitic, but, as the augites are so far gone, the relation of this mineral to the feldspar is not clearly made out. The feldspars, however, while usually in more or less idiomorphic grains, are frequently partly or wholly allotriomorphic.

Three sections.

Age. Manitou(?)

U. S. G.

NO. 235. BASALT (?)

"A rock similar to No. 232, cut by the dikes, having a slaty structure without any dikes; forms the beach next north of the dike No. 234, which is out in the water."

Ref. Annual Report, ix, pages 59, 60; Annual Report, x, page 47.

Meg. A compact, hard, very fine-grained, almost aphanitic, red-brown rock.

Mic. The section, which is a very poor one, shows microliths of *feldspar* and grains of *magnetite*, in a reddened background whose nature is not discernible on account of the thickness of the section. There is also one sub-angular *quartz* grain present.

One section.

Age. Cabotian.

Remarks. This rock is probably the same as No. 232.

U. S. G.

NO. 236. BASALT.

"From a dike twenty-one feet wide; a fine-grained, black basalt, running out into the lake about 250 feet, but often in the form of islands that occur a little out of line. The basaltic structure of this is very irregular. In some places it is fine and in others it is coarse; runs N. 15° W., being intersected by the dike No. 234, apparently in the same manner as No. 233."

Ref. Annual Report, ix, page 59.

Meg. A heavy, compact, very fine-grained, greenish, black rock. It contains a little pyrite.

Mic. The section shows microliths of *plagioclase* in a confused, altered background, which is composed of *magnetite*, *chlorite* and cloudy, greenish, or grayish (sometimes with a shade of brownish) areas. These cloudy areas under polarized light, are seen to be sometimes feldspathic, but most commonly show no effect on polarized light, except for a few bright points. The whole background of the rock was

evidently originally *glassy*, or nearly so, and it has been considerably altered from its original condition.

One thick section.

Age. Manitou (?)

U. S. G.

NO. 237. BASALT (*with olivine*).

From a curious isolated mound of thin-layered, almost slaty, rock, with curving lamination, which rises eighteen feet on the beach, or between the beach and the lake, a short distance east of No. 236. Shaped like a haystack. (See Nos. 1824-1826.) In structure and lamination reminds of a sedimentary rock, but its amygdaloids show it is an eruptive.

Ref. Annual Report, ix, page 59.

Meg. Compact, fine-grained, brownish diabasic rock. Evidently distorted and curved by pressure.

Mic. The little *feldspars* are mostly idiomorphic, lying in a nearly isotropic brown *glass* which still renders a confused polarization.

Magnetite, in very fine particles, is common.

Olivine appears largely replaced by magnetite, yet, occasionally in the centre of a magnetited grain, a green decomposition product remains. The olivines, thus changed, still show their original idiomorphic outlines. They appear occasionally to break the symmetry of the feldspars, but in general the still mobile magma was so abundant that the feldspars found room to form entire without being trenced upon by the earlier olivines.

Hematite, and apparently *chlorite*, resulted from alteration.

One section.

Age. Cabotian.

N. H. W.

NO. 238. BASALT (*with olivine*).

Same place as No. 237, but from a slaty condition of this rock.

Ref. Annual Report, ix, page 59; Annual Report, x, page 47.

Same rock as No. 237, except that it contains a little quartz, and occasionally a porphyritic feldspar of the first consolidation; entirely reddened by oxide of iron.

One section.

Age. Cabotian.

N. H. W.

NO. 239. BASALT (*with olivine*).

The same rock as No. 238, but non-fissile, firm, weathering brown, rather finer grained.

One section.

Age. Cabotian.

N. H. W.

NO. 240. BASALT (*with olivine*).

From the same place as No. 238, and from the same rock.

Ref. Annual Report, ix, pages 59, 60.

Meg. Finer grained, breaking conchoidally.

Basalt. Diabase.]

Mic. The elements in the slide are hardly differentiated. The *feldspars* are indistinctly combined in the matrix. There are minute polarizing spots, but without the crystallographic outlines of feldspar. This may have resulted from the consolidation of a tuff. In another slide the rock appears the same as in No. 237, but has larger amounts of *hematite*; also *calcite* and *biotite*.

Two slides.

Age. Cabotian.

N. H. W.

NO. 241. BASALT (*with olivine*).

Same rock, same place, but nearly black. Cannot be distinguished from No. 237, except that the feldspars are not so well formed as to crystalline boundaries. A minutely fine basalt.

One section.

Age. Cabotian.

N. H. W.

NO. 242. DIABASE (*with quartz*).

From a dike cutting Nos. 237-241; 100 feet wide, running nearly east and west.
Ref. Annual Report, ix, pages 59, 60.

Meg. Grain medium in size. Some feldspars being conspicuous and striated. Grayish-brown rock.

Mic. The *feldspar* is of two periods of generation, the earlier one having twinning after the Carlsbad law, the two individuals being twinned after the albite law. A section of such a twin is perpendicular to n_v (a) and has extinction at 56° , which indicates a feldspar near *anorthite*. Another section is yellow between crossed nicols, and happens to be cut perpendicular to n_m (b), showing the thickness of the slide at this place is about .0525 millimeters. It varies, however, being in other places .0325 millimeters.

There is considerable *quartz* in the rock, in independent grains, yet in some cases it is minutely distributed through other minerals in the form mentioned in No. 225, forming a micropegmatyte.

Augite is not abundant nor well preserved. It is granular amongst the feldspars rather than ophitic, causing the rock to take on the character of a granular gabbro, and identical with the rock of Nos. 233 and 234.

One section.

Age. Manitou.

Remark. Nos. 232 and 235, and their modifications to No. 241, run under No. 230, the Eastern Palisades, and below the red rock of the point east of the Eastern Palisades. These are basic surface flows, and the Eastern Palisades are of an acid effusive.

N. H. W.

NO. 243. BASALT (*with olivine*).

From the west point of Deronda bay; N. W. $\frac{1}{4}$ N. W. $\frac{1}{4}$ sec. 30, T. 63-6 E.
Ref. Annual Report, ix, page 60.

Meg. Fine-grained, hard, nearly black, homogeneous rock. It is rather bedded, but not basaltic, lying on an amygdaloid (No. 244).

Mic. The thick section is only sufficient to show that this rock is essentially one of the series to which No. 235 belongs. It holds some *calcite* and some *quartz*.

One section.

Age. Cabotian.

N. H. W.

NO. 244. DIABASE. (*Amygdaloidal.*)

From the west point of Deronda bay. A reddish brown amygdaloid with green amygdules, underlying No. 243, passing irregularly into No. 245, which is mainly non-amygdaloidal, but has nests of a lighter mineral; probably of the series represented by Nos. 232-235, 237-242.

Ref. Annual Report, ix, page 60.

Mac. Reddish-brown, rather fine-grained, spotted with fine green amygdules, resembling No. 232 and that series.

Mic. A diabase, with lath-shaped feldspars, magnetite and altered minerals which cannot be determined from the section.

The amygdules are of a green substance, finely radiated, and having a positive extinction, *i. e.*, parallel with the fibres, and seem to belong to *antigorite* (*Minéralogie de France*, vol. i, page 426), or to *delessite*. The fibres are parallel with n_e . A Boricky test, however, was made to detect the possible presence of potassium, by which celadonite differs from antigorite, with the result that no potassium was found.

One section.

Age. Cabotian.

N. H. W.

NO. 245. DIABASE.

West point of Deronda bay; N. W. $\frac{1}{4}$ N. W. $\frac{1}{4}$ sec. 30, T. 63-6 E. Is mainly non-amygdaloidal. Passes into No. 244.

Ref. Annual Report, ix, page 60.

Meg. A dark-gray, compact, fine-grained, diabasic rock. The hand sample shows very fine, indistinct, yellowish to greenish amygdules.

Mic. A fine-grained diabase, with alteration products, mainly *chlorite*. The *augite* is not abundant, but usually occurs in plates of considerable size, including the plagioclases. The rock is very rich in plagioclase, there being considerable areas where the *augite* is lacking; here the plagioclase is in ill-defined laths and allotriomorphic grains. A few small green areas, probably representing original *olivine*, are present.

One section.

Age. Cabotian.

U. S. G.

No. 246. DIABASE (*with olivine*).

About three-fourths of a mile east of Deronda bay, at the mouth of a little creek; near the centre of sec. 19, T. 63-6 E.

Ref. Annual Report, ix, page 60.

Meg. A dark-gray to greenish, fine-grained diabasic rock appearing much decayed. It contains much calcite, some of which is pinkish.

Mic. A diabase with the abundance of *feldspar* and the large plates of *augite* seen in No. 245. There are, however, more of the altered olivines than in No. 245, and what is peculiar is that the interior of these altered grains is frequently a clear, subangular grain of quartz surrounded by the usual decomposition products of the olivine.

One section. [It is possible that the section marked No. 246 is not from the hand sample of that number. The latter appears more decayed than is indicated by the section.]

Age. Manitou(?)

U. S. G.

No. 246A. CALCITE.

From No. 246.

Ref. Annual Report, ix, page 60.

Meg. A mass of calcite in small, transparent crystals and also massive and flesh colored.

No section.

Age. Manitou(?)

U. S. G.

No. 247. BASALT. (*Amygdaloidal.*)

Rock similar to No. 246, but more amygdaloidal.

Ref. Annual Report, ix, page 60.

Meg. A fine-grained, much decayed, dark-greenish gray, diabasic rock. It contains amygdules of calcite, both pink and colorless; also of chlorite and chalcedony. Much chlorite permeates the rock.

Mic. The section, which is too thick, shows *plagioclase* microliths in a dirty, confused mass of alteration products—*chlorite*, *calcite*, *iron ores* and a little *quartz*. It is impossible to tell what the original nature of this groundmass was, but it seems probable that part of it, at least, was glassy.

One section.

Age. Manitou(?)

U. S. G.

No. 248. GABBRO. (*Altered.*)

From a dike which has an indefinite width, at least 200 feet, on the third little point east of Deronda bay, after a pebbly beach of half a mile. The second point is like rock No. 246.

Compare rock No. 41, at Duluth, and No. 1855.

Ref. Annual Report, ix, page 60.

Meg. Porphyritic, with a glassy, clear plagioclase, hard and massive, but fresh and rather light colored, owing to the general effect of the feldspars when fractured. The matrix is dark and medium grained.

Mic. The feldspar has an extinction on 010 of 25° , indicating *labradorite*. It is abundant in the rock, and was formed after the augite or cotemporary with it. It is clear and brilliant, but slightly zoned. It shows occasional Baveno and Carlsbad twinning, in addition to the albite and pericline types.

The *augite* is markedly translucent and clear, but not colorless. It has strong prismatic cleavage, but is not diallagic. Its forms are in part independent of the feldspar, and the crystals are not large. They are well preserved, considering the fact that adjoining them are quite commonly seen hornblendic areas which are usually considered the result of alteration of augite.

Olivine is in the rock in small amount, serpentized in the cleavages, embracing the feldspars. *Quartz* also is not uncommon. It is usually found in the form of small, angular grains embraced in or near those areas that show considerable alteration as from undifferentiated magma, accompanied by brownish or greenish and by opaque substances.

Hornblende is not common, absorptive and yellowish green to brown in natural light. In its immediate vicinity are sometimes small areas of *chlorite*, which seem to be the result of further alteration.

Glass, or glassy remnants from the original magma, seem to have been the instigating cause of all these changes. It appears that, perhaps during the cooling stage after solidification, the remaining portions of the magma were the seat of further differentiation, and that the resultant crystals were hornblende, quartz and chlorite.

Apatite spicules are very abundant. They pierce all the other minerals, and seem to have been the oldest secretion from the molten magma.

Magnetite is present, but not in considerable amount. Another section shows more magnetite.

Two sections.

Age. Manitou(?)

Remark. This is the most westerly known point on the lake shore where this rock, which seems to be a representative of the Grand Portage Manitou dike series, occurs in sight. These dikes constitute a mountain range lying north from the Sawteeth range, and distant from the latter at Double bay from three to six miles. Still, notwithstanding the classification adopted, it is impossible to separate the Cabotian dikes at Grand Portage from those seen at Double bay, and at Deronda and Horse-shoe bays.

Basalt. Diabase.]

The field-note (Annual Report, ix, page 60) indicates that this rock cuts an amygdaloid (No. 249). There are two series of surface flows concerned in the Grand Portage region, and at present it is impossible to separate them geographically. There are also, in the same region, two inseparable series of dikes. N. H. W.

NO. 249. BASALT. (*Amygdaloidal.*)

Adjoins No. 248. Third little point east of Deronda bay; probably in N. W. $\frac{1}{4}$ N. W. $\frac{1}{4}$ sec. 20, T. 63-6 E.
Ref. Annual Report, ix, page 60.

Meg. A fine-grained, dark greenish to gray, diabasic rock, considerably decayed. Contains amygdules of calcite, quartz, and probably chalcedony.

Mic. Feldspar microliths in a confused, greenish mass of alteration products, which are largely *chlorite*, *calcite* and *magnetite*. The original nature of this ground-mass cannot be determined, but it is not improbable that it once contained considerable *glass*. The section contains part of an amygdule of calcite and *quartz*, in which minerals are a few small grains, with a rather high index of refraction and strong double refraction, which may be *epidote*.

One section.

Age. Manitou (?)

U. S. G.

NO. 250. BASALT. (*Amygdaloidal.*)

West point of Grand Portage bay; N. W. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 16, T. 63-6 E.
Ref. Annual Report, ix, pages 60, 61.

Meg. A fine-grained, brown, diabasic rock, with amygdules of calcite, and with some of quartz and chlorite.

No section.

Age. Manitou (?)

Remark. This is probably the same rock mass as No. 249.

U. S. G.

NO. 251. DIABASE (*with olivine*).

"Underlying No. 250; an amygdaloidal of a greenish color. These beds (Nos. 250 and 251) dip south at a low angle and do not extend into the bay. They apparently form the coast line between Grand Portage bay and Deronda bay, there being but little outcrop, with a low shore between these places."

Ref. Annual Report, ix, page 61.

Meg. A heavy, compact, rather fine-grained diabase. It is dark gray, with a tinge of yellow. The hand sample is not amygdaloidal.

Mic. The section shows an *olivine* diabase of medium grain. The *olivine* and *augite*, especially the former, have been largely replaced by a greenish, yellow serpentine like material and *magnetite*. Possibly, some of this secondary material represents an original glassy residuum. There are some pseudamygdaloidal areas, which are filled mostly with what appears to be *thallite*, with some *calcite* and serpentine-like material, and the calcite is also found elsewhere in the rock, especially in the areas once occupied by olivine. One section.

U. S. G.

Age. These beds are Manitou, lying above the conglomerate, which is in outcrop a little further north in the hills west from Grand Portage bay. N. H. W.

NO. 252. SLATE.

From the Animikie at the village of Grand Portage. The outcrop is near the water along the beach, rising also into short hills a short distance inland.

Ref. Annual Report, ix, pages 61, 62.

Meg. Rather hard and gritty; the slatiness is due to the sedimentation, with occasionally a clay-ball impression.

Mic. Principally of *quartz* and *feldspar*, in angular and sub-angular fragments, with a rare scale of *muscovite*. Some of the feldspar is scantily banded with albite striations.

One section.

Age. Taconic.

N. H. W.

NO. 253. GABBRO.

From a dike at Grand Portage, near the village, cutting the slates. This dike is thirty-nine feet wide and runs E. 15° S.

Ref. Annual Report, ix, page 61; Bulletin ii, page 112.

Meg. Apparently the same kind of rock as No. 248.

Mic. The composition and grain of this rock are identical with those of No. 248.

One section.

Age. Manitou(?)

N. H. W.

NO. 254. CONGLOMERATE.

From the base of Portage Bay island, on the northeastern side.

Ref. Annual Report, ix, page 61; Annual Report, x, page 34; American Geologist, xiii, page 437, June, 1894.

Meg. Rather coarse, firm, quartzose conglomerate, but containing fragments of a gray, slaty rock, resembling the slate of No. 252. This lies in large fallen pieces on the shore. These masses are evenly stratified, and show false bedding. The dip *in situ* is S. 10° E., at an angle of 8° to 10°. It shows at least twenty feet, and is cut by a dike nine feet wide. Its color is, in general, gray, but it is spotted sparingly with red pebbles, which can be referred, with the slate fragments, to the hills of the mainland adjacent to this bay, where the red rock of the region appears. It also holds gray quartzite and flint.

Mic. This conglomerate, consisting largely of vitreous *quartz* grains, yet contains some grains of a triclinic *feldspar* showing the albite twinning, and of *microcline* with its characteristic quadrillage. The cement is *calcite*, but this calcite is so abundant that it serves more than as a cement, and occupies independent areas as if it were rapidly accumulating when the conglomerate was being formed.

In some parts of the thin section examined, indeed in a large part of it, calcite is not so abundant, but in its place, apparently, is an isotropic, greenish, fibrous

Conglomerate.]

substance, whose nature it is difficult to determine. There are other sub-isotropic grains, filled with impurities, some of them having a poikilitic quartz background, and some that are derived from feldspathic grains, now much altered. The only plausible interpretation of the isotropic grains, from a petrographic point of view, which presents itself, is to assign them to an original volcanic glass, which may have existed in considerable quantity in the vicinity where this conglomerate was being formed. Structurally, however, there is no warrant for such a supposition, and it seems necessary to refer these isotropic and sub-isotropic grains to alteration from debris derived from some crystalline rock of older date. (See Part I; compare No. 2069.)

Two sections.

Age. Basal conglomerate of the Potsdam.

Four additional sections, from pebbles of this conglomerate, were made subsequently by Marchand. Of these, two were of the "red rock" pebbles. They show a rock consisting largely of *quartz*, but between crossed nicols so dark that it is necessary to allow the existence of considerable isotropic matter. The quartz is in small, irregular grains, sometimes clear and sizable, but for the most part closely intergrown and overlapping, with tortuous outlines. The pebble also embraces *triclinic feldspar* fragments, and *calcite* spreads abundantly through some parts of it. There are also other small, brightly-colored and lamello-fibrous crystallites which can hardly be named specifically, but may be of muscovite. The aspect is that of a composite, siliceous rock, hardened and partially recrystallized by heat, but not wholly fused. Surrounding this pebble are other, smaller, elastic grains and composite pebbles, some of them being apparently from a rock that would bear the name of quartz-porphry, with bipyramidal quartzes whose orientation controls the poikilitic quartz that surrounds them and embraces more or less colored and isotropic matter.

Of two other sections made from pebbles from this conglomerate, one is of a granular quartzite resembling much the rock No. 1838. Mingled with fine, rounded quartz pebbles are some that are clouded with reddish impurities. These last have regular extinctions, and appear to have resulted from a silicification of an older rhyolite, but on testing them in convergent light they exhibit indistinctly, when cut favorably, the single dark bar of a biaxial mineral which rotates with the stage, but in reverse order. They are therefore elastic grains of *orthoclase*. In the same pebble are other minerals. *Epidote* shows by its high refraction and double refraction. It is rather abundant. A dichroic, fibrous, greenish to brownish mineral, somewhat resembling hornblende, is probably *clinoclone*, as its double refraction, though in the colors of the first order, is but little above that of quartz cut in the same thick-

ness. A single subrounded grain of *zircon* is greenish between crossed nicols, clear and bright, and extinguishes parallel to its greater diameter. Its green color (the section being about .03 millimeters in thickness) is in the third order.

