

Quartzite. Gneiss.]

times rise in bold exposures 125 feet above the lake, becoming a characteristic coarse conglomerate, undistinguishable from the Ogishke conglomerate, hard, semi-granitized, generally green but weathering with a red tint. At points a little further east granitic dikes cut it and replace it, changing it to a micaceous condition (No. 1728).

Mic. The rock has a coarse schistosity, expressed in the uniform direction of the longer axes of the minerals. *Quartz* is the most conspicuous and the most coarse of the elements of the rock. It is of secondary origin, interlocking with the finer grains of the matrix in which it lies. These quartzes are isolated, having an oval or sub-oval general outline (with but few exceptions) and but seldom coming into contact with each other. There are also finer quartzes, pertaining to the matrix, equally of secondary date, and on careful examination it can be seen that a few grains occur intermediate between the coarse and the fine, thus causing a gradation from one to the other, but the contrast between the large quartzes and the groundmass is not destroyed by this gradation. The most conspicuous part of the groundmass consists of *hornblende* in small irregular and ragged bits. The larger pieces are about one-half or one-third the size of the larger quartzes, but there are many much smaller and quite irregular, not actinolic. The groundmass, so called, also embraces isolated grains that are of *diopside*(?) of *sphene*, and considerable *epidote*. Still, the finer substance which embraces the coarser parts is apparently composed of altered old feldspar crystals and crystal fragments whose integrity is almost destroyed by inclusions, but which still can be discerned by an occasional feeble trace of albite twinning, and also by a general simultaneous extinction over certain areas. The minute inclusions in these feldspars are chiefly of *sericite*, globular minute feldspars whose orientations are various and thus obscure the general extinction, and other indeterminable grains, some of which are apparently of *zoisite*. There is also an occasional grain of iron ore which may be large enough to rank with the larger quartzes. One section.

Age. Archean (Keewatin).

Remark. Structurally and petrographically this rock is referable to the conglomerate, but it has been largely reconstructed in the generation of secondary minerals. Even the old, "much altered" feldspars appear in high powers to consist, so far as they are of feldspar, of a fresh feldspar material, generated in the same spaces as originally were filled by an older species.

N. H. W.

NO. 1725. GNEISS.

The country rock, a short distance east of No. 1724, S. W. $\frac{1}{4}$ sec. 26, T. 64-9, shore of Snowbank lake.

Ref. Annual Report, xxi, page 156.

Meg. Fine, granitic, a portion of the same mass as No. 1724.

Mic. The coloring element is green *hornblende* in irregular small shreds (with one or two grains of *zircon*) and a small amount of *hematite*. There are two or three feldspars and some *quartz*, all united in a fine, uniform, granular structure. One feldspar is filled with inclusions, largely of *mica*, but sometimes of *epidote*, *hornblende* and apparently of another feldspar. The feldspathic substance that now occupies these grains has a higher refractive index than quartz and is probably *andesine*. It is sometimes coarsely twinned. The fresh feldspars are *microcline* and apparently *albite* and *oligoclase*. One section.

Age. Archean.

N. H. W.

NO. 1726. GRANITE. (*Augitic.*)

Appearing in irregular patches, somewhat dike-like, in No. 1725, though these two rocks apparently grade into each other.

Ref. Annual Report, xxi, page 156.

Meg. Intrusive granite.

Mic. This rock is much like No. 1725, but is coarser grained. It also contains *sphene*, while the *hornblendes* are replaced by *augite*, which is green, and appears like *hornblende*. The *microcline* exhibits *microperthitic* and other intimate relations to small grains of other feldspar, often surrounding them in a *poikilitic* manner. One section.

Age. Archean.

N. H. W.

NO. 1727. GRANITE. (*Augitic.*)

S. W. $\frac{1}{4}$ sec. 26, T. 64-9, Snowbank lake, near No. 1726.

Ref. Annual Report, xxi, page 156.

Meg. As a dike, cuts the crystalline condition of the conglomerate, contact running about east and west.

Mic. Like No. 1726, but contains also a little *hornblende*. One section.

Age. Archean.

N. H. W.

NO. 1728. MICA SCHIST.