The fourth section, made from a pebble from this conglomerate, is finer grained, but essentially a clastic quartzite. The grains are interlocked by secondary *quartz* growths, and these growths embrace many clouded impurities which served to make up the original surrounding mass. Hence this interstitial silica is rather dark, especially between crossed nicols. Whether this secondary growth took place prior or subsequent to the incorporation of these grains in this quartzite is an important question, for it cannot be distinguished from a poikilitic extension of secondary quartz through an aporhyolyte. If it preceded the formation of the conglomerate, there must have been surface rhyolitic rocks to serve as its source. It would not be safe to affirm, on the evidence of this section alone, the existence of such a rock in the Grand Portage region at the date of the formation of this pebble.

Remark. The importance of determining the stratigraphic position of this conglomerate precludes a discussion of the question at this place. It has been supposed to lie at the base of the Keweenawan. It is similar to that represented by No. 1903, which was found about the centre of N. W. $\frac{1}{4}$ sec. 25, T. 64-4 E., southward from South Fowl lake, and to that seen near Fond du Lac, in the valley of the St. Louis river. It outcrops on the mainland in the hills about a mile west of Grand Portage village, and is illustrated by figure 1 of this volume. N. H. W.

No. 255. BASALT. (*Amygdaloidal.*)

"This overflow comes down to the water at once and hides the conglomerate, and rises perpendicular about twelve feet. It weathers very rough and open angular, from containing fragments, apparently, of rock from contiguous formations, that were not wholly molten." Grand Portage island.

Ref. Annual Report, ix, page 61.

Meg. A very fine-grained, much decayed, greenish-gray rock, which holds small amygdules of calcite. One side of the specimen has some gray shaly material and also some of the underlying sandstone, indicating that this side of the specimen was in contact with the sandstone or that it included a fragment of the sandstone.

Mic. The groundmass of the rock is green, in fact the whole section is, due to the presence of a large amount of *chlorite*. This groundmass is made up of *calcite*, *chlorite*, small, black spots, and the remains of *plagioclase* microliths. There is also a little *hematite* and *pyrite*. The small black spots are opaque, black in transmitted light and gray in reflected light. There are the outlines of many porphyritic crystals, the crystals having been replaced entirely by calcite, or chlorite, or both. In no case was any of the original material of the crystal discernible. Some of these phenocrysts show eight-sided sections which might be referred to cross-sections of pyroxenes, and others, by the arrangement of the chlorite, suggest olivines. There are

Gray Sandstone.]

also many small amygdules of calcite and chlorite. The peculiar feature of the rock is the large amount of calcite; this mineral not only fills the amygdaloidal cavities and the spaces left by the porphyritic crystals, but exists in large amount in the groundmass of the rock. The calcite evidently makes up more than one-half of the rock mass.

Two other sections show essentially the same features described above, with the additional fact that the rock has included fragments and grains of the adjacent quartzite. Sometimes rounded grains of quartz are seen in the midst of the basaltic mass.

Three sections.

Age. Manitou.

U. S. G.

Remark. Whether this rock be an amygdaloid or a tuff or both (more probably), it is a surface rock, and not an intrusive; and as it is overlain by a sandstone it indicates an interrupted volcanic action in the near vicinity during the accumulation of the fragmental rocks at the base of this island, and it therefore makes more plausible the suggestions of glass in the conglomerate No. 254.

N. H. W.

NO. 256. GRAY SANDSTONE.

"Sandstone; of even grain and bedding, lying between layers of trap-rock immediately over No. 255."
Grand Portage island.

Ref. Annual Report, ix, page 61.

Mag. A light-gray, fine-grained sandstone or quartzite. It contains a few small red grains—feldspar. The hand sample shows a few dark-gray, or greenish-gray, spots roughly circular in outline and about a quarter of an inch in diameter. This spotted character is somewhat similar to the spotted rocks of the Animikie on Pigeon point (see description of future rock numbers, and also W. S. Bayley, Bulletin six, U. S. Geol. Survey).

Mic. The section is composed almost entirely of interlocking, angular grains of quartz. A few semi-rounded grains are seen, but the most of them show no evidence of having been rounded. Practically no cementing material is present. The various grains fit into each other, and some of them by their outlines show that they could not have had this form as original fragmental grains. It seems evident that they have been enlarged by the addition of secondary silica, but no distinct examples of this were seen. There are also a few grains of feldspar—*orthoclase*, *microcline* and *plagioclase*—and some areas composed of very minute grains, probably of quartz.

One section.

Age. Potsdam.

Remarks. The rock has been changed somewhat from its original fragmental state and would, perhaps, better be styled a quartzite than a sandstone. The change

in the rock has most probably been induced by the eruptives which are in contact with it, as is evidently the case with the quartzites of the Animikie just to the east on Pigeon point. However, the change from sandstone to quartzite (by the growth of the quartz grains) sometimes occurs in beds that have not been subjected to the influence of any eruptive or to any "metamorphosing" action. There is, in this section, one conspicuous grain of *zircon*. It is highly refractive and doubly refractive, showing red of two orders, the highest color being green. It is thus distinguished from rutile. It has parallel extinction.

U. S. G.

NO. 257. QUARTZYTE. (*Micaceous.*)

"Gray, thinly-bedded, hard, quartzite, styled *siliceo-argillaceous* shale by Norwood; at a short distance having the aspect of a bedded slate, probably belonging to the slate formation of No. 252; from the west side of Hat point [sec. 11, T. 63-6 E.] near the extremity, overlain by the next. On the east side of the point can be seen numerous dikes cutting this rock, which probably has a thickness of 500 feet."

Ref. Annual Report, ix, pages 61-63.

Meg. A hard, compact, very fine-grained quartzite, dark gray in color. It contains a considerable amount of a silvery micaceous mineral.

No section.

Age. Animikie.

U. S. G.

NO. 258. GABBRO (*with olivine*).

East side of Hat point, overlying or cutting No. 257 (Animikie slate). Basaltic trap-rock, rising at least 150 feet, and finally culminating in the summit of mount Josephine further north. (See No. 1829.)

Ref. Annual Report, ix, page 62; Bulletin ii, page 105.

Mic. The feldspar is quite pure. A grain cut nearly perpendicular to n_p has extinction 55° , according to the method of Fouqué for determining the feldspars cut perpendicular to the axes of elasticity.* If the section were exactly perpendicular to n_p , this measurement would indicate anorthite, but, allowing for the slight obliquity, it is only an evidence of a very basic feldspar, and can safely be named *labradorite* or *labradorite-bytownite*.

There is some difficulty in distinguishing the *olivines*, which preceded the feldspars in origination, from those augites which also preceded or accompanied the feldspars, since the cleavages of the latter are not always evident. They both possess irregularly rounded outlines, independent of the forms of the feldspars, and are similarly refractive and doubly refractive. The olivines, however, when perpendicular to an axis of elasticity, have very indistinct cleavage parallel to one or both of the threads of the ocular when in extinction; in other positions their cleavages are very irregular, while the augites, on the other hand, always show some straight cleavages, and occasionally a diallagic structure. They frequently manifest those

*In the employment of this method the extinction angle is always read from the vertical thread of the ocular after bringing the optic plane into agreement with it. This is conventionally chosen by M. Fouqué in order to make the readings comparable and consistent. This feldspar, on n_p , has an extinction angle on the horizontal thread of 34° . *Bulletin de la Société de Minéralogie Française*, 1894, vol. xvi, p. 428.

Gabbro.]

peculiar included plates, coincident with cleavage, which gives them a specked or spotted aspect. Another peculiarity of the augite in this rock is its including poikilitically a number of smaller augites which have different orientation. This is shown in the upper portion of the figure below.

The *olivine* in this rock is abundant, and, like the augite, is quite light colored, indicating its low content of iron, and concordant with its lateness in date. It uniformly embraces the feldspars ophitically, but is embraced by the augites. This is not a usual structure for olivine. One of the larger grains is represented below. In this figure those areas marked *a* are of olivine and have simultaneous extinction in the direction shown by the arrow. Those marked *b* are of augite and have extinction in various positions, while those marked *c* are of labradorite-bytownite. This was also photographed. (See plate I, figure 7.)

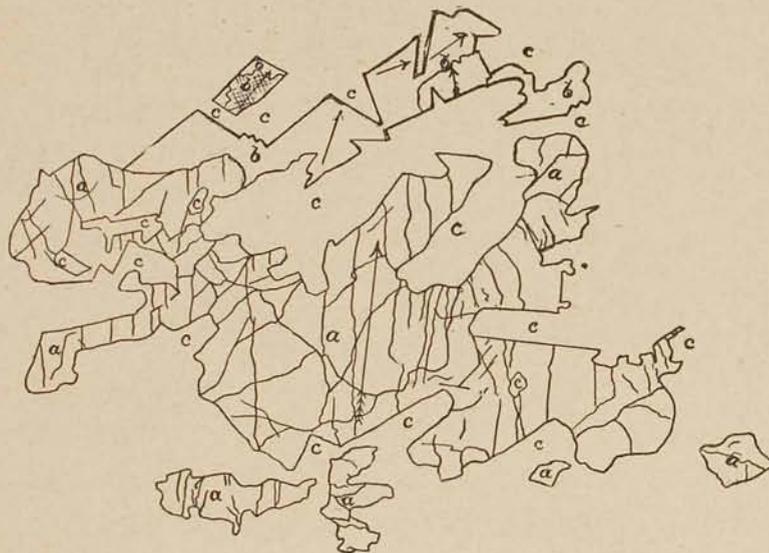


FIG. 18. OPHITIC STRUCTURE OF OLIVINE.

In the upper part of the figure, where four orientations of augite are shown, the mineral contains numerous inclusions. It appears as if the crystallizing force in the augite, the last mineral to be generated from the magma, had embraced the remnants of the glass and undifferentiated magma. In the small isolated figure at the top of the figure a distinctly cleaved augite, evidently corroded, is surrounded by a later augite having the same orientation, the whole exactly filling an angular interstice between feldspars. In other cases two augites, similarly situated, have different orientations.

One section.

Age. Cabotian.

Remark. This is a beautiful rock in thin section, owing to the good preservation of the elements, even the olivine being nearly intact. The section examined by Wadsworth is very thick, and the feldspars appear fissured and darkened. N. H. W.

NO. 259. QUARTZITE. (*Gray.*)

From the east side of Hat point, underlying or cut by the rock No. 258, forming a part of the slate formation at Grand Portage.

Compare Nos. 257, 270.

Ref. Annual Report, ix, page 62.

Meg. This rock is largely composed of *quartz* in sub-angular grains with an occasional fragment of *plagioclase*, the cement being of smaller grains of the same and of feldspathic (?) material and of *mica*; occasionally a grain appears to consist of much kaolinized feldspar, but still charged with impregnations of iron oxide.

This rock is illustrated by several other numbers, which afford better facilities for description. It contains globular masses or colored spots which, on a fractured surface, give the rock a spotted aspect, the spots being lighter than the rock in general, and often reddish. These reddish spots consist apparently of the indigenous elements stained at their borders by an accumulation of ferric oxide which here permeates the feldspars. A thin section, made so as to cut one of these spots, appears to have a different matrix for the quartz grains, consisting largely of *calcite*. This calcite is in crystals which embrace, under one orientation, many of the grains of the sandstone. Throughout the rest of the rock no calcite is seen, but the section is singularly dark between crossed nicols, as if it contained considerable devitrified *glass*.

Two sections.

Age. Animikie.

N. H. W.

NO. 260. DIABASE (*with olivine*).

Near the head of Wausaugoning bay. From a dike cutting the Animikie slates and quartzites, and running S. 45° W.

Ref. Annual Report, ix, page 62; Bulletin ii, pages 115, 116.

Meg. A compact, heavy, dark-gray diabase of medium grain.

Mic. A diabase composed of *plagioclase* laths, *augite*, *olivine* and *magnetite*. The rock has been considerably altered. The olivine is all replaced by a brown material (*bowlingite?*). The feldspar is also altered, and the section has much dirty greenish chloritic material and some magnetite, *hornblende* and a little *biotite*, all of which seem to be alteration products from the augite. The augite is light violet brown in color and some of it is slightly pleochroic, varying from the usual color to a pale straw color.

Two sections.

Age. Cabotian.

U. S. G.

NO. 261. DIABASE (*with olivine*).

From the summit of the hill on N. E. $\frac{1}{4}$ sec. 25, T. 64-7 E. Northeast of the head of Wausaugoning bay. Represents the rocks of the hills about Grand Portage.

Ref. Annual Report, ix, pages 63, 66, 70; Bulletin ii, page 106; American Association for the Advancement of Science, vol. xxx, page 163.

Quartzite.]

Mac. Medium-grained basic, uniform in color and composition, rather dark gray.

Mic. The *feldspar* is ophitically embraced by the pyroxene. It is not much altered. It constitutes about one-half of the rock.

The *pyroxene* is abundant and contains not only the feldspar but also *olivine*, which is in granules rounded before the generation of the pyroxene. These grains are sometimes isolated, but frequently are grouped in clusters. The olivine is easily distinguished from the augite by the difference in colors. It is yellowish, while the augite is reddish-brown in common light.

The *magnetite* is not secondary, in the sense that it is derived from the alteration of the other minerals. It is sometimes closely associated with the augite, but it is also embraced in the feldspars. Still more frequently, it is plainly the latest of the generations of the magma, since it fills the angles between the other elements. There is a brownish-red mineral occasionally associated with the magnetite which has been called biotite by Dr. Wadsworth. It has, however, the appearance of the brown mineral mentioned already as possibly *bowlingite*.

One section.

Age. Cabotian(?)

This rock differs from the rock of mount Josephine in having an ophitic structure in place of a granitic one.

N. H. W.

No. 262. QUARTZYTE. (*Gray.*)

"Below the outcrop of No. 261 can be seen slaty red quartzite beds with slate, in the southern slope of the hill, dipping toward the north, or into the hill, at a low angle. The hill [in N. E. $\frac{1}{4}$ sec. 25, T. 64-6 E.] is largely made up of this kind of rock".

Ref. Annual Report, ix, page 63; Annual Report, xiii, pages 100 (No. 163), 103; Bulletin viii, page xxxiii.

Meg. A fine-grained, gray quartzite. It contains numerous red grains (feldspar) and small black grains.

Mic. The section shows rounded and subangular grains of *quartz* and *feldspar*. The larger of these grains appear rounded or water-worn in ordinary light, but in polarized light their peripheries are seen to be jagged, as if the original rounded grains had been enlarged and filled up the spaces between the grains. These larger grains are surrounded by a very fine-grained aggregate of quartz and feldspar, but there is no sharp distinction between large and small grains, as all intermediate sizes can be seen. The feldspar, except for a very few plagioclase grains, is much clouded and reddened and often shows very little effect on polarized light; it is probably *orthoclase* and *anorthoclase*. This cloudy feldspar is quite abundant and even seems to pervade the rock in the nature of a cement, although this feature is not so marked as in some of the other quartzites from this immediate vicinity (especially No. 264). There are a few small flakes of greenish *biotite* in the section, also minute flakes of *chlorite*, and small opaque gray spots.

edge, into a greenish hornblende which is the second step in the diallage alteration. Apatite and magnetite are common and some biotite was observed.

"Figure 1, plate IX, indicates the graphic or eozoon stage in the alteration of this rock, while figure 2 of the same plate shows a more highly altered or a biotite-hornblende-granite form. The quartz contains microliths and fluid cavities."

Remark. The foregoing is substantially the same that the writer would give as a description of the appearance and composition of this rock. He would, however, call attention to the unusual conditions which surround this rock in its structural relations. It is evident that this altered condition is due to the contact with quartzites of the region and not to any normal or widespread change which could give rise to such a rock. The plagioclase therefore is more likely to be original than secondary. The alteration which pervades the reddened areas, permeated with micropegmatitic quartz, seems more likely to be the residue of the quartzite inclusions which did not respond to the crystallization which affected the quartz. As the quartz of the pegmatite darkens over considerable areas simultaneously, it is plain that one orientation prevailed throughout areas which were not actually in contact, but were separated by a "feldspathic" ingredient which did not crystallize. Whether that ingredient was an original feldspar, which now has lost its power to crystallize, as believed by Dr. Wadsworth, or was simply the rejected impurities left after the quartz was regenerated, is a question worthy of consideration. That the circumstances of injection of a molten basic rock between the layers of an acid one would be favorable for the absorption of silica throughout the region of contact by the basic rock, and for the rearrangement of crystalline orientation of those portions of the quartzite included in the zone of greatest heat, cannot be questioned. Heated alkaline waters would be generated. These would seize on the quartz and would transform it readily into such shapes as the adjacent surroundings permitted. Several other members illustrate the same transformations. The viridite is probably penninite. It has a distinct cleavage and a hexagonal form. In a new section the plagioclase is seen to be posterior to both augite and olivine. Three sections examined.

The field description, published in the Ninth Annual Report, page 63, makes it plain that this rock is an intrusive in the Animikie along the bedding, being the first published observation of an actual intrusion in that manner in the Animikie. The intruding rock here is evidently a spur from the great dikes of the region, and is of Cabotian age.

N. H. W.

NO. 264. QUARTZYTE. (*Altered.*)

From the shore of Wauswaugoning bay due north (by compass) from Birch island; near the centre of E. $\frac{1}{2}$ sec. 36, T. 64-6 E. Sample shows changed quartzite enclosed in the gabbro (No. 263).

Ref. Annual Report, ix, page 63; Annual Report, x, page 141; Proceedings American Association for the Advancement of Science, vol. xxx, page 165.

Meg. A fine-grained, pinkish quartzite, composed of quartz, feldspar and a black mineral. It is indistinctly mottled by gray and pink, the gray areas being composed almost entirely of quartz, and the pink areas of quartz imbedded in feldspar. Along one side of the specimen, and in drusy cavities the minerals of the rock exist in small crystals. The hand sample is sharply divided into a pink and a dark gray portion. The above description is of the pink portion; the dark gray part is essentially the same except that the quartz is much decreased in abundance, and there is a corresponding increase of the black mineral.

Mic. The section, which was made from the pink part of the hand specimen, is composed of *quartz* and *feldspar* with a little *chlorite* and green *biotite*. The quartz is in sub-angular and more or less rounded grains, and a noticeable feature is the tendency of many of these grains to assume bipyramidal outlines. The outlines, however, are not perfect, but approximate to the perfect bipyramidal form. In some cases these crystals are short and stout, and again they are ragged and irregular, but still show an indication of crystal outlines. This form of the quartz has been noted by Bayley (U. S. Geol. Survey; Bulletin six), and figured (see figure 12, page 86; plate XII, figure a; figure 13, page 93). Some of these imperfect quartz crystals are shown in the accompanying figure. The quartz is also in the form of more or less rounded grains with no indication of crystal planes, and sometimes several of these grains, separated by veins of feldspathic material, are seen to have the same optical orientation.

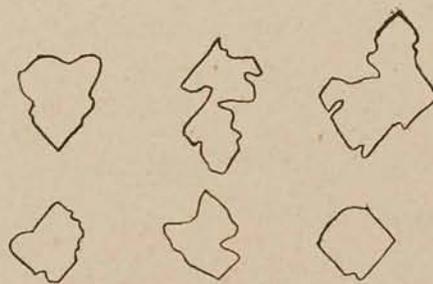


FIG. 19. OUTLINES OF IMPERFECT QUARTZ CRYSTALS FROM QUARTZITE.
Crystallographic *c* in each case is vertical.

The *feldspar* is clouded, as in No. 262, and its peculiar feature is that it exists as a *cement* between the quartz grains. It does not occur in distinct grains, as in No. 262, but two or three clear plagioclase grains are seen. The feldspar sometimes extinguishes simultaneously over considerable areas.

One section.

Age. Animikie.

Remarks. This rock, and a number of others from Pigeon point and vicinity, are similar to those described by W. S. Bayley in Bulletin six, U. S. Geol. Survey, where detailed descriptions, illustrations and analyses are given.

U. S. G.

No. 265. DIABASE. (*Contacting alteration.*)

From the upper (altered) part of No. 263. Wauswaugoning bay, where in contact with the quartzite at the coast due north by compass, from Birch island.

Ref. Annual Report, ix, page 63; Annual Report, x, page 141; American Association for the Advancement of Science, vol. xxx, page 165.

Meg. Principally reddish, rough rock, with geodic cavities containing quartz and a softer, greenish substance.

Mic. Similar to some parts of No. 263. Throughout the reddish matrix is much quartz, which is in the form of *graphic quartz*, polarizing simultaneously over considerable areas in the same manner as in No. 263. The quartz has been subjected to a common orientation. Much of the remaining material of the slide is dark between crossed nicols, being made up of finely crystalline elements. Yet it has sometimes a layered structure, lying between the quartz bands as if it occupied the place of some cleaved mineral, perhaps an original feldspar, whose skeleton remains in the form of its original cleavage. Very rarely, also, may be seen a grain which shows still a characteristic plagioclase striation. The rock in general, then, is to be considered a silicified eruptive.

It contains, however, many other minerals secondary or accessory to the minerals of a basic eruptive, viz., *biotite*, *penninite*, *sphene*, *rutile* (and apparently *zircon*?) as detected by Prof. Lacroix.

The *biotite* is sometimes closely interwoven with the chlorite, but also sometimes they both fill considerable areas entirely separate. The former is also disseminated widely throughout the rock. It is hardly perceptible in ordinary light, being uncolored, but by lowering the condenser its fibrous and cleaved structure becomes apparent. It is sometimes in radiating and intersecting plates which, as cut by the section, show star-shaped spangles and confused knots of fine fibres. Between crossed nicols it polarizes in blue, red and yellow, even in a section having no greater thickness than 1.5 millimeters. There is evidence of this mineral changing to the next. This consists of the remnants of its polarizing colors in the midst of the contrasted gray colors of the chlorite.

The *chlorite* has a pale, yellowish-green color in ordinary light. It is fibrous and linear, with extinction parallel to the fibres, which are parallel to n_p . It is the principal mineral in the open geodes. It shows well the characteristic colored aureoles or round dark spots. When cut parallel to the base it has hexagonal outlines, and is not distinctly fibrous.

Sphene appears as small, yellowish and yellowish-green, isolated grains of irregular shapes and not abundant. Sometimes the grains are nearly colorless and have the characteristic high refractive index.

Rutile, twinned and crossed, appears in isolated, darker-yellow grains than the sphene. The twinning or lamellation forms a network within the central part of

the grain, but is invisible about the exterior, owing to the total reflection which darkens the peripheries of the grain. The general contour is pear-shaped. Both rutile and sphene are doubtless results of change from titaniferous magnetite contained in the original rock.

Two sections examined.

Age. Cabotian.

N. H. W.

NO. 265A. QUARTZYTE. (*Dark gray.*)

Birch island, Wausaugoning bay; S. E. $\frac{1}{4}$ sec. 36, T. 64-6 E. Darker and firmer parts, appearing somewhat like dikes. "Birch island is caused by four hardened belts in the quartzite and slates, from five to ten feet wide, which run east and west, making the slates darker and in spots basaltic, and yet showing in other spots their bedded slatiness. These belts resemble dikes of igneous rock, and they run as a reef almost to the shore northwardly."

Ref. Annual Report, ix, page 64.

Meg. A fine-grained, hard, heavy, compact, dark-gray, impure quartzite, looking almost like a diabase. Quartz grains, and a few of feldspar, are seen embedded in a darker background.

No section.

Age. Animikie.

U. S. G.

NO. 265B. QUARTZYTE.

Birch island. Shows peculiar fractures due to glaciation (?).

Ref. Annual Report, ix, page 64.

Meg. Sample not found.

No section.

Age. Animikie.

U. S. G.

NO. 266. DIABASE.

South shore of Pigeon point, east of Birch island; probably in S. $\frac{1}{2}$ sec. 31, T. 64-7 E. From a dyke which cuts the quartzite and contains scattered pyrite.

Ref. Annual Report, ix, page 64.

Meg. A rather-fine grained, dark-gray diabase.

Mic. The rock is considerably altered. In structure it is ophitic. The original minerals are *plagioclase*, *augite* and *magnetite*. The secondary minerals are magnetite, a greenish chloritic substance and a dirty brownish opaque material. These alteration products seem to have come from the augite, although some unindividualized material may have been present. Minute needles of *apatite* are common, penetrating all the minerals of the rock except the magnetite. One small porphyritic plagioclase, having minute twinning lamellæ which are seen only with a high power, is present.

One section.

Age. Cabotian.

U. S. G.

NO. 267. DIABASE.

"Basaltic rock from the main vein, containing a calcite centre, and which is about twenty-five feet wide." A dike. South shore of Pigeon point, east of Birch island; probably in S. $\frac{1}{2}$ sec. 31, T. 64-7 E.

Ref. Annual Report, ix, page 64.

Calcite and chalcopyrite. Quartzyte.]

Meg. A very fine-grained, dark-gray, diabasic rock.

Mic. The section is too thick for careful study. The rock is composed of small *plagioclase* microliths, plagioclase in allotriomorphic grains, subangular, more or less rounded grains of a greenish mineral regarded as *augite*, and *magnetite*.

One section.

Age. Cabotian(?)

Remarks. The structure of the rock is different from that of the usual diabase dykes in this vicinity. It is possible that this is a facies of the usual diabase, but it is also possible that this dyke is really of later age than the rest of the dykes (Cabotian) and represents a later intrusion (Manitou).

U. S. G.

NO. 267A. CALCITE AND CHALCOPYRITE.

From No. 267.

Ref. Annual Report, ix, page 64.

Meg. A mass of these two minerals.

No section.

Age. Cabotian(?)

U. S. G.

NO. 268. QUARTZYTE. (*Dark.*)

"Blackened quartzyte, with red (hematitic) specks; from near the dike No. 267. This is of a dark color, but represents the prevailing color."

Ref. Annual Report, ix, page 64.

Meg. A fine-grained, greenish-gray, impure quartzyte. Quartz grains and a few of feldspar occur in a dark background. The hand sample contains a few red spots of hematite.

Mic. The section is composed of distinctly rounded and subangular grains of *quartz* and some of *feldspar* in a dirty, greenish cement. The distinctive feature of the rock is its clearly sedimentary nature, as shown by the worn quartz grains. Another feature, which is shown very clearly, is the secondary enlargement of the quartz grains. The feldspars are much clouded and decayed. The cement is quite abundant; it is composed very largely of *chlorite* with some finely crystallized quartz and feldspar, and much dirty undeterminable substance.

One section.

Age. Animikie.

Remarks. This rock, although so near the eruptive, is very little altered. Bayley has shown (Bulletin six, U. S. Geol. Survey) that the clastic nature of the quartz grains is not evident, even in the slightly altered portions of the quartzytes of Pigeon point.

U. S. G.

NO. 269. DIABASE.

"From Island No. 2, being the easterly of the first two islands near the coast; a porphyritic doleryte, the larger crystals being of a triclinic feldspar. The whole rock is gray, and has small grains of pyrite. The whole island is formed by a dike of No. 269, flanked by a little quartzyte and slate near the water. The dike is about fifty feet wide, and the island is not much more." This island is at the S. E. corner of sec. 31, T. 64-7 E.

Ref. Annual Report, ix, pages 64, 65, 66; Bulletin ii, pages 47 (as No. 169), 118.

Meg. A gray diabase of medium grain. A few porphyritic plagioclases are present. One of these is three-fourths of an inch across, but the rest are much smaller. A little pyrite is present. The feldspathic part of the rock is gray and the rest of the rock is darker and apparently decayed.

Mic. A much-altered diabase. The original minerals are *plagioclase*, *augite*, *magnetite* and *apatite*. The first two are much changed. The secondary minerals are *hornblende*, *chlorite*, *biotite*, *magnetite*, *pyrite*, *quartz* and a brown almost opaque material. The feldspars contain flakes of a micaceous (kaolin?) mineral.

Two sections.

Age. Cabotian(?)

U. S. G.

NO. 270. QUARTZYTE. (*Graphitic.*)

Pigeon point, S. W. $\frac{1}{4}$, sec. 32, T. 64-7, nearly on the axis of the peninsula. (Compare No. 552.) This rock, at large, is charged with graphite. Some pieces twelve inches and more in diameter have been extracted in the shallow working which has been accomplished. The rock also contains a little native copper and pyrite. It embraces also irregularly angular patches of quartzyte. The graphite occurs most plentifully in the quartzyte, over a belt twenty to thirty feet wide.

Ref. Annual Report, ix, pages 62, 65; Annual Report, x, page 48; Bulletin vi, pages 123, 420.

Meg. A gray, medium-grained, irregular rock, rusty, yet sparsely specked with pyrite, and giving the dark metallic lustre of graphite, which seems to be disseminated throughout it. It is evidently the product of the mutual reaction of the sedimentaries on the basic eruptives of the region, and it is, in many cases, hence, not possible to state the greater alliance of a hand specimen, whether with the sedimentaries or the eruptives. Yet, this has uniformly been considered as a modified portion of the quartzytes and slates of the Animikie of the region.

Quartz is abundant, probably the most abundant element of the rock, though it hardly constitutes one-half. It is all in secondary form, usually in angular grains, not generally pegmatitic, but micro-granulitic.

Biotite is common, some of the larger plates being brown and giving a uniaxial interference figure. When cut perpendicular to the cleavages, or at least when not parallel to them, this mineral is alternately brown and light green, or greenish brown when, with one nicol in use, it is rotated on the stage. The brown color appears when the direction of the edges of the cut plates agrees with the principal section of the nicol in use. When it is not brown and is cut oblique to the cleavage, it gives colored polarization, approaching that of muscovite.

Quartzite. Barite, calcite.]

Graphite, which resembles magnetite, even in reflected light, is common. It is an element of the sedimentary strata.

Penninite, having nearly the same appearance as in No. 265, but in less amount, seems to exhibit a gradation in color from the "aureoles" mentioned under No. 265 to the characteristic brown of the biotite, at the same time fading out in the opposite direction to green. These aureoles have usually quite distinctly a nucleus of very dark color, as if a foreign substance provoked the change or centralized it, or retarded it, and that hence the aureoles are remnants of biotite not wholly converted to pennine. The aureoles, moreover, are not always aureoles, but patches that spread irregularly, sometimes shading into the brown of the biotite.

Titanite (sphene) in small, generally roundish, light yellow grains.

Rutile, in rods, closely associated with dark, opaque grains, resembling magnetite.

Pyrite and hematite, the latter in very small amount. The rock might be considered a changed eruptive.

Two sections examined.

Age. Animikie.

Remark. This rock is completely changed, but there is no apparent generation of secondary plagioclase. There are various areas in the section occupied now by sub-opaque or kaolinic substances which are perhaps the remnants of original plagioclases.

N. H. W.

NO. 271. QUARTZYTE. (*Graphitic.*)

"Finely graphitic quartzite; from the same place as the last."

Ref. Annual Report, ix, page 65.

Meg. A rather fine-grained, gray quartzite. It consists of grains of quartz and feldspar in a darker mass which is mostly graphite. The rock is indistinctly mottled with gray or pinkish, this being due to small areas where the graphite is much decreased in amount or is almost absent.

No section.

Age. Animikie.

U. S. G.

NO. 272. BARITE, CALCITE, ETC. (*Vein material.*)

From the vein on S. W. $\frac{1}{4}$ sec. 32, T. 64-7 E. Pigeon point.

Ref. Annual Report, viii, pages 15, 16; Annual Report, ix, page 65.

Meg. The hand sample is a coarsely crystallized mass of calcite, barite and quartz.

No section.

Age. Embraced in the Animikie rocks; crosses a dike running N. 60° E.

U. S. G.

NO. 273. DIABASE.

From a dike running N. 60° E., crossed by the vein No. 272, situated in S. W. $\frac{1}{4}$ sec. 32, T. 64-7 E.
Ref. Annual Report, ix, page 65.

An ordinary diabase, with quartz and much apatite, considerably altered, spotted with reddish brown.

One section.

Age. Cabotian(?)

N. H. W.

NO. 274. GABBRO.

From near the trail to Parkerville.* About three-quarters of a mile north of the lake shore, near the north line of sec. 32, T. 64-7 E. This rises in a low hill, just north of the point where the trail runs over a stony beach fifty-two feet above lake Superior.

Ref. Annual Report, ix, pages 66, 69, 70.

Meg. Coarsely crystalline with porphyritic glassy feldspars. Sample much decayed. Probably a hornblende gabbro, like the rock at the extremity of Pigeon point (No. 291). The section is worthless for examination.

Age. Cabotian.

N. H. W.

NO. 275. DIABASE (*with olivine*).

From the dike at the brink of Pigeon River falls, running north 50° E.

Ref. Annual Report, ix, page 66; Annual Report, x, page 140; American Association for the Advancement of Science, vol. xxx, page 163.

This rock is an ordinary ophitic diabase, with considerable magnetite.

One section.

Age. Cabotian(?)

N. H. W.

NO. 276. DIABASE (*with olivine*).

From a dike just below Pigeon River falls, running east 10° north. These two dikes seem to converge toward the hill where No. 261 was obtained.

This rock is not different from No. 275, as evinced by the thin section with that number. Yet the specimen bearing that number is coarse and rough with the ophitic augites.

N. H. W.

NO. 277. DIABASE (*Porphyritic*).

"Porphyritic basalt, from a small island west of Governor's (or Susie)† island, south of the island which furnishes No. 269. This island is caused by this dike, but has the country quartzite on the flanks. On the east and north side, it dips a little east of south, or as the slates at Pigeon River falls. It rises about twenty-five feet." This is from the island called Oley island, in the northwest corner of sec. 5, T. 63-7 E.

Ref. Annual Report, ix, page 66.

Meg. A fine or medium-grained diabase, black and heavy and apparently somewhat altered. It contains small porphyritic plagioclases and a few reddish areas.

No section.

Age. Cabotian(?)

U. S. G.

*Parkerville was the name given originally to a settlement at the mouth of Pigeon river. It embraced but two or three buildings and has now entirely disappeared.

†The islands of the Lucille group have received two sets of names; one by Dr. Hanchett, state geologist in 1864, and the other by the officers of the U. S. Lake Survey in 1870. The former having priority have the first claim to acceptance.

NO. 278. DIABASE.

"Is from the east end of the long island west of Governor's (or Susie) island, next south of No. 277; from the main dike of the island." From the long island in N. E. $\frac{1}{4}$ sec. 6, T. 63-7 E.
Ref. Annual Report, ix, page 66.

Meg. A fine or medium-grained diabase, somewhat altered and containing much red, feldspathic material.

No section.

Age. Cabotian(?)

U. S. G.

NO. 279. DIABASE.

From a dike west end of Governor's (or Susie) island.
Ref. Annual Report, ix, page 66.

An ordinary gray, rather fresh diabase, in which, in thin section, an ophitic structure is evident, and in which is a very small amount of olivine.

Age. Cabotian(?)

N. H. W.

NO. 280. DIABASE. (*Porphyritic.*)

"Rock like No. 269, and in its bearing. Forms the north point that encloses the long bay on the east end of Governor's (or Susie) island, cutting the quartzitic slates that dip south on each side." S. E. $\frac{1}{4}$ S. E. $\frac{1}{4}$ sec. 32, T. 64-7 E.

Ref. Annual Report, ix, pages 66, 67.

Meg. A fine-grained, dark-gray diabase with some red material. A few porphyritic plagioclases are present.

Mic. The section shows a considerably altered diabase, quite similar to No. 269.

One section.

Age. Cabotian(?)

U. S. G.

NO. 281. BORNITE (*and vein matter.*)

About half a mile from the east end of Governor's (or Susie) island. From a vein which runs north and south. This vein has since been extensively exploited, but without finding copper or silver in paying quantities (see Nos. 1851, etc.) The vein is about three feet wide and is probably in continuation from one of the veins of the mainland of Pigeon point. There are several other such veins in the vicinity.

Ref. Annual Report, ix, page 67.

N. H. W.

NO. 282. DIABASE. (*Altered.*)

From the main dike of the north part of Governor's (or Susie) island.

Ref. Annual Report, ix, page 67; Annual Report, x, page 142; American Association for the Advancement of Science, vol. xxx, page 165.

Mic. This is a diabase in which the augite has become changed to chlorite and hornblende. Otherwise it is similar to several others already described, but has an occasional feldspar of an earlier consolidation.

One section.

Age. Cabotian(?)

N. H. W.

NO. 283. PORPHYRYTE. (*Diabase.*)

"From the larger little island at the west end of High (or Lucille) island." N. W. $\frac{1}{4}$ sec. 8, T. 63-7 E.
Ref. Annual Report, ix, page 67.

Meg. A fine-grained, dark-gray, diabasic rock, with porphyritic plagioclases, some of which are over half an inch across. Some of these phenocrysts show, especially at their edges, a pinkish color; otherwise they are glassy and gray in color.

Mic. The porphyritic *plagioclases* are imbedded in a groundmass which is composed of plagioclase laths in an abundant background of secondary minerals. These secondary minerals are almost entirely *chlorite*, *hornblende* and *magnetite*. It is probable that most of this secondary material, especially the hornblende, originated from augite, although no augite is now present. It is also possible that part, at least, of the areas filled with alteration products, were originally *glassy*. There are a few green areas which suggest olivines, especially as some of these areas interfere with the outlines of the plagioclase phenocrysts.

One section.

Age. Cabotian(?)