S. W. $\frac{1}{4}$ sec. 26, T. 64-9, north shore of Snowbank lake.

Ref. Annual Report, xxi, page 156.

Meg. A micaceous, fine-grained condition of the conglomerate (No. 1724), cut by granitic dikes. There is a distinct dip visible on the tops of the knobs (E. S. E.), and the strike is 15° E. of N., the dip throwing the rock under the granite. Not schistose.

Mic. This rock differs from rock No. 1724 only in the following respects: Less *hornblende*, considerable *mica* (*biotite*), greater invisibility of many of the old *feldspars*, absence of *quartz*, and the greater number of the "globular feldspars," which last character gives the finer parts of the slide a granulitic, interlocking structure.

Quartz-feldspar schist.]

There are, at the same time, fewer of the "old feldspars" now apparent, and hence the granulitic structure has the appearance of a second generation from a molten rock, there being no visible schistosity. One section.

Age. Archean (metamorphosed Keewatin).

NO. 1729. QUARTZ-FELDSPAR SCHIST.

North side of the same point, in a narrow westward-running bay. (Not shown on the township plats.) Underlies No. 1728.

Ref. Annual Report, xxi, page 157.

Meg. Appearing porphyritic with feldspar.

Mic. This differs from No. 1724 in the following respects: *Quartz* less common, almost wanting, but present in the finer portion of the slide, and in one case developed in the central part of the feldspar; the feldspars are frequently large, giving a porphyritic facies, but they are decayed about their margins and over large irregular areas, the little sericitic scales being uniformly prevalent. These large feldspars are much twinned on the Carlsbad, albite and pericline plans, and having an extinction on n_p of 86° seem to be near *anorthoclase* or *microcline-anorthoclase*. Numerous smaller fragments of the same feldspar are in various stages of decay—even to total obliteration. In case of the complete disappearance of a smaller feldspar grain its former presence is only evinced by the existence of a finely granular spot in the slide, the replacing minerals being interlocking fine feldspars, *sericite* and *hornblende*, like the same minerals in the slide at large, but usually with less of the hornblendic element. It is of course probable that all the finest original feldspathic debris has thus been replaced, and that the feldspars remaining visible are only visible because of their greater size, and hence greater endurance. There is no schistose structure. The rock suggests esterellyte.

Age. Archean (Keewatin).

N. H. W.

NO. 1730. QUARTZ-FELDSPAR SCHIST. (*Epidotic.*)

At the same place as No. 1729.

Ref. Annual Report, xxi, page 157.

Meg. Somewhat porphyritic with feldspars, irregularly associated with and blending into No. 1731.

Mic. The porphyritic aspect is due, as in No. 1729, to the occurrence of numerous clastic fragments of *feldspar* of large size. These are, however, very much altered, crowded with *epidote*, *sericite* and *zoisite* and almost lost in the general granulation; indeed, it appears that many of the smaller feldspar fragments have become entirely unidentifiable as such by reason of this tendency to fine granular disintegration and the generation of secondary interlocking quartz and feldspar. This gives the rock in general a fine micro-granitic structure. The large amount of *epidote*,

with considerable *hornblende*, gives a greenish coloration to this rock. *Calcite* is also common. Some of the *quartz* seems to be in its original clastic state, but most of it is of secondary origin. One section.

Age. Archean.

N. H. W.

NO. 1731. QUARTZ-FELDSPAR SCHIST.

Same place as No. 1729.

Ref. Annual Report, xxi, page 157.

Meg. Part of the conglomerate, a phase of No. 1730. These are both intimately associated with characters pertaining to the Keewatin greenstone, of which they seem to be conditions more feldspathic and coarser.

Mic. The *feldspars* are all smaller, roundish, altered in the same way but usually also containing *chlorite* as one of their products of decay. The same chlorite is distributed sparsely, moreover, throughout the slide, result of alteration of hornblende. *Quartz* in clastic, angular grains of considerable size, considerable *epidote* and a little *pyrite* should also be noted. One section.

Age. Archean.

N. H. W.

NO. 1732. HORNBLLENDE SCHIST.

S. W. $\frac{1}{4}$ sec. 24, T. 64-9, shore of Snowbank lake.

Ref. Annual Report, xxi, page 157.

Meg. The conglomerate grades into this. It is cut