U. S. G.

NO. 284. GABBRO. (*Porphyritic.*)

"From the main dike (?) of High (or Lucille) island, on the south side. The dike itself is horizontally basaltic toward the west end of the island; and a part of the high of the island is caused by a heavy overflow, but perhaps not from this dike. This dike "hades" to the south, and is a coarse porphyritic greenstone. The samples are from that part that is dike-like."

Ref. Annual Report, ix, page 67; Bulletin ii, page 118.

Meg. A fine-grained, gray rock, consisting of small gray feldspars in a darker background. It contains porphyritic crystals of a gray to glassy plagioclase.

Mic. The section shows but one phenocryst; this is considerably clouded. The groundmass is much altered, even the feldspars being much altered. In structure this groundmass is granitic and is composed essentially of *plagioclase* and *hornblende* with some *quartz*, thus justifying the name quartz diorite applied to this rock by Dr. Wadsworth (Bulletin ii, page 118). It seems quite evident, however, that the rock was originally a gabbro and is here so-called, the hornblende and quartz being regarded as secondary. Some iron ore occurs in the section and this in places is seen adjoining a gray opaque substance evidently derived from it; the iron ore is thus *ilmenite* or *titaniferous magnetite*, rather than magnetite. One section.

Age. Cabotian(?)

U. S. G.

NO. 285. QUARTZ KERATOPHYRE.

From the first island northwest of Magnet (or Belle Rose) island. The south side of this island is conspicuously red with this rock, but the north shore appears of the usual color. This rock is embraced between two or three narrow basaltic dikes running east and west. As the dikes crumble by reason of their more close jointage the surfaces of this red rock stand out to view. The island next further northwest (Little Brick island) appears reddish in the same way on the south side.

Ref. Annual Report, ix, pages 67, 68 (rock No. 1845); Annual Report, xiii, pages 100 (No. 164), 103; Bulletin viii, page xxxiii; BAYLEY, Bulletin cix, U. S. Geol. Survey.

that it was and that the rock was a fine-grained diabase. The section shows one grain of *pyrite*.

One section.

Age. Cabotian(?)

U. S. G.

NO. 287. DIABASE.

From the big dike (like No. 274), the axis of Pigeon Point peninsula, near the location of Kindred and Baker's barite vein. (Compare No. 1843.)

Ref. Annual Report, vii, pages 16, 17; Annual Report, ix, page 69; Bulletin ii, page 96.

Of this rock Wadsworth says: "Has a section composed of *plagioclase*, *diallage*, *magnetite*, altered *olivine*, and other secondary products. The olivine is replaced by reddish and yellowish brown *serpentine*, showing the usual network or 'maschen-structur' of serpentine, replacing olivine along a network of fissures. The diallage has suffered considerable alteration, is of a cloudy, brownish color, and is in part replaced by *biotite*, *chlorite*, etc."

The feldspar, which, having on 010 an extinction angle of 20°, seems to be labradorite, appears to have embraced, in some instances, small amounts of the uncrystallized magma, which is now converted to a greenish and grayish substance which gives the interference figure of a possible monoclinic mineral, but charged, for the most part, with *magnetite*. In some cases the result of change in the olivines is a highly absorptive, brownish yellow, cleaved mineral, which may be the same that has been referred to already as *bowlingite*. Augite distinctly ophitic.

Two sections examined.

Age. Cabotian.

Remark. In another section of this rock, there is much less decay; the augite is ophitically related to the feldspar, and no olivine is apparent.

N. H. W.

NO. 288. DIABASE.

"Fine, green rock from the shaft at the barite vein," Pigeon point; probably in S. E. $\frac{1}{4}$ sec. 28, T. 64-7 E. Baker and Kindred's location.

Ref. Annual Report, vii, pages 16, 17; Annual Report, ix, page 69.

Meg. A very fine-grained, dark-gray, diabasic rock.

Mic. The section shows small lath-shaped plagioclases, considerably altered, in a groundmass of greenish and yellowish alteration products, which are *hornblende*, *chlorite* and *magnetite*. No augite is now present, although it probably was originally. Some unindividualized interstitial material may have also occurred.

One section.

Age. Cabotian(?)

U. S. G.

NO. 288A. BARITE, ETC. (*Vein material.*)

From the shaft. Same locality as No. 288.

Ref. Annual Report, vii, pages 16, 17; Annual Report, ix, page 69.

Barite. Quartzyte. Gabbro.]

Meg. A coarsely crystallized mass of barite, with a few specks of pyrite, *chalcopyrite* and *sphalerite*.

No section.

Age. A vein in Animikie rocks.

U. S. G.

NO. 288B. BARITE, ETC. (*Vein material.*)

From another vein adjoining No. 288A.

Ref. Annual Report, vii, pages 16, 17; Annual Report, ix, page 69.

Meg. A coarsely crystallized mass of *barite*, with *calcite*, some earthy material and decayed rock.

No section.

Age. A vein in Animikie rocks.

Remarks. The age of these veins is not known. They are, however, probably of the same age as No. 272, which is clearly later than the dike No. 273.

U. S. G.

NO. 289. QUARTZYTE.

"The country rock at the barite vein." Same locality as No. 288.

Ref. Annual Report, ix, page 69.

Meg. A very fine-grained, greenish-gray quartzyte, showing quartz grains in a darker greenish background.

Mic. The section, which is a poor one, shows the rock to be essentially the same as No. 268.

One section.

Age. Animikie.

U. S. G.

NO. 290. QUARTZYTE. (*Brownish.*)

"Fair samples of the quartzyte of the region—the chief rock of Pigeon Point peninsula, as exhibited on the south shore; obtained three miles west of the extremity. This is a dark-red or brownish quartzyte, becoming black near the dikes, and in some places having red orthoclase mixed with the quartz grains."

Ref. Annual Report, ix, page 69; Annual Report, x, page 49.

Meg. Quartzyte, fine-grained and brownish. Small quartz grains and red feldspars are discernible in a greenish cement.

Mic. The section is essentially similar to No. 262 except that the greenish chloritic material is in much larger amount.

One section.

Age. Animikie.

U. S. G.

NO. 291. GABBRO (*with olivine.*)

From the extremity of Pigeon point. (Compare Nos. 274, 287, 1843.) Forms the main axis of the peninsula.

Ref. Annual Report, ix, pages 69, 70; Annual Report, x, pages 57, 140; Bulletin ii, page 105; American Association for the Advancement of Science, vol. xxx, page 163.

Meg. Two consolidations are apparent, the first embracing the feldspars and probably olivine, and the second the bulk of the rock. This structure is visible,

however, only in one of the sections. The other, and the rock sample from which it was taken, do not show any porphyritic structure. The rock is otherwise coarsely and evenly crystalline, gray and gabbroid in aspect, and not much decayed.

Mic. The later *augite* embraces both *olivine* and *augite* ophitically. *Magnetite* and brown and greenish *biotite*, sometimes in contiguous masses, each color showing the darkened aureoles, accompany the *augite*, and brown-yellow *serpentine* occupies fissures in the *olivine*. It is evident that these aureoles are not imperfectly biotitized remnants of chlorite remaining in the *biotite* mass, since they are equally distinct in both places. Their cause antedates both minerals.

The earlier *augites* seem to have been affected, in some cases, in such a manner by the vicissitudes through which they have passed as to become nearly uniaxial. At least, in one grain, cut perpendicular to n_s , the optic angle $2E$ is so small that the mineral was at first taken to be some other than a monoclinic pyroxene on account of the black cross presented by the interference figure. After more careful examination, it was noticed that the hyperbolas separate about 5° . This is an unusual optical anomaly for *augite*.

Magnetite has shapes similar to those of the *augite*, but is occasionally embraced by the latter in the characteristic ophitic manner.

Quartz appears as isolated grains of good size, and also as pegmatitic filling in some of the plagioclase.

Two sections.

Age. Cabotian.

Remark. The brownish substance above referred to as *serpentine*, which is sometimes brownish red, may be the same that has been alluded to before as a product of a very ferruginous *olivine* in process of decay. (M. Hannay, *Mineralogical Magazine*, vol. i, page 154, 1877.) The methods of distinguishing this mineral from *antigorite*, and a summary of all its characters, are given by Lacroix (*Minéralogie de France*, vol. i, pages 442-445.) See under No. 162. N. H. W.

NO. 292. GRANITE (*with biotite*).

"The next rock just west of the canoe portage, on the north shore of the peninsula; forms a similar kind of coast; also is heavily jointed and bedded like No. 291, but it is red with orthoclase. The microscope reveals also hornblende and quartz; occasionally, also, is a grain of milk-white, foliated, soft mineral. This is a granular rock, derived from the fusion and crystallization of the associated sedimentary beds. It weathers and parts as if a conglomerate near the water. This rock continues but a short distance, making one blunt point, when the features and color of No. 291 return again. (See the notes on Nos. 604-613.)" S. E. $\frac{1}{4}$ N. W. $\frac{1}{4}$ sec. 26, T. 64-7 E.; north side of Pigeon point.

Ref. Annual Report, ix, page 70; Bulletin ii, pages 81-83.

Meg. A medium-grained red granite, composed of red feldspar, quartz and a soft dark green mineral, probably chlorite. There are some drusy cavities on the sides of which are crystals of the minerals of the rock and calcite.

Gabbro. Quartzyte.]

Mic. The section shows a granular rock composed mostly of *quartz* and reddened *feldspar*. The other minerals present are *biotite*, *chlorite*, *epidote*, *calcite*, *pyrite*, *magnetite* and *hematite*. Quartz is in grains and also in pegmatitic intergrowths with the feldspars, especially around the peripheries of crystals of the latter mineral.

Chemical analysis. The following analysis was made by professors J. A. Dodge and C. F. Sidener:

SiO ₂	-	-	-	-	-	-	-	-	-	61.09
Al ₂ O ₃	-	-	-	-	-	-	-	-	-	15.34
Fe ₂ O ₃	-	-	-	-	-	-	-	-	-	5.74
FeO	-	-	-	-	-	-	-	-	-	3.69
CaO	-	-	-	-	-	-	-	-	-	3.10
MgO	-	-	-	-	-	-	-	-	-	1.33
Na ₂ O	-	-	-	-	-	-	-	-	-	3.41
K ₂ O	-	-	-	-	-	-	-	-	-	3.65
H ₂ O	-	-	-	-	-	-	-	-	-	1.80
Total	-	-	-	-	-	-	-	-	-	99.15

The analysis shows a lower percentage of silica than would be inferred from the large amount of quartz in the sections. In chemical composition this rock is more basic than the granular red rock described by Bayley from this locality,* and probably this hand sample would belong with the rock intermediate between the granular red rock and the gabbro. A considerable part of the lime shown in the analysis can be accounted for by the presence of calcite, and with this in mind it seems probable that the feldspar is largely *anorthoclase*, the feldspar common to the granular red rock.

Age. Cabotian.

U. S. G.

NO. 293. GABBRO (*with olivine*).

From the north side of Pigeon point a mile and a half east of the mouth of Pigeon river. This rock forms the coast line, which rises sometimes fifty feet above the lake, nearly all the way from the extremity of the point and is doubtless in continuation from No. 291 and from No. 287.

Ref. Annual Report, ix, pages 50, 70.

Mic. The thin section made from this rock presents a fresher appearance than those from No. 291, and contains much fresh *olivine*, a little *biotite* and *chlorite* with characteristic aureoles. The *augite* is more frequently ophitic than in No. 291,—indeed it is generally ophitic, and at this point therefore this rock hardly deserves the name gabbro.

Two sections.

Age. Cabotian.

N. H. W.

NO. 294. GABBRO (*with olivine*).

From the hills next north of the glacier plain on the Grand Portage trail, probably S. E. $\frac{1}{4}$ sec. 30, T. 64-6 E., near the point where the Arrow River trail crosses them. This rock is identical with rock No. 293.

Ref. Annual Report, ix, pages 72, 73.

NO. 295. QUARTZYTE.

Near upper end of the Grand portage; probably in N. E. $\frac{1}{4}$ sec. 29, T. 64-5 E.

Ref. Annual Report, ix, page 73. (See, also, rock No. 772 [W.] from this same locality.) Annual Report, xvi., page 291; Final Report, iv, page 510.

* U. S. Geol. Survey, Bulletin cix.

Meg. A fine-grained, rather light greenish, gray quartzite.

Mic. The section is composed of rounded and subangular *quartz* grains, sometimes showing secondary enlargements, and a few *feldspar* grains in an abundant cement, which is composed largely of *chlorite*, and quartz and feldspar in minute grains.

One thick section.

Age. Animikie. (Grand Portage graywacke.)

U. S. G.

NO. 296. DIABASE (*with olivine*).

From a dike near the brink of Partridge falls in Pigeon river. The axis of a hill range, supposed to be the same as that from which was derived No. 294. This dike runs W. 5° N.; at least 110 paces wide.

Compare No. 774 (W.), Annual Report, xvi, page 291.

Ref. Annual Report, ix, pages 73, 74; Bulletin ii, page 106.

Meg. Apparently an olivine diabase of a dark color, and of uniform grain.

Mic. This rock has the same characters as No. 293. The rock is fresh, and the olivines even are well preserved.

One section.

Age. Cabotian.

N. H. W.

NO. 297. GABBRO (*with olivine*).

English rapids (upper end), near the centre of the N. $\frac{1}{2}$ sec. 21, T. 64-4 E.

Ref. Annual Report, ix, page 74; Annual Report, x, page 140; Bulletin ii, page 106; American Association for the Advancement of Science, vol. xxx, page 163.

This rock, which also comes from a dike, again illustrates these great dikes, which cut so numerously the Animikie slates of the region. The augite is both ophitic and idiomorphic, and the whole rock is fresh, making a beautiful microscopic slide. In one of the ophitic augites the same character is observed as seen in No. 291, *i. e.*, the optic angle round n_x is abnormally small, in this case being about 20°.

Two sections.

Age. Cabotian.

N. H. W.

NO. 298. DIABASE (*with olivine*).

Top of the hill on the east of the portage trail, at the foot of South Fowl lake. This lies on the slates, and was probably injected as a sill between the slates originally, the overlying slates having been destroyed. It has a perpendicular basaltic structure.

Ref. Annual Report, ix, pages 74, 75; Bulletin ii, page 108.

Mic. This rock is undistinguishable from Nos. 293, 296 and 297, except that the minerals are all more decayed. Macroscopically, much pyrite is apparent in this rock.

Two sections.

Age. Cabotian.

N. H. W.

NO. 299. SLATE.

"Fragment of the slate from below No. 298; ten feet below the contact." Same locality as No. 298.

Ref. Annual Report, ix, page 75; Annual Report, xvi, page 72.

Gabbro.]

Meg. A very fine-grained, gray or greenish gray, fissile slate. Contains some micaceous mineral along the cleavage planes.

No section.

Age. Animikie.

U. S. G.

NO. 300. GABBRO (*with hornblende and quartz*).

From a hill S. W. $\frac{1}{4}$ sec. 30, T. 65-3 E. South of Moose lake (of the international boundary). Rises 485 feet above Moose lake. One of the common coarse eruptives of the region.

Ref. Annual Report, ix, page 76; Annual Report, x, page 84; Bulletin ii, page 80, plate VII, figure 1.

Mac. Coarse, gray, apparently altered basic irruptive, containing hornblende.

Mic. The *feldspar* is changed by the entrance of micropegmatitic quartz; in some crystals the *quartz* occupies one-third of the total area. Micaceous and ferruginous products of decay cloud the feldspar, but in some grains its triclinic character is still manifest. Extinction on 010 indicates a labradorite near *andesine*. Extinction on a section perpendicular to n_g is 22° , indicating labradorite adjoining andesine. (Fouqué.)

In the decay of the augite, it seems to have changed first to "*diallage*," and then to *hornblende*. In the diagram presented by Wadsworth, this transition is well shown. (Bulletin ii, plate VII, figure 1, and page 80.) The cleavages of the augite are all parallel, indicating a section in the prism zone. These lines are marked and continuous, though not rigidly straight. The fibrous intercalation, however, which marks the progress of decay and the orientation of the "*diallage*," as shown by him, forms an angle of about 72° with the cleavage of the augite, which is very near the angle β , *i. e.*, the angle between the base and the orthopinacoid. It appears, hence, that the fibrous disintegration, which follows certain coarse cracks, is parallel to the base of the augite crystal. Its origin, in this case, therefore differs from that which is assigned to the diallagic schillerization by Judd, not only in its cause, but also in its direction in the crystal (Quarterly Journal, Geology Society, xlii [1886], page 82). This change is here probably one that results from weathering. The whole section indicates a weathered condition of the rock from which it is obtained. The diallagic parting which is found in the older augites of the gabbros is seen in numerous cases, and is parallel to the orthopinacoid. It is a strong cleavage-like parting, not fibrous nor lacking in transparency. Such crystals are found, not where weathering has affected them, nor dynamic pressure, but in the deep-seated and most protected portions of the gabbro masses. This parting coexists with the prismatic cleavage. It seems probable that two different forms of alteration in augite may have been confounded, one due to the cooling stage of the rock, when gases and hot solutions permeated it, and the other due to ordinary weathering. They seem to differ not only in the direction in which the lamellation grows in the original crystal, but in the cause which produced them, and also in the degree of integrity which is preserved

by the crystal in general. The true diallagic structure does not destroy the orientation of the augite, but in this case the fibrated mineral has an orientation different from that of the original augite.

Another section was made of this rock for the purpose of studying more fully the changes undergone by the augite. There are four facts that appear distinctly in the course of this change: (1) The augite changes to what may be called diallage, by the loss of the prismatic cleavages and the acquirement of a cleavage parallel to 100. This can be seen in a single grain, in which the centre is still augite with its prismatic cleavages at right angles, and in which the surrounding mass is still augite, having the same extinction but only the cleavage 100. (2) A cleavage is developed parallel to the base 001 which appears at first imperfectly and in short cracks. (3) Parallel with this basal cleavage is a finely fibrous alteration product, called diallage by Wadsworth (Bulletin ii, plate VII, figure 1), which is the so-called *viridite* of numerous authors. (4) This substance, which has no longer the orientation of the augite and cannot be considered diallage, is further altered, by a new crystallization, into amphibole whose cleavages, in the section represented by Wadsworth, are parallel to the prismatic cleavages of the original augite.

Biotite can be distinguished by its pleochroism, though it is not always brown.

The *chlorite* is decorated with the characteristic dark halos. It is about hexagonal, and gives a black cross in convergent light.

Bowlingite seems to have been generated in abundance, the product of changed olivine, which is now wholly wanting.

Hornblende, a uralitic product of change from the pyroxene is scattered in grains that vary much in size. It is prevailingly of a faint green color, distinctly cleaved and pleochroic.

Quartz is common both as individual grains of considerable size, of secondary origin, and as pegmatitic growths in the feldspars.

Apatite is seen in the quartz grains and in the altered feldspar.

Two sections.

Age. Cabotian.

N. H. W.

NO. 301. CALCITE, QUARTZ, ETC. (*Vein material.*)

"Vein matter from Kindred and Baker's shaft on the White Rose vein, near Arrow lake in Canada. This is about one and a quarter miles north of the east end of the first lake [Rove lake] west of Mountain lake."

Ref. Annual Report, vii, page 17; Annual Report, ix, pages 77, 78.

Meg. Calcite and quartz with some chalcocite (?) and pyrite and rock fragments.

Mic. The section shows *calcite* and *quartz* with particles of the rock which is black and opaque. One section.

Age. Vein in Animikie rocks.

U. S. G.

Quartzite. Taconyte.]

NO. 302. QUARTZ AND QUARTZINE. (*Vein matter.*)

From the Baker shaft on the White Rose vein near Arrow lake (in Canada).
Ref. Annual Report, vii, page 17; Annual Report, ix, page 78.

Mic. Consists largely of *quartz* and *quartzine*, the latter differing from chalcedony only in having its fibres elongated parallel with n_g instead of n_p . The fibres are coarse and readily pass into pyramidal quartz.

There is, besides this siliceous element, apparently a large amount of altered rock material. *Pyrite* is visible macroscopically. The colored ingredients are *hornblende*, alteration of *augite*, *biotite*, *magnetite*, and a few isolated grains of *titanite*.

Four sections.

Age. Vein in the Animikie rocks.

N. H. W.

NO. 303. QUARTZYTE. (*Vein material.*)

Apparently auriferous quartzite from the large quartz vein near the north shore of Pine lake; S. E. $\frac{1}{4}$ sec. 31, T. 65-2 E.

Ref. Annual Report, vii, page 21; Annual Report, ix, page 79.

Meg. A gray, cherty mass, holding small fragments of a darker material. There is also some pyrite in the rock.

Mic. The section, which is very thick, shows finely crystallized *quartz* and much of an opaque gray substance.

One section.

Age. Vein in Animikie rocks.

U. S. G.

NO. 304. TACONYTE.

Point in North lake; N. E. $\frac{1}{4}$ sec. 16, T. 65-2 W.

Ref. Annual Report, ix, pages 80, 81.

Meg. A cherty rock which varies in color from gray to greenish and to pinkish. A few small spots of finely crystallized *quartz* are seen; also some small dark spots which have a little pyrite on their peripheries.

Mic. The section shows numerous small rhombs of *siderite* in a *cherty* groundmass. The section is too thick to enable the exact nature of this groundmass to be determined, but it is probably made up of a very finely crystallized mass of *quartz* grains.

One section.

Age. Animikie.

Remarks. This rock is similar to those described as sideritic cherts, by Irving and Van Hise, in Monograph xix, U. S. Geol. Survey. For a full discussion of these rocks, see that work, and also "The Mesabi Iron Bearing Rocks" (Bulletin x, Geological and Natural History Survey of Minnesota), by J. E. Spurr.

NO. 305. DIORYTE(?)

North lake, Canadian side, just east of the first narrows in the outlet of North lake. (If the United States survey were extended over this point it would be found in N. W. $\frac{1}{4}$ sec. 16, T. 65-2 W.) This rock is the same as No. 744W.

Ref. Annual Report, ix, pages 81, 83, 107; Annual Report, x, page 85; Annual Report, xvi, page 270, Bulletin ii, pages 83, 85, 86, plate VIII, figure 1.

Meg. Black and white, or pepper-and-salt rock, composed largely of hornblende, quartz and one or more white feldspars, granular, rather coarse, sharply crystalline and fresh. It forms low irregular knolls, veined and blotched with irregularities of composition.

Mic. This rock has been carefully and fully described by Wadsworth, who shows that the original *pyroxene* has undergone great alteration, passing from diallage to green hornblende, thence to brown hornblende, showing its prismatic cleavage, and also into *biotite*, with which last is associated a little *magnetite*. The quartz he considers secondary. There is a little *titanite* (sphene) and *epidote*, as well as *apatite*, and doubtfully *zircon*. He says:

"The steps in the alteration shown by the different diallage cores irregularly interlocked with the hornblendic substance, and gradually passing into it, are as follows: (1) A palish green substance, not dichroic, and destitute of cleavage. (2) A deeper green substance, having a longitudinal cleavage, but not dichroic, or only slightly so. (3) The same dark green substance (all being connected), but of a somewhat darker green color, and dichroic, varying from a slight yellowish green to a dark green. (4) A well marked light hornblende, with not only the hornblende cleavage in a longitudinal direction, but also across the longer or vertical axis. This is dichroic, varying from a yellowish brown to a dark brown color. These changes resemble those shown by Williams in the Baltimore gabbro. The first three stages are to be seen united about a single diallage core, as are also the third and fourth stages."

One section.

Age. Archean.

N. H. W.

NO. 306. GRANITE (*with biotite*).

Same locality as No. 305, in which it occurs somewhat in the manner of a vein.

Ref. Annual Report, ix, page 81.

Meg. A rather fine-grained, gray granite, composed of quartz, gray to glassy feldspar and biotite.

Mic. The section shows a granite composed almost entirely of quartz and feldspar. The feldspar seems to be *orthoclase* and a *plagioclase* showing fine twinning striae and a low extinction angle,—probably near *oligoclase*. A little *biotite* is present, and also some *chlorite*, and a few small grains of *sphene*. Some of the quartzes and feld-

spars are set in a mosaic of finer grains, probably caused by peripheral granulation of the larger grains; the section, however, is too thick to show this point with certainty.

One section.

Age. Archean.

U. S. G.

NO. 307. TUFF (?)

At a point about a mile west of the last, on the south side of the Gunflint river, west of the "narrows."
Ref. Annual Report, ix, pages 81, 83.

Meg. Apparently an iron and carbonaceous shale, pyritiferous, firm and heavy, with flinty nodules, exposed perhaps two feet, nearly black.

Mic. The rock is fragmental and confused, of varying texture and grain, a considerable percentage being opaque black. The aspect is that of a finely vesicular or scoriaceous, mainly fragmental, rock whose cavities have become filled with *calcite*, or with *hematite* and calcite set in a dark, even opaque, ground work. Some rounded areas are much finer than others, and some of the fragments are very fine and scarcely polarize light. Sometimes *quartz* shares in the fillings of the minute cavities.

Three sections.

Age. Taconic (near the base of the Animikie).

Remark. The nature of this rock cannot be determined from the data at hand, except that it may be affirmed that its origin was through the accumulation of a peculiar fragmental debris. It is more nearly like a Carboniferous tuff of King's county, Ireland (No. I, 1397 of the series of the Survey of Great Britain), of which thin sections have been made from samples furnished by Sir Arch. Geikie, than any rock with which it is now possible to compare it. It is darker than that, and its ground work is less greenish. There are, however, isotropic, apparently glassy, portions which have a finely fluidal structure.

It is comparable, stratigraphically, with the glassy breccia described by Williams at Sudbury, Canada,* and with the tuffs of the Penokee range described by Van Hise.†

N. H. W.

NO. 308. GABBRO.

*The trap of the country; south side of Gunflint lake; sec. 24, T. 65-3 W.

†Compare Nos. 721-727.

Ref. Annual Report, ix, page 81; Annual Report, x, page 86.

Meg. A fine-grained, dark-gray, diabasic rock.

Mic. The section shows a gabbro of rather fine grain, and considerably altered. The feldspar is much kaolinized, but a number of comparatively fresh grains remain. Some of these show equal extinction angles on each side of the albite twinning line running up as high as 30° , thus indicating *labradorite*. The *augite* is in part fresh, and part altered, the alteration products being *chlorite*, *hornblende* and *biotite*.

* *Bulletin of the Geological Society of America*, vol. iii, p. 138.

† *Bulletin of the Geological Society of America*, vol. iv, pp. 435, 436, 1893.

Apatite is also present, as is also *magnetite*, both secondary and original. In structure the rock approaches granitic; the augite, while in some cases later than the feldspar, is mostly of about the same date as the feldspar, and the rock is a gabbro.

One section.

Age. Cabotian.

Remarks. This rock is from one of the Logan sills of the Animikie (see A. C. Lawson, Bulletin viii). In general these sills are diabases, but the section of this rock can properly be called a gabbro. The evidence, however, is not conclusive that it is an apophysis from the gabbro of the great gabbro mass which lies just to the south of this area of Animikie.

U. S. G.

NO. 309. SLATE.

North side of Gunflint lake, about half way from the eastern extremity.

Ref. Annual Report, ix, pages 81, 82; Annual Report, xvi, page 68.

Meg. An aphanitic, dark, greenish-gray slate or schist.

Mic. Under a low power the rock shows a few grains and crystals of *magnetite* and *pyrite*, small specks of an opaque substance which is black in transmitted light and gray in reflected light, and numerous black dust-like particles, all imbedded in a minutely crystalline groundmass. Under a high power, this groundmass appears to be made of minute grains of *quartz*, scales of *chlorite* and a few minute *muscovite* scales.

One section.

Age. Archean (Keewatin).

U. S. G.

NO. 310. GRAYWACKE.

North side of Gunflint lake, half way from the eastern extremity; associated with vertical slates into which it graduates.

Ref. Annual Report, ix, pages 82, 85; Annual Report, x, page 17; Annual Report, xvi, page 68.

Mac. Firm, harsh, siliceous rock, with grains of free quartz, of a light green color; evidently also contains much feldspathic material.

Mic. A fragmental, slightly schistose rock, the grains all much altered. *Quartz* is the most conspicuous element, in sub-rounded grains, some of them being composed of several individual grains, as if from a sandstone or a conglomerate originally. *Feldspar*, clouded and semi-opaque between crossed nicols, but occasionally showing albite twinning, is very abundant, in sub-angular fragmental grains. The matrix for these two consists of finer grains of the same and a little coloring matter such as *hematite*, *biotite* and *chlorite*. The fibrous and laminated minerals are mainly arranged in one direction.

One section.

Age. Archean (Keewatin).

N. H. W.

NO. 311. QUARTZ-PORPHYRY (?) (*Consolidated debris, porphyrel.*)

Greenish, "porphyritic," schistose and fibrous, with free quartz, embraced in the slate No. 310, parallel with its bedding, running E. 20° N., standing vertical.

Ref. Annual Report, ix, pages 82, 85, 97, 102; Annual Report, xvi, page 68. (Compare No. 1283.) This rock is the same as No. 731 (W.), Annual Report, xvi, page 256, and No. 1008 (G), Annual Report, xxii, page 85.

Meg. The fibrous structure is characteristic of a pressed rock. The larger elements form knots, round which the fibres are compelled to shape themselves. The quartz and the feldspar seem to be intact, but the former is sub-rounded.

Mic. The *feldspar* belongs to the acid series. It is twinned on the Carlsbad and albite plans. A section in the zone of symmetry,* shows, accidentally, an optic axis, vertical on each side of the line of an albite twinning, which, according to the épures of Michel Lévy (*Détermination des feldspaths dans les plaques minces, planches 3 and 4*) can happen only with *oligoclase* and *andesine*. Another section, nearly perpendicular to n_p , has extinction, according to Fouqué's method, at 81° or 82°. As this is much too high for andesine, and yet as the feldspar cannot be albite, it must fall on the oligoclase side of oligoclase-albite of Fouqué's table (*Bulletin de la Société de Minéralogie de France, vol. xvii, page 428*), *i. e.*, between oligoclase and andesine-oligoclase. If the section were strictly perpendicular to n_p , it is therefore certain that the extinction would be about 88°, in agreement with the table, and the feldspar is thus shown to be *oligoclase*.

The feldspar has a great many inclusions, the most frequent and conspicuous of which, owing to its polarization colors, is *muscovite* in minute isolated scales. *Apatite* also occurs in this situation, elongated parallel with the twinning. Spots, which in the feldspars are nearly isotropic, are probably of *chlorite*, cut parallel to the base. Much *calcite* occurs, both in the feldspar and throughout the section.

The outlines of the feldspars are plain. No granulation is perceptible. The edges, whether crystalline or fragmental, are abrupt and distinct.

Throughout the matrix, which is fine and made up of angular pieces, no feldspar fragments can be distinguished readily, since unless albite twinning is apparent, they would have a strong resemblance to quartz, which is abundant.

Quartz is in porphyritic masses and is finely disseminated through the largely isotropic matrix. The larger grains sometimes show a cloudiness which shifts about on rotation between crossed nicols, indicating a distortion produced by pressure.

Apatite, as already stated, is found in the feldspars. It is also in the matrix in larger though microscopic crystals. These are distinguished when cut parallel to their elongation by parallel extinction, by conspicuous shagreen on lowering the polarizer, and by the conspicuous transverse cleavages. Usually but a single crystal is found alone, but in a few instances two or three are associated lying parallel.

* That is, in the triclinic feldspars, to the zone perpendicular to 010, and nearly to the vertical axis.

Chlorite gives color to the rock, which is a greenish gray. In a section parallel with the laminated structure, the chlorite scales overlap each other and give a general isotropic appearance to the matrix between crossed nicols, relieved by the sprinkling of angular grains of quartz and a few other minerals.

Age. Archean (Keewatin).

Remark. This rock has had a long history and no name can properly be assigned to it in its present form. It is equally impossible to state what its original nature was. In many respects it resembles some of the "porphyritic" fragmentals near the base of the Upper Keewatin, and its intimate structural association with, and petrographic alliance to, the graywacke (No. 310) in the midst of which it occurs, point to its original fragmental nature. It would then be a porphyrel. N. H. W.

NO. 312. LIMESTONE.

Matrix of a flint conglomerate or breccia. Occurs on both sides of Gunflint lake, most conspicuously on the north side, west of No. 311, on the points of the peninsula.

Ref. Annual Report, ix, page 82; Annual Report, x, page 87; Annual Report, xvi, page 69; Annual Report, xix, pages 126, 127; Bulletin vi, pages 121, 129, 130, 420.

Mag. This rock is gray, finely crystalline, and covered with a coating of iron rust, from which fact it has been supposed to consist essentially of siderite. The angular pieces embraced by it are of gray flint. It has a fine color-banding due to sedimentation, and occasionally fragments of rock other than flint are scattered in it, some of which is nearly black, resembling the dark rock of No. 307, and some is quartz, the latter being quite rare. Some of the dark rock is apparently a calcite amygdaloid.

Mic. The shimmering iridescence of *calcite*, or *dolomite*, is the most pronounced feature between crossed nicols, in convergent light, due to the high double refraction which is capable of giving the different colors even for roughness of the ordinary grinding and especially for the varying thicknesses in the individual grains of the rock as left by the slicing. There are a few other substances in the slide for the most part opaque, and too fine for determination. They are not pyrite. The section does not cut any of the vesicular dark ingredient of this rock.

In another section, made so as to cut one of the darker portions, the darker portion is seen to be made up largely of fine angular *quartz* with a matrix of finer grains of the same. There is also a considerable percentage of *chlorite*. Between the nicols the darker portion is so much darkened as to indicate the presence of an isotropic substance, perhaps of *glass*. The slide still does not show the vesicular portion mentioned above.

In still another sections made by Marchand, there are occasional areas which, sprinkled with a few minute opaque specks, are for the most part transparent, but between crossed nicols are either wholly dark or are indistinguishable from a devitrified *glass*.

Granite.]

Prof. C. F. Sidener, who analyzed this rock, obtained the following result (Bulletin vi, page 121):

Silica,	2.70	per cent.
Alumina,	.35	"
Ferric oxide,	17.23	"
Ferrous oxide,	8.35	"
Calcium carbonate,	49.80	"
Magnesium carbonate,	19.65	"
Potassium oxide,	.04	"
Sodium oxide,	.20	"
Water,	.47	"
Total,	98.79	per cent.

Age. Taconic, near the base of the Animikie, or perhaps Upper Keewatin.

Remark. The stratigraphic horizon of this limestone is much below that of the calcareous conglomerate of Grand Portage island (No. 254) and of the nondescript somewhat vesicular calcareous rock (No. 255) which overlies it. Further examination has shown that the latter was cotemporary with a volcanic epoch in the Keweenawan near the bottom of the same, while the former is near the base of the Animikie, or belongs in the Keewatin.

N. H. W.

No. 313. GRANITE.

N. E. $\frac{1}{4}$ sec. 24, T. 65-4 W., south shore of Magnetic lake (a part of Gunflint lake north of the narrows).
Ref. Annual Report, ix, page 83.

Meg. A light-colored, micaceous, medium-grained rock.

Mic. With much *quartz* is mingled *microcline* and perhaps *orthoclase*, *biotite* and *chlorite*. Some of the feldspar is finely twinned on the albite plan and probably comes near *oligoclase*.

One section.

Age. Archean (igneous).

N. H. W.

No. 314. GRANITE (*with hornblende*).

North shore of Magnetic lake; S. E. $\frac{1}{4}$ sec. 13, T. 65-4 W.
Ref. Annual Report, ix, page 83. Compare No. 650 (W.), Annual Report, xvi, page 237.

Meg. A rather coarse pinkish granite, composed of quartz, pink feldspar usually not showing twinning striae, and *hornblende*. There is some *epidote* present, and also probably *chlorite* and *biotite*. A noticeable feature of the rock is the presence of several good sized crystals of a cinnamon brown mineral, most probably *sphene*.

No section.

Age. Archean (igneous).

U. S. G.

No. 315. GRANITE (*with hornblende*).

First falls north of Gunflint lake, on the international boundary; N. E. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 13, T. 65-4 W. Compare Nos. 800, 1318; also, No. 649 (W), Annual Report, xvi, page 233, and No. 62 (G), Annual Report, xvii, page 160.

Ref. Annual Report, ix, page 83; Annual Report, x, page 106.

Meg. This is similar to the rock No. 305, but has generally less amphibole and more quartz.

Mic. The thick section is composed of *quartz* with shadowy extinctions, a clouded *feldspar* that cannot be determined, *chlorite*, *epidote* and a little *hornblende*.

One section.

Age. Archean (igneous).

N. H. W.

NO. 316. GRANITE (*with hornblende*).

Saganaga lake, N. E. $\frac{1}{4}$ sec. 4, T. 66-4 W. A few rods below the rapids.

Ref. Annual Report, ix, page 84; Annual Report, x, page 106.

Meg. A rock in general similar to the last, but having large quartzes.

Mic. Consists of much *quartz*, *microcline*, *orthoclase*(?) and *oligoclase*. The last is indicated by the fine, uniform striations, and the constant parallel, or nearly parallel, extinction. At the same time the striations are not fine enough to be characteristic of anorthoclase. The section also shows *epidote*, *chlorite* and *sphene*, the chlorite no doubt a result of decay of the hornblende common in the rock.

A feldspar grain cut nearly perpendicular to n_p , has extinction at 75° , which agrees tolerably well for oligoclase, according to the table of Fouqué.* In general the feldspar is much kaolinized. The quartz grains, which appear larger in the hand sample, are seen under the microscope to consist of many parts, the result of a crushing to which they have been subjected. A shadowy extinction passes over them, and many fragments sometimes have nearly the same point of extinction, but so removed that a slight rotation in the same direction brings them successively into darkness. Two sections.

Age. Archean (igneous).

N. H. W.

NO. 317. GRANITE (*with hornblende*).

Small island in Saganaga lake, sec. 5, T. 66-4 W.

Ref. Annual Report, ix, page 84.

Meg. A medium-grained, pinkish granite, composed of approximately equal amounts of pink feldspar, quartz and hornblende. There are two small hand samples, one of which has a rude banding due to excess of hornblende in rough layers.

Mic. A granite composed of feldspar, *quartz*, *green hornblende* and some *chlorite*. The feldspar has a tendency to an idiomorphic form, is much decayed, but sometimes shows traces of fine twinning striae and of zonal structure. When the twinning striae (albite) are present the extinction on either side of the twinning line is low, indicating most probably *anorthoclase* or *oligoclase*. There is also a little *magnetite* and *epidote* in the section. One section.

Age. Archean.

* *Bulletin de la Société de Minéralogie de France*, vol. xvii, p. 428 (1894).

Quartz.]

Remarks. No careful study of the feldspar of the great Saganaga granite has yet been made. This mineral is usually too much altered for a satisfactory optical examination. It is, however, clear, from the sections examined, that a considerable part of the feldspar is plagioclase. This shows fine twinning lamellæ according to the albite law; in grains showing an equal extinction angle on each side of the twinning line the extinction angle is very low, indicating that the feldspar is most probably oligoclase.

An analysis of a characteristic specimen (made by Mr. A. D. Meeds) of the Saganaga granite from the S. W. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 22, T. 66-5 W. [see Annual Report, xx, page 88; Annual Report, xxi, page 43, No. 686 (G.)] is as follows:

SiO ₂	- - - - -	69.34
Al ₂ O ₃	- - - - -	17.25
Fe ₂ O ₃	}	2.46
FeO		
CaO	- - - - -	3.43
MgO	- - - - -	1.18
K ₂ O	- - - - -	.71
Na ₂ O	- - - - -	4.33
H ₂ O	- - - - -	1.17
Total	- - - - -	99.87

From the analysis it is seen that very little potash feldspar is present, and in this case the rock might properly be called a quartz diorite. It is possible that other samples of this rock from different parts of the lake would show a much higher percentage of K₂O; at any rate, on account of the large quantities of quartz and the general character of the rock as a whole, it seems best to refer the great Saganaga mass of coarsely crystalline quartz-feldspar-hornblende (or biotite) rock to the granites rather than to the diorites.

U. S. G.

NO. 318. QUARTZ. (*Vein matter.*)

Northeast side of a small island in Saganaga lake; S. E. $\frac{1}{4}$ N. W. $\frac{1}{4}$ sec. 14, T. 66-5 W.

Ref. Annual Report, ix, page 84. (Compare No. 835W.) Annual Report, xvi, page 215. (For a description of this island, on which is a fluorite granite, see A. WINCHELL, Annual Report, xvi, pages 215, 216; U. S. GRANT, Annual Report, xx, page 89; N. H. WINCHELL, Annual Report, xxiv, page 22, No. 2046.)

Meg. Coarsely crystalline, pure, milk-white quartz. There is also a very little purple fluorite.

Mic. The section shows a large mass of clouded quartz, with similar orientation throughout. The cloudiness is due to innumerable minute cavities filled with liquid, and frequently containing a bubble.

One section.

Age. A vein in Archean rocks.

Remarks. From the field descriptions, reference to which is made above, it appears that this island contains an irregular quartz vein. The surrounding rock, which is the usual Saganaga granite, has been much decayed and silicified, and in some places penetrated with purple fluorite, forming a beautiful fluorite granite. It

seems that a fissure of some depth must have existed here, and that from it have come solutions bearing silica, and also gases. See rocks Nos. 835-841 (W.), Nos. 676-680 (G) and No. 2046.

U. S. G.

NO. 319. GRANITE. (*Decayed.*)

Saganaga lake; southwest corner of an island just north of that on which No. 320 was found; S. W. $\frac{1}{4}$ N. W. $\frac{1}{4}$ sec. 14, T. 66-5 W.

Ref. Annual Report, ix, page 84. See, also, under No. 318.

Meg. Apparently a highly siliceous rock, containing some feldspar and pyrite, and in spots stained brownish yellow.

Mic. The section is composed of *quartz* and much decayed *feldspar*. There are also numerous small rhombs of what appears to be *siderite*, and some *pyrite* crystals. The *siderite* is seen in connection with a brownish yellow material (*limonite*), and this same substance is common throughout the section. It seems most probable that all of the *limonite* is an alteration from the *siderite*.

One section.

Age. Archean.

Remarks. This rock is regarded as part of the decayed granite mentioned under No. 318.

U. S. G.

NO. 320. GRANITE. (*Decayed.*)

Saganaga lake; N. W. $\frac{1}{4}$ sec. 10, T. 66-5 W.

Ref. Annual Report, ix, pages 84, 85.

Meg. A coarse-grained rock composed of large, sometimes roughly rounded, areas of quartz, and feldspar which is much decayed and is pinkish, gray or yellowish in color. There are also small areas of a rather soft greenish-yellow material.

Mic. The section is composed largely of *quartz* and very much decayed *feldspar*. There are areas which are now opaque and greenish or gray in color, which seem to represent old *chlorite* areas; these are probably the greenish-yellow material seen in the hand sample. A few small grains of a green mineral are seen; the nature of this cannot be determined owing to the thickness of the section. Two rusty, reddish brown spots are also seen, possibly an alteration product from some ferruginous mineral.

One section.

Age. Archean (igneous).

U. S. G.

NO. 321. GRANITE.

Lake Saganaga. Probably near the northwest corner of sec. 16, T. 66-5 W.

Ref. Annual Report, ix, page 85.

Meg. Greenish-gray, with quartz and a pinkish feldspar, and a chloritic mineral.

Mic. Essentially composed of *quartz* and a saussuritized feldspar which cannot be determined on account of the loss of cleavage and twinning lines.

Arkose. Quartz.]

One of the variations of the rock of the region.

One section.

Age. Archean (igneous).

N. H. W.

NO. 322. ARKOSE.

Oak portage, on the international boundary at the west end of Saganaga lake; S. E. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 24, T. 66-6 W.

Ref. Annual Report, ix, page 85. Same as No. 565 (W.); Annual Report, xvii, page 213; Nos. 2031-2045, Annual Report, xxiv, pages 18-22.

Meg. Rather fine grained; composed of angular grains of quartz and feldspar in an apparently feldspathic background.

Mic. The section shows angular grains of *quartz*, also some of much decayed *feldspar*. Between these grains is a dirty, almost opaque, isotropic, gray or yellowish material. It in part appears like decayed feldspar and sometimes the feldspar grains are not sharply set off from this material but seem to grade into it. A little *pyrite* is present.

One poor section.

Age. Archean (Keewatin).

Remarks. This rock is regarded as an arkose, whose elements have been obtained from the adjoining granite, and it may thus be termed a recomposed granite. This is not the place to discuss the relations of the Saganaga granite to the surrounding rocks. It may, however, be stated that here (west side of Saganaga lake) the rocks change from granite to clastics (slates, graywackes and recomposed granite). These clastics are of a later date than the granite and the rock here described (No. 322) represents part of the base of the clastics composed of debris derived immediately from the adjoining granite, and not water-worn. The granite may have been in a semi-decayed state when this rock was formed from it. U. S. G.

NO. 323. QUARTZ SCHIST.

Oak lake, north side, which is the first lake west of Saganaga lake on the international boundary. The shores of this lake are composed of this rock.

Ref. Annual Report, ix, page 85.

Meg. Gray or greenish-gray schist, having a structure which is due apparently to pressure and shearing.

Mic. The section is largely made up of microgranulitic clastic *quartz*, in the midst of which is strewn a large amount of *chlorite*, which, being in shreds or fibro-lamellar, renders the field nearly dark constantly between crossed nicols. There is also some *calcite* and some *hematite*. The structure may have been produced in part by shearing, but the rock is evidently a clastic one.

Two sections.

Age. Upper Keewatin.

NO. 324. GRAYWACKE. (*Fine.*)

From the portage from Oak lake to Otter Track lake, on the United States side. Said to be a condition or variation of rocks Nos. 323 and 311.

Ref. Annual Report, ix, pages 85, 86.

Meg. Very fine grained and dense, of a slate color, massive (*i. e.*, not sheared), and homogeneous.

Mic. The section (which is too thick) consists of angular fragments of various minerals, but the most evident is *quartz*. This is perhaps also the most common. A few similar fragments of a striated *feldspar* are also observable. These lie in an abundant matrix of translucent grains, which seem to be darkened between crossed nicols by mutual overlapping and by a little *chlorite*. In a thinner section the clastic origin of the rock is evident. A few grains still give colored polarization. These are in part *muscovite*, and in part *epidote*. Between crossed nicols the slide is rather dark, except in the areas occupied by the quartz and feldspar grains.

Two sections.

Age. Upper Keewatin.

Remark. The fine debris of which this rock is composed is essentially granitic, and was doubtless derived from the Saganaga granite, on which this series of strata is seen to lie about one-fourth of a mile east of the portage from Oak lake to Saganaga lake. (Compare No. 322; also Nos. 2031-2045.)

N. H. W.

NO. 325. ARKOSE.

East end of Knife lake, on the international boundary, S. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$ sec. 32, T. 66-6 W. From the slate series of the region which extends from the portage from Saganaga lake to Oak lake. This member is an important one in the series, as it represents the rock which continues a good part of the distance from the east end of Knife lake, at least to the narrows of the same lake (between sections 11 and 12). The rocks all have a greenish color, but are not always slaty.

Ref. Annual Report, ix, page 86.

Meg. A non-slaty, much greener variety of a rock similar to No. 324.

Mic. This rock is very similar to rock No. 322 and doubtless had the same origin. It is coarser than Nos. 323 or 324.

Age. Archean (Upper Keewatin).

Remark. It is an interesting fact that the coarser parts of the Upper Keewatin, about Saganaga lake, are not at the contact on the granite, but at a considerable distance from it. (See Part I.)

N. H. W.

NO. 326. SLATE. (*Pyritiferous.*)

Ontario; north side of Knife lake, about three-fourths of a mile east of the portage to Maple Leaf lake. (Maple Leaf lake is a small lake, not more than a mile across, lying in Ontario between the north bay, near the west end of Knife lake, and the northward extension of Carp lake; Carp lake is called Pseudomesser lake in the fifteenth and sixteenth annual reports. The usual canoe route between Knife and Carp lakes is through Maple Leaf lake.)

Ref. Annual Report, ix, pages 86, 87.

Flint. Slate.]

Meg. A dark gray, rather coarse-grained slate or schist, containing cubes of pyrite. It is rather soft and not decidedly siliceous.

Mic. The section shows a coarse band lying between two finer ones. The coarse band has numerous rough rhombs of *siderite*, a few angular *quartz* grains and a little *pyrite* in a finely fibrous groundmass. This groundmass is made up largely of minute greenish fibres or flakes, which have very little influence on polarized light, much of the section remaining practically dark between crossed nicols; these greenish flakes are regarded as *chlorite*. There are a few brightly polarizing flakes, probably *muscovite*, and a few minute quartz grains. The finer bands lack the *siderite* and angular quartzes, and are practically similar, although somewhat finer grained, to the groundmass of the coarser band. Throughout the section is much black dust-like material, and also specks, which are opaque, black in transmitted light and gray in reflected light.

One section.

Age. Archean (Keewatin).

U. S. G.

No. 327. FLINT.

Knife lake end of the portage between Knife lake and Maple Leaf lake; in Ontario.

Ref. Annual Report, ix, page 86. Compare rock No. 1429; also No. 973 (A. W.), Annual Report, xvi, page 210.

Meg. Flint, nearly black, but weathering light, with conchoidal fracture and sharp edges which gave name to Knife lake, about whose shores it is common. It is only local or in beds, or sometimes in ridges.

Mic. The rock is a very fine-grained clastic, of the nature of Nos. 322 and 324. With a high power, numerous angular fragments of quartz can be seen lying in a matrix, which, between crossed nicols, is rather dark, and which consists, probably, of much decayed feldspathic debris, in which, however, are sprinkled a few scales of *muscovite*.

One section.

Age. Archean (Lower Keewatin).

N. H. W.

No. 328. SLATE.

Ontario. Maple Leaf lake end of the portage between Maple Leaf and Carp (Pseudomesser) lakes.

Ref. Annual Report, ix, pages 86, 87.

Meg. From the roofing slate series of Knife lake. The sample shows alternations of fine and coarser-grained rock.

Mic. The section, evidently made from the coarser part of the specimen, embraces conspicuous angular *quartzes* and a few striated *feldspars*, lying in a matrix similar to the matrix of several already mentioned (Nos. 324, 325, 326) which is semi-isotropic between crossed nicols, the exact nature of which it is difficult to decide but which may have been derived from a devitrification of volcanic glass. It is

grayish to greenish, or even clear and translucent in natural light. In some cases a fibrous or scaly structure like chlorite is visible, but in most of the grains of this sort, the clear parts are simply the background for many microliths, some of which are opaque and some transparent and capable of polarizing light.

The slide also contains areas of *calcite*, and one cubic section of *pyrite*, in the vicinity of which is some *chalcidony*, at least a minutely fibrous glass-clear mineral in which the elongation is sometimes negative and sometimes positive.

The slide also shows variations in the relative abundance of the opaque grains. These are sometimes so grouped as to suggest that fragments of some different rocks were involved in the accumulation of this. These fragments are not vesicular, distinctly, but seem to be composed of rock similar to the rock in which they lie.

One section.

Age. Archean (Keewatin).

N. H. W.

No. 329. SCHIST. (*Hornblendic.*)

East end of Bassimenan (Basswood) lake, near Prairie portage; probably in N. E. $\frac{1}{4}$ S. E. $\frac{1}{4}$ sec. 2, T. 64-9 W.
Ref. Annual Report, ix, page 87.

Meg. A rather soft, dark-green rock, slightly schistose. The rock is too fine-grained to allow the components to be distinguished. Along seams some calcite is deposited.

Mic. The section shows green *hornblende*, *calcite*, *quartz*, *plagioclase*, *epidote*, *chlorite* and *pyrite*. The hornblende, which is the most abundant mineral, is elongated in one common direction, thus giving a decided schistose structure to the section—much more pronounced than would be thought from an examination of the hand sample. The hornblende is wrapped around quartz and plagioclase grains which show no clastic features, but are fresh and interlock with each other. Scattered through the section is abundant calcite (probably in part siderite) and small flakes of chlorite.

One section.

Age. Archean (Keewatin).

Remarks. This rock is part of the "greenstones" of the Keewatin. From the field notes, the hand sample and the section it is impossible to draw any definite conclusion as to the original nature of the rock. It shows no indication of structures which are definitely characteristic of either clastic or igneous rocks. It seems probable that the rock represents a sheared and recrystallized diabase or basic ash.

U. S. G.

No. 330. GRANITE (*with hornblende*).

Bassimenan (Basswood) lake, N. E. $\frac{1}{4}$ N. W. $\frac{1}{4}$ sec. 2, T. 64-9 W.
Ref. Annual Report, ix, page 87.

Meg. Rock varies from rather dark to lighter colored, as the hornblende and micaceous elements vary.

Mic. The rather thick section only permits the determination of the essential minerals present, which are *quartz*, *feldspar*, *chlorite* and *hornblende*.

One section.

Age. Archean (igneous).

N. H. W.

NO. 331. GRANITE (*with hornblende*).

"The rock of the country at Basswood lake, taken from an island two miles northwest of the eastern extremity." Perhaps in sec. 34, T. 65-9 W.

Ref. Annual Report, ix, page 88.

Meg. A gray granite of medium grain, composed of quartz, white feldspar which rarely shows twinning striæ and hornblende.

Mic. The section is composed of *quartz*, *feldspar*, *hornblende* and a little *epidote*. The quartz shows undulatory extinction. The feldspar is apparently *orthoclase*, *microcline* and *plagioclase* which seems to be near *oligoclase*.

One section.

Age. Archean.

U. S. G.

NO. 332. GRANITE (*with hornblende*).

"Near the portage landing, west end, in a low exposure; a fine chloritic (?) gneiss, the bedded structure sloping south at a high angle." Bassimenan (Basswood lake); west end of portage from the main lake to a narrow arm; sec. 5, T. 64-10 W.

Ref. Annual Report, ix, page 88.

Meg. Fine-grained, gray granite, composed of quartz, white feldspar and hornblende.

Mic. The most noticeable feature of the section is the large crystals of feldspar, which, however, are not idiomorphic. These feldspars are in a groundmass of finer grained *quartz* and *feldspar*. The *feldspar* of the rock is frequently considerably altered, but much of it is comparatively fresh. Some of it appears to be *orthoclase*, but much of it is *plagioclase* with low extinction angles—probably *oligoclase*. One grain, which was cut almost perpendicular to the positive bisectrix, gave an extinction on the cleavage of about 4°; this indicates *oligoclase* or *andesine-oligoclase*. (M. Fouqué, Bulletin de la Société Minéralogique de France, tome xvii, 1894.) The large feldspars frequently show a zonal structure. There are some small green *hornblendes* in the slide; also a few small *sphenes* and a little *epidote*.

One section.

Age. Archean (igneous).

U. S. G.

NO. 333. DIORYTE.

Same place as No. 332.

Ref. Annual Report, ix, page 88.

Meg. The abundance of hornblende in this rock gives it a dark aspect.

Mic. This only differs from No. 332, so far as can be seen, in the relative amount of *hornblende* it contains. The *sphenes* are sometimes large for microscopic

crystals. Slender spicules which are associated with the feldspar seem to consist of *apatite*, while *epidote* is quite common.

The existence of quartz in this rock is very rare. The feldspars have the appearance of quartz, being clear and limpid in extinctions as the stage rotates. These grains, when tested for the characteristic interference figure, uniformly give a biaxial sign, and on lowering the nicol they are seen to contain numerous enclosures, and sometimes show a cleavage or a structure indicating feldspar. In one such instance the bisectrix (n_x) gave an extinction angle of 8° , which is near *andesine*. Another exactly perpendicular to n_p gave an extinction angle of 66° , which exactly agrees with *andesine*.

One section.

Age. Archean (Coutchiching).

Remark. The transition from the igneous rock of the "Laurentian" of the region of Bassimanan lake to the Coutchiching at this place is no less noticeable petrographically than it is outwardly. The abundant quartz of the light colored igneous Laurentian disappears almost entirely, and the clouded, semi-saussuritized oligoclases, microclines and orthoclases, give place to a glass-clear andesine.

N. H. W.

NO. 334. DIORYTE.

Same locality as No. 332. "Chloritic hornblende schist, conformable with No. 333."

Ref. Annual Report, ix, page 88; Bulletin ii, pages 87, 88, plate VIII, figure 2.

Meg. A dark, almost black, medium-grained rock composed very largely of hornblende, with some gray feldspar.

Mic. The section shows *hornblende* in abundance, feldspar, *epidote* and *sphene*. The feldspar is sometimes very highly altered and sometimes quite fresh. In the highly altered portions much epidote has been developed. The fresher feldspar frequently shows fine twinning lamellæ and a low extinction angle—and probably is near *oligoclase*. Many of the smaller grains do not show twinning, but still seem to be plagioclase. An untwinned grain cut almost exactly perpendicular to the positive bisectrix shows an extinction angle of about 3° , indicating *andesine-oligoclase*. (A section of orthoclase cut parallel to the brachypinacoid would show the positive bisectrix and a low extinction angle, as would also a similar section of andesine-oligoclase. In this case, however, it is probable that no orthoclase is present.)

Remark. In Bulletin ii, a quartz-pseudomorph after plagioclase is described and figured. This very grain, however, seems to be feldspar and so do the surrounding smaller grains. This grain and many others which seem to be quartz on casual examination, were tested and many of them were found to show a distinct biaxial character, and *not one* showed clearly a uniaxial nature. There were, however, a

number of grains whose characters could not be determined positively. It thus seems that quartz is very rare, if not entirely lacking, in this section.

One section.

Age. Archean (Coutchiching).

U. S. G.

NO. 335. MICA SCHIST.

"Biotite mica schist, separated from No. 334 by a recurrence of rock like No. 332, conformable in dip with the last. This includes irregularly shaped masses or agglomerations of Nos. 336 and 337; also has thin, irregular, interrupted and contorted interlamination of the same. They are certainly interstratified." Same locality as No. 332.

Ref. Annual Report, ix, pages 88, 89.

Meg. There are two hand samples. The first is a gray mica schist of fine grain. The second is a darker, greener rock, and seems to be a hornblende schist.

Mic. The section, which is remarkably thick, was evidently made from the first hand sample. It shows *biotite* and *quartz* (with possibly feldspar) in fine grains. The biotite is in flakes lying approximately parallel, and to this is due the schistose structure of the rock.

One section.

Age. Archean (Coutchiching).

U. S. G.

NO. 336. GRANITE (*with hornblende*).

"Biotite(?) hornblende gneiss, of a light-gray color, alternating along the beach two or three times, conformably with No. 335." Same locality as No. 332, but along the beach further south.

Ref. Annual Report, ix, pages 88, 89.

Meg. Fine-grained, gray granite, composed of gray feldspar, quartz and hornblende.

Mic. The section is closely similar to No. 332.

One section.

Age. Archean (Coutchiching).

U. S. G.

NO. 337. GRANITE (*with hornblende*).

Same locality as No. 332, near No. 336.

Ref. Annual Report, ix, page 89; Annual Report, x, page 95.

Meg. A rather fine-grained, gray granite, composed of gray feldspar, hornblende, (with probably some biotite) and quartz. No section.

Age. Archean (Coutchiching).

U. S. G.

NO. 338. GNEISS (*with hornblende*).

Same locality as No. 332, still further south, near the beach and island.

Ref. Annual Report, ix, page 89.

Meg. A rather fine-grained, dark-gray granitic rock having a somewhat schistose structure due to the arrangement of the hornblende. Composed of hornblende, gray feldspar and apparently quartz.

Mic. The section is composed essentially of green *hornblende*, feldspar and quartz, the last two in rather small grains. The feldspar seems to be similar to that of the other rocks from this locality—*i. e.*, near *andesine-oligoclase*; many of the grains are clear and glassy. Quartz is not as common as at first sight would be supposed, but still is present. The other minerals of the rock are biotite, epidote, sphene and apatite.

One section.

Age. Archean (Coutchiching).

U. S. G.

NO. 339. HORNBLLENDE SCHIST.

"Hornblendic schist, from the shore of the same lagoon, on the north side, where the same interstratified condition of the same kinds of rock appears again." Near the same locality as No. 332, etc.

Ref. Annual Report, ix, page 89; Annual Report, x, page 95.

Meg. A dark rock, very rich in hornblende. Besides this mineral there is a fine-grained granular aggregate of glassy grains.

Mic. The section shows much green *hornblende*, sometimes very dark and practically opaque. Between the hornblendes and sometimes in them are fine grains of *feldspar*. This is sometimes cloudy and sometimes quite clear. The section is very thick and no careful determination of the feldspar could be made, but it seems to be of the same nature as the feldspar of the associated rocks. Quartz may be present in small amount, though none was determined.

One section.

Age. Archean (Coutchiching).

U. S. G.

NO. 339B. DIORYTE. (*Coarse.*)

"From the shore near Nos. 337 and 338, not in place, but supposed to be from these beds."

Ref. Annual Report, ix, page 89.

Meg. A very coarse-grained aggregate of green hornblende, biotite and gray to pinkish feldspar.

Mic. The section shows large plates of more or less fibrous green *hornblende*, large and small grains of feldspar and some *biotite*. The feldspar is mostly cloudy. One grain which gave a positive bisectrix almost exactly perpendicular shows an extinction of 6° . This might indicate *oligoclase-andesine* or *orthoclase*, but in this case the general characters of the mineral and its similarity to the feldspar of the associated rocks make it more probable that the feldspar is of the oligoclase-andesine series. Considerable *sphene* is present, and one peculiar feature of the section is the abundance of large stout prisms of *apatite*. This mineral occurs in the hornblende, biotite and feldspar, but more especially in the last. A little *calcite* is present.

One section.

Age. Archean (Coutchiching).

U. S. G.

NO. 340. MICA SCHIST.

"A little further west from No. 339, on the north side of this little water, the rock appears as a micaceous quartzite, which also varies to No. 341."

Ref. Annual Report, ix, page 89.

Meg. A very fine-grained, hard, dark greenish-gray micaceous rock, somewhat schistose.

Mic. The section shows the schistose structure of the rock finely. It is composed of *biotite*, *feldspar*, *quartz*, *chlorite* and *pyrite*. The feldspar is very abundant; it is quite clear, but often inclined to become cloudy; it rarely shows twinning, and then the twinning lamellæ are minute. The feldspar rarely shows any trace of cleavage. A number of grains showing bisectrices were found, but only one of these showed cleavage; in this grain the cleavage was not pronounced, it gave a negative bisectrix and an extinction of 76° , indicating *andesine-oligoclase*. Quartz is not nearly as abundant as the feldspar, although it is present.

One section.

Age. Archean (Coutchiching).

U. S. G.

NO. 341. MICA SCHIST. (*Tuff?*)

Same locality as No. 340; a variation of No. 340.

Ref. Annual Report, ix, page 89.

Meg. A dark, fine-grained rock, hardly schistose.

Mic. This is a fragmental rock, and in the slide all the elements have a prevailing elongation in one direction. The sparse *quartz* and abundant *feldspar* are so nearly alike that they cannot be distinguished except by the closest scrutiny at high power, and in convergent light. They are in angular small bits, and, with a little *pyrite*, they are set in a loose and scant frame-work of *biotite*. The feldspars are nearly always destitute of cleavage, and the most of them present a deceptive, limpid appearance, with double refraction lower than quartz. Some of them have a shadowy extinction, indicative of dynamic deformation. Other grains of feldspar are probably of another species, for they are much clouded with saussuritic particles; so much so, that an effort to determine them is fruitless.

Throughout much of the slide, instead of evident mica there is a greenish, clouded, semi-isotropic (perhaps chloritic) ingredient. It is probably this element that gives the rock its dark color.

Two sections.

Age. Archean (Coutchiching).

N. H. W.

NO. 342. GNEISS.

"A gneissoid quartzite, and makes a high bluff, the beds in all cases dipping to the south." Near the same place as Nos. 340 and 341.

Ref. Annual Report, ix, page 89.

Meg. A fine-grained, siliceous rock, showing gray to pinkish feldspars in a fine groundmass.

Mic. The section is very similar to Nos. 332 and 336, *i. e.*, it contains large cloudy feldspars (*oligoclase*) in a finer groundmass. The groundmass is made up largely of feldspar (near *oligoclase*), with some *quartz*, *biotite*, *chlorite*, *epidote*, *magnetite* and *apatite*.

One section.

Age. Archean (Coutchiching).

U. S. G.

NO. 343. SYENYTE.

Bassimenan lake. East end of the portage, E. $\frac{1}{2}$ sec. 6, T. 64-10 W.
Ref. Annual Report, ix, page 89.

Meg. A light-colored, granitoid, medium-grained rock.

Mic. The greater part of this rock consists of a feldspar which greatly resembles quartz, along with another that shows albite striations. The latter is *oligoclase*, as it gives an extinction angle of 88° , in a section cut perpendicular to the bisectrix n_p . An occasional large feldspar seems to be of *microcline*, but the peculiar cross-hatching of that species is not conspicuous, and cannot be relied on. Hence this peculiar rock may be said to consist essentially of *andesine* and *oligoclase*, with a few conspicuous *epidotes* and a very little *chlorite*.

One section.

Age. Archean (Coutchiching).

N. H. W.

NO. 344. MICA SCHIST (*with hornblende*).

"At the other end of this portage, and at one or two spots on the trail, the rock is a tough mica schist. This here also embraces strips of syenite and of quartz. These appear mainly as interlamination, but also as veins crossing the laminations." Bassimenan (Basswood) lake; west end of portage; W. $\frac{1}{2}$ sec. 6, T. 64-10 W.
Ref. Annual Report, ix, page 89.

Meg. There are two hand samples. One is a fine-grained, dark, greenish-gray hornblende schist, with perhaps some biotite. The other is a fine mica schist in contact with a gray, granitic rock composed almost entirely of white feldspar and quartz.

No section.

Age. Archean (Coutchiching).

U. S. G.

NO. 345. GRANITE (*with hornblende*).

Bassimenan lake. Probably in N. E. $\frac{1}{4}$ S. E. $\frac{1}{4}$ sec. 1, T. 64-11 W. "The rock along the shore, passing up this long bay, is syenite [granite?], but the sample of this number is taken from the place where the first view is presented up the long bay southwest. Here it is evenly bedded, dipping west, and is of pinkish or red color. This continues past one or two small points, when it is seen to dip in the opposite direction; then, on the next, it dips again southwest."

Ref. Annual Report, ix, pages 89, 90.

Meg. Red granite of medium grain.

Mica schist. Granite or gneiss.]

Mic. The section consists largely of non-striated and striated feldspars, one of the latter giving on n_p an extinction of 79° , indicating a feldspar between *andesine-oligoclase* and *oligoclase*. The non-striated feldspar is probably *andesine*, and would show striations if the section were thinner and the grains were properly cut. The presence of evident grains of *microcline*, however, rather favors orthoclase instead of andesine. *Quartz* is quite common, and *hornblende* is sufficient simply to warrant the name hornblende-granite.

One section.

Age. Archean (Coutchiching).

N. H. W.

NO. 346. MICA SCHIST (*with epidote*).

"Passing to the north side of this bay, within a half mile, or perhaps more, the whole changes to a fine, tough gneiss, which has a coarse schistose structure that makes it resemble the schists, being probably only a variation of the schists." Bassimenan (Basswood) lake; perhaps in sec. 11, T. 64-11 W.

Ref. Annual Report, ix, page 90.

Meg. A fine-grained, dark greenish schistose rock, composed of much biotite (with some chlorite) and gray to pink feldspar.

Mic. The section shows a decided schistose structure due to the approximately parallel "streams" of *biotite* and *epidote*. Besides these minerals there are *feldspar*, *quartz*, *chlorite*, *calcite* and a micaceous mineral due to alteration of the feldspar. The feldspar is often much altered, and this and the quartz are often in very fine grains.

One section.

Age. Archean (Coutchiching).

U. S. G.

NO. 347. GRANITE OR GNEISS (*with hornblende*).

"A little further along, across the bay, the syenite returns; but here a schistose structure can be seen on weathering, parallel to that seen all along. This forms the coast for some distance on the north side, at least to within one-half mile of the next portage." Bassimenan (Basswood) lake; perhaps in sec. 11, T. 64-11 W.

Ref. Annual Report, ix, page 90.

Meg. A gray, rather fine-grained, granitic rock, consisting of hornblende, gray to pinkish feldspar, quartz and epidote.

Mic. The section shows feldspar, *hornblende*, *quartz* and *epidote*. Part of the feldspar is very highly altered; a large part of that which is fresh shows the characteristic *microcline* grating in polarized light. One of these grains, showing but one set of twinning striæ and thus cut parallel to the brachypinacoid, gave a positive bisectrix and an extinction angle of 9° , all of which corresponds closely to microcline. Sometimes the larger feldspars include the other minerals poikilitically. The *epidote* is abundant, especially in minute grains and crystals in the immediate vicinity of the hornblende.

One section.

Age. Archean (Coutchiching).

U. S. G.

NO. 348. ACTINOLITE SCHIST.

Ridge and rapids at the mouth of Pipestone river, where the water comes down to the level of Bassimenan lake, the descent being about ten feet. S. W. $\frac{1}{4}$ sec. 22, T. 64-11 W.

Ref. Annual Report, ix, page 90; Annual Report, x, pages 89, 95; Annual Report, xv, pages 104, 105.

Meg. A tough greenish schist, crushing under the hammer like a chloritic schist; irregular and broken by jointage planes in different directions, and confused by a slight schistose structure, rather fine grained.

Mic. The slide is composed, almost entirely, of a network of spicules of green *hornblende*, which are not so compactly interwoven but that in their meshes can be seen grains of *feldspar* and of *quartz*. They do not have any prevalent direction of elongation, but overlap and cross each other as if accidentally thrown together. They show usually very faint dichroism, or none, but occasionally a marked dichroism is observable; a little *sphene* is also seen.

Two sections.

Age. Archean (Lower Keewatin).

Remark. This is a common rock in the Lower Keewatin, lying next above the igneous portion of the Kawishiwin. It is probably derived from an ancient sediment in which volcanic debris and erosion products were mingled. It is the horizon which contains elsewhere the most of the Keewatin jaspilyte. N. H. W.

NO. 349. SERPENTINE.

Pipestone rapids, a short distance above the rapids, in the right bank which rises about two feet above the river. S. W. $\frac{1}{4}$ sec. 22, T. 64-11 W.

Ref. Annual Report, ix, page 91; Annual Report, x, page 95; Annual Report, xv, pages 104, 105; Annual Report, xvi, page 111; Bulletin ii, page 29.

Following is Wadsworth's description of this rock (*op. cit.*):

Meg. "The hand specimen is a compact, dark-green rock, traversed by veins of talc and dolomite and coated in places by a limonitic deposit.

Mic. "The section shows a pale grayish and yellowish green groundmass, traversed by a reticulated network of *magnetite*, and cut by a dolomite vein. The magnetite preserves in part the outlines and fissures of the original *olivine* grains, while the groundmass itself is composed principally of a pale greenish isotropic *serpentine*, talc scales and fibres and *magnetite* granules. The talc is in single plates and in aggregations of fibres. The general character of the rock is similar to the serpentines of Michigan, New Jersey and Massachusetts."

Having had another section prepared we are able to add to the foregoing description. The term "serpentine" here may be employed in a general sense, somewhat as suggested by Lacroix,* indicating a rock rather than a mineral, consisting essentially of the products of alteration of the magnesian schists, which

* *Minéralogie de France et de ses Colonies*, part I, p. 417.

may be separated into distinct types on their differing optic properties. In this sense the entire rock is essentially a serpentine, retaining still a sort of porphyroidal microscopic structure, such as mentioned by Dr. Wadsworth.

In the section examined there are five minerals, not including magnetite.

1. An isotropic, pale green or yellowish mineral, which occupies areas of considerable size, entirely different and distinct from the other areas. This mineral is very finely fibrous, or structureless, and cannot be distinguished from that frequently seen in the centres of decayed olivines in the Keweenawan eruptives.

2. *Calcite* (or *dolomite*) is present, not only in microscopic veins, but more or less disseminated in the mass of the rock.

3. A highly bi-refractive mineral, which occasionally is in distinct fibres, but for the most part is in flakes or scales, and which occurs scatteringly in the porphyroidal areas of the original olivines referred to by Dr. Wadsworth. They do not probably consist of antigorite, owing to their high double refraction. They have positive elongation and parallel extinction, and with a thickness of .03 millimetres, their highest colors are in the second order, viz.: red, yellow and green. They appear, therefore, to be *talc*, of which there is a microscopic vein visible on one end of the hand specimen.

4. The most of the space of the supposed old olivines is occupied by a much less bi-refractive mineral. Its highest colors are a faint yellow, and most of it does not rise above the white of the first order. It is also in fine scales and is probably *antigorite*. The network which occupies these areas renders it impossible to get a uniform darkness.

5. There is also a noticeable amount of a fibrous or fibro-lamellar mineral, whose double refraction is still lower, viz., in the grays below the white of the first order, which is referable to *pennine*.

The rock is therefore a serpentine with a considerable amount of *steatite*.

Two sections.

Age. Archean (Lower Keewatin).

N. H. W.

NO. 350. CHLORITE SCHIST (?)

"Chloritic (?) slate from Pipestone rapids, just above the pipestone rock. The slate stands nearly vertical, but dips to the south." S. W. $\frac{1}{4}$ sec. 22, T. 64-11 W.

Ref. Annual Report, ix, page 91; Annual Report, x, page 95. For description of this locality see, also, Annual Report, xv, pages 104, 105.

Meg. A very fine-grained, soft, fissile, greenish-gray schist. It has minute laminae, green in color and probably composed largely of chlorite; also gray or flesh colored laminae perhaps composed of feldspathic material.

No section.

Age. Archean (Keewatin).

U. S. G.

No. 351. SERICITE SCHIST.

"About three-fourths of a mile above the rapids the slates dip northwest." Newton lake; probably in N. E. $\frac{1}{4}$ sec. 27, T. 64-11 W.

Ref. Annual Report, ix, page 91. Same as No. 257 (W.), Annual Report, xv, page 104.

Meg. A very fine-grained, light greenish gray, rather fissile schist. Occasionally a small grain of feldspar can be seen,—otherwise the rock is almost aphanitic.

Mic. The schistose structure is finely shown in the section; there are irregularly parallel streams of fine gray opaque material, and the scales of *sericite* and *chlorite* are elongated in a common direction. The rock consists of sericite, chlorite, quartz, feldspar, the gray opaque substance, calcite and a brownish stain. The sericite (or what is so regarded) and the chlorite are in minute flakes or scales; the former polarizes brightly. With these scales is a very fine-grained aggregate of quartz and apparently feldspar also. The section shows also larger grains of feldspar, which are broken and show undulatory extinction. Usually several grains of almost parallel orientation, and separated by growths of sericite, are close together, suggesting that the several grains are from one broken crystal. In this respect they are closely similar to the "stretched" grains of feldspar figured by G. H. Williams in Bulletin lxii, U. S. Geol. Survey (figure 2, plate IX; figure 2, plate XIV). These feldspars very rarely show twinning; they are somewhat altered, sericite being developed in them, and do not as a rule show cleavage, so their species was not determined. They are, however, probably *orthoclase*. The opaque gray material, spoken of above, under a high power is seen to be made of minute highly refractive grains and crystals which seem in part to be epidote. One section.

Age. Archean (Keewatin).

Remark. What this rock was originally cannot be determined from the single specimen and section at hand. It may not be amiss, however, to suggest that it represents an advanced stage of shearing and stretching in a quartz-porphry or similar rock, the broken and almost obliterated feldspars being the only original grains left in the rock. It may also be a sheared debris derived largely from quartz-porphry.

U. S. G.

No. 352. QUARTZ. (*Vein.*)

"At the upper end of the second rapids, or a little distance above, near the portage landing, is a large white quartz vein in the chloritic rock that makes the rapids. This runs S. 30° W., and coincides with the slate in dip, which is toward the northwest. This quartz embraces rusted pyrite, and has an auriferous aspect." Near the S. E. $\frac{1}{4}$ sec. 22, T. 64-11 W.

Ref. Annual Report, ix, page 91. This vein is illustrated by figure 1, plate AA, vol. iv.

Meg. Milk-white quartz enclosed in a green, fine-grained chloritic schist. The schist contains rusty spots probably due to the decay of a ferruginous mineral—*pyrite*.

No section.

Age. Vein in Archean (Lower Keewatin) rocks.

U. S. G.

Remark. A section of the rock embracing the vein is almost wholly dark constantly between crossed nicols, but affords scattered scales of a highly bi-refractive mineral which seems to be of *sericite*, besides a little *calcite* and a few grains of secondary plagioclase.

It also contains a single microscopic crystal of a rare mineral, viz.: *tourmaline*. This exhibits a longitudinal section whose absorption is very strong, bi-refraction strong and single refraction weak. It is crossed by many transverse irregular fissures, but is otherwise without cleavage. It has a dark gray color, and its elongation is negative, and its extinction parallel.

N. H. W.

No. 353. SERICITE SCHIST.

"Slate, soft, greenish (talcose or chloritic), from about two miles further up the lake, on the south side. There is not much exposure, but sufficient to show the formation extends to here, at least." South end of Newton lake, at the portage to Fall lake; probably near centre of sec. 3, T. 63-11 W.

Ref. Annual Report, ix, page 91.

Meg. Soft, light greenish-gray, sericite schist. Resembles, though more fissile and apparently less siliceous, No. 351. Contains a little pyrite and rusty spots probably from the decay of this mineral.

No section.

Age. Archean (Keewatin).

U. S. G.

No. 354. CHLORITE SCHIST (?)

"A less slaty, chloritic slate, from the same place. The slates here run S. 30° W., standing nearly vertical, sloping south. Indeed, this direction is about that of the narrow, long lake (Newton) in which the route lies." Same locality as No. 353.

Ref. Annual Report, ix, page 91.

Meg. A soft, fine-grained, dark, greenish-gray schist, apparently containing much chlorite.

No section.

Age. Archean (Keewatin).

U. S. G.

No. 355. TUFF (?) ("Greenstone.")

South side of Fall lake, east of the falls. Probably in the S. ½ sec. 17, T. 63-11 W.

Ref. Annual Report, ix, pages 91, 92; Annual Report, x, pages 89, 95.

Meg. A massive, yet coarsely schistose, siliceous light-green, fine-grained rock, with white quartz veins, apparently the same continuous rock mass as at Kawasachong falls (No. 356), but more like a graywacke. The single (poor) section at hand shows a fragmental rock composed of shreds of triclinic *feldspar* and much semi-opaque material, amongst which can be recognized, with greater or less certainty, *epidote*, *mica* and some *chloritic* mineral. Quartz has been generated so as to embrace the other minerals poikilitically.

Another section, made by Marchand, shows a general composition essentially of a basic débris, the original elements of which have been much altered. It contains

hornblende, epidote, feldspar, quartz, isotropic (chloritic?) substance, and is similar to the next.

Two sections.

Age. Archean (Kawishiwin of the Lower Keewatin).

N. H. W.

NO. 356. TUFF (?) ("Greenstone.")

Kawashachong falls, forming the brink, and the bluffs below the falls; south side sec. 17, T. 63-11 W.

Ref. Annual Report, ix, page 92; Annual Report, x, pages 89, 95; Annual Report, xv, page 319; Annual Report, xix, pages 126, 127; Bulletin ii, page 123; Bulletin vi, pages 37-40, 420. This is also the same rock as Nos. 997, 998, 999 and 138 (W.).

Meg. Appears similar to the rock at Pipestone rapids. It contains narrow, white quartz veins and deposits, some of which are two or three feet wide. This rock is neither bedded, jointed nor distinctly schistose, but it breaks in a very coarsely schistose manner, and each piece runs to blunt points lenticularly. Chlorite permeates and colors it. It seems to be closely seamed in all directions, but not with any regularity, if we except the general schistoid fracture, which coincides with the slates in being nearly perpendicular, and yet in sloping to the south. It abounds in talcose(?) or chloritic and hematitic slickensides. It is everywhere rough superficially and mashes under the hammer before breaking, and then breaks toughly and roughly.

Mic. The sections do not show any schistosity, but that may be owing to being parallel to the structure. That the rock is fragmental is evident, as remarked by Wadsworth, and it has undergone not very much deformation since its deposition. Along with a few fragments of triclinic (probably secondary) *feldspar* and much *clinochlore*, indicating a basic source for the ejection which supplied the materials of this rock, are numerous quartzes which, also, to some extent, have been enlarged so as to embrace the surrounding rock material. The chloritic element is sometimes *pennine*, and is sometimes also isotropic. A considerable amount of the green color of the rock is also due to the presence of *hornblende* which appears in the thin section with higher double refraction than any other mineral. This mineral is sometimes in large grains with reeded extremities, but occurs in some places quite abundantly as finer grains and fibres. Its alteration is to *clinochlore* and to an isotropic chloritic substance. *Calcite* is common, as is also a gray, *leucoxene*-like substance. *Hematite* and *pyrite* are rarely seen. *Magnetite* is questionable.

Two sections.

Age. Archean (Kawishiwin of the Lower Keewatin).

Remark. The hornblende in this rock has a very varied aspect, and it is often difficult to distinguish the finer grains from epidote. Their index of refraction is sufficiently near that of epidote and the overlapping produces a darkness that likens the aggregate to the obscure upper colors of the third order as required by *epidote* of

the same thickness. Hence we are disposed to consider that a portion of the higher polarizing mineral may be epidote. Such grains are abundant and not fibrous, but subangular and constitute an important element in the rock.

N. H. W.

NO. 357. SERICITE SCHIST.

"A chloritic slate, running nearly southwest and sloping to the southeast." Fall lake, at end of portage to Long lake; N. E. $\frac{1}{4}$ sec. 24, T. 63-12 W.

Ref. Annual Report, ix, page 92.

Meg. A soft, fine-grained, fissile, greenish-gray, sericite schist.

Mic. The section does not show any schistose structure and was thus cut parallel to the cleavage. The rock is very fine grained, being composed essentially of very minute grains (most probably both quartz and feldspar) and of flakes of *sericite* and *chlorite*. There is also considerable *epidote* in minute grains and crystals, and also a few *hornblende* fibres, and *calcite*. A number of larger *quartz* and *feldspar* grains occur in the rock; these are not sharply angular, nor rounded, but they interlock with the minute surrounding grains. The rock in general is quite similar to No. 351, but the feldspars are more numerous and do not so much suggest that one larger grain has been broken up to form smaller ones.

One section.

Age. Archean (Keewatin).

U. S. G.

NO. 358. TUFF (?) ("Greenstone.")

Island near the west end of Long lake. Perhaps N. W. $\frac{1}{4}$ sec. 29, T. 63-12 W.

Ref. Annual Report, ix, page 93; Annual Report, x, pages 89, 95; Bulletin ii, page 119.

Meg. Light green, scarcely schistose, evidently decayed deeply, fine-grained, with veins of quartz, resembling No. 356.

Mic. This rock is one of the tuffaceous parts of the Kawishiwin, the minerals being very indefinite. Still, there may be seen a considerable amount of *calcite*, a secondary *feldspar*, which shows no cleavage and can hardly be distinguished from quartz, quartz broken by pressure and with shadowy extinction, an isotropic substance, and a *leucocene*-gray sub-isotropic substance. The only brightly polarizing mineral is *calcite*.

Two sections.

Age. Archean (Lower Keewatin).

N. H. W.

NO. 359. TUFF (?) ("Greenstone.")

From the hill range running on the north side of Fall and Long lakes, taken on the portage from Burntside river to Burntside lake; S. E. $\frac{1}{4}$ sec. 23, T. 63-13 W.

Ref. Annual Report, ix, pages 93, 94.

Meg. Firm, tough, dark gray or greenish, fine-grained, appearing gray and granite-like at a distance when weathered.

Mic. The rock is fragmental, either because of crushing or by reason of original derivation. It consists, so far as can be determined, of triclinic *feldspar*, (probably *albite*), in fine pieces which have very irregular twin striations, and *chlorite* in fine shreds and strings. How much of the colorless ingredient may be of quartz cannot be determined certainly, because of its resemblance to the clear and limpid feldspar, but a considerable part of it appears to be *quartz*. A little *pyrite* is scattered through the rock.

Two sections.

Age. Archean (Lower Keewatin).

N. H. W.

NO. 360. HORNBLLENDE SCHIST.

Burntside lake, near the north end of the portage from the river which flows into Long lake; S. E. $\frac{1}{4}$ sec. 23, T. 63-13 W.

Ref. Annual Report, ix, pages 93, 94.

Meg. A dark green rock of medium grain, composed almost entirely of hornblende. A little feldspar is present, and many small veins of epidote.

Mic. The section is composed of matted, green *hornblende* fibres and a fine-grained aggregate of *quartz*, and considerably altered *feldspar*; also *epidote* and a little *pyrite*.

One section.

Age. Archean (Coutchiching).

Remarks. "Near the west end of the portage trail, on Burntside lake, within an area of thirty feet square, the following numbers, from 360 to 367, both inclusive, were obtained, Nos. 360 and 361 comprising the bulk of the rock."

"The rocks of these numbers are all arranged in a crooked lamination or coarse schistose structure, parallel with the same seen in the slates about here. The hornblende schist (No. 363) and the hornblende and feldspar rock (No. 364) gradually interchange, or pass onward to Nos. 365 and 366. Large masses in knolls and hills lie in the immediate neighborhood, made up of the same rocks."

U. S. G.

NO. 361. HORNBLLENDE SCHIST.

Same locality as No. 360.

Ref. Annual Report, ix, pages 93, 94.

Meg. A dark-green rock composed of hornblende and a little feldspar. It is quite similar to No. 360, but is coarser grained and does not contain as much epidote.

No section.

Age. Archean (Coutchiching).

U. S. G.

NO. 362. HORNBLLENDE SCHIST.

Same locality as No. 360.

Ref. Annual Report, ix, pages 93, 94.

Meg. A green rock, somewhat similar to the last two, but decidedly more schistose. It seems to contain chlorite and sericite as well as hornblende.

No section.

Age. Archean (Coutchiching).

U. S. G.

NO. 363. HORNBLLENDE SCHIST.

Same locality as No. 360.

Ref. Annual Report, ix, pages 93, 94.

Meg. A dark-green rock, finer grained than Nos. 360 and 361; composed of hornblende and some grayish feldspar, rather evenly distributed.

No section.

Age. Archean (Coutchiching).

U. S. G.

NO. 364. SYENYTE.

Same locality as No. 360.

Ref. Annual Report, ix, pages 93, 94; Bulletin ii, page 87.

Meg. A rather coarse-grained, granitic rock, composed of hornblende and gray to pinkish feldspar.

Mic. The section is too thick for careful study. It shows green *hornblende* and much decayed *feldspar*, which is probably largely *orthoclase*.

One section.

Age. Archean (Coutchiching).

U. S. G.

NO. 365. GRANITE. (*Chloritic.*)

Same locality as No. 360.

Ref. Annual Report, ix, pages 93, 94.

Meg. A pinkish medium-grained granitic rock, composed of gray to pinkish feldspar, quartz and chlorite.

Mic. The section shows a large quantity of feldspar, with less quartz and a little chlorite. The *feldspar* is highly kaolinized; it does not usually show twinning striæ; some of the grains, however, show minute twin lamellæ which fade out in more altered parts of the same grain, thus suggesting that possibly all the feldspar was originally twinned. Its species cannot be certainly determined, but it is probably *orthoclase* and *anorthoclase* or *oligoclase*. The quartz shows very pronounced undulatory extinction. The *chlorite* is in small amount and is intimately associated with a brownish mineral, perhaps *bowlingite*. A few very minute grains of *epidote* are present. One section.

Age. Archean (Coutchiching near transition to Laurentian).

U. S. G.

No. 366. HORNBLLENDE GRANITE.

Same locality as No. 360.

Ref. Annual Report, ix, pages 93, 94.

Meg. A medium-grained, granitic rock, composed of pink feldspar, hornblende, and a little quartz.

No section.

Age. Archean (Coutchiching near transition to Laurentian).

U. S. G.

No. 367. QUARTZ (*from a vein*).

Same locality as No. 360.

Ref. Annual Report, ix, pages 93, 94.

Meg. White, glassy, also stained by hematite; an accidental, thin fissure, or lamella, still retaining a little pyrite.

No section.

Age. Vein in the Archean (near Coutchiching).

N. H. W.

No. 368. GRANITE.

North side of Burntside lake.

Ref. Annual Report, ix, page 94.

Meg. Light-colored, medium-grained granite.

Mic. Feldspar, sometimes plainly a *plagioclase*, and sometimes so kaolinized as to be undistinguishable from *orthoclase*, composes the greater part of this rock; but mingled with the feldspar is a little *quartz* in grains of some considerable, though mainly microscopic, size, and still less of *muscovite*, *calcite*, *epidote* and *pennine*.

Two sections.

Age. Archean (igneous).

Remark. This is not a freshly crystalline rock, like those which are plainly eruptive and later than some of the schists, but appears to have suffered dynamic and other forces, and may date from before the general eruption of the granites. For the present, however, both the older granites and gneisses, and the later eruptives are included under one category.

N. H. W.

No. 369. GRANITE.

North side of Burntside lake, a vein or layer in No. 370.

Ref. Annual Report, ix, pages 94, 95.

Meg. Flesh colored, gneissic, rather fine grained.

Mic. Consists of *microcline*, a *plagioclase*, resembling *oligoclase* in its regular and fine striations and apparently of *orthoclase* with some *quartz*.

One section.

Age. Archean (igneous).

N. H. W.

No. 370. HORNBLLENDE SCHIST. (*Siliceous.*)

North side of Burntside lake.

Ref. Annual Report, ix, pages 94, 95.

Meg. Gray, firm, apparently siliceous, like a quartzite, with an angular, sharp fracture.

Mic. The rock consists very largely of *quartz*, but holds also *plagioclase* and *hornblende*. There are three feldspars. One is closely striated and rather fresh. One is clear and glassy, and the third is non-striated, but not glassy. The first has an extinction angle that sometimes reaches 18°. The second appears to be the same that has sometimes been identified in the sheared Archean as *andesine-oligoclase*, a secondary feldspar generated by the dynamic deformation to which the rock has been subjected, and the third appears to be of *orthoclase*. The *quartz* is broken and largely of secondary generation also, but probably pre-existed in the rock in large percentage in a free state. The *hornblende* constitutes a loose frame-work surrounding, in a lenticular manner, the quartz and feldspar, and producing by its prevailing direction a structure produced probably by pressure accompanied by some shearing. *Muscovite* is seen in the older feldspar, and some *apatite* is embraced in the secondary feldspar. There is also a little *epidote*.

One section.

Age. Archean (Coutchiching).

Remark. This rock was probably at first a graywacke, but has been recrystallized by the heat and pressure that accompanied the granitic intrusions. N. H. W.

No. 371. GRAYWACKE. (*Metamorphic.*)

At the mouth of the river entering Burntside lake at the portage to Mud lake; N. E. $\frac{1}{4}$ sec. 36, T. 63-14 W.
Ref. Annual Report, ix, page 95.

Meg. Similar to No. 370, but somewhat more gneissic.

Mic. In place of hornblende this rock has an isotropic *chlorite*, varying to a *mica*, and more *epidote*. Otherwise the thin section does not differ from No. 370 in any noteworthy manner.

One section.

Age. Archean (Lower Keewatin).

Remark. The foregoing (Nos. 359-370) are all conformable when they show any stratification at all, which is always the case except where there is a full transition from No. 363 or No. 364, or even from No. 360 to No. 368. In that case, when No. 368 is fairly set in, the parallel structure, always dipping at a high angle to the south (or a little east) becomes more and more indistinct, or is lost, and in its place a jointage running in different directions, hardly ever parallel with the schists, is substituted. Yet even then, in some weathered situations, a natural parting of the rock brings

out a rude schistose structure parallel with that in the slates. It is impossible to state whether these alternations of rock indicate a coming on of igneous rock, interstratified with the Couthiching, or that the strata all belong to the Couthiching, but all the appearances, both in the field and under the microscope, point to the gradual transition from the non-crystalline to the crystalline.

A similar alteration is seen again at the western end of the lake (Nos. 371 and 372), near the river, where the route leaves the lake westward. The bedding is here quite marked, running more south, and dipping at a high angle toward the northwest.

Besides this gradual transition, there is to be noted a sudden transition, which occurs when eruptive granite of a date later than the schists has invaded the schists, in the manner described by A. C. Lawson. Such rocks are strictly not of the same age, although they have commonly been together called Laurentian. (Compare Part I, page 27, *et seq.*)

N. H. W.

NO. 372. GRANITE. (*Chloritic.*)

Same locality as No. 371.
Ref. Annual Report, ix, page 95.

Meg. A rather fine-grained, pink granite composed of quartz, a pinkish feldspar and a little chlorite.

Mic. The section shows a granite composed largely of *quartz* and *feldspar*, with a little *chlorite* and *epidote*. The feldspar is quite extensively kaolinized and much of it shows no twinning lamellæ. There are, however, a number of grains with fine twinning lamellæ and very low extinction angles. While no distinctive characters were determined, it seems that the feldspar is *orthoclase* and *anorthoclase* or *oligoclase*. One grain, cut perpendicular to the positive bisectrix, gave an extinction of about 7°. The quartz and the less altered feldspars show pronounced undulatory extinction, and there is one vein-like band, crossing the rock, which is made up of fine grains of quartz and feldspar evidently formed by a crushing and shearing of the rock along this line.

One section.

Age. Archean (near Couthiching).

U. S. G.

NO. 373. CLAY SLATE.

Northeast end of Mud lake; N. W. $\frac{1}{4}$ sec. 2, T. 62-14 W.
Ref. Annual Report, ix, page 95.

Meg. A dark aphanitic rock, appearing like a hardened clay slate; rather soft; crossed by minute white veins probably composed of quartz and calcite.

No section.

Age. Archean (Keewatin).

U. S. G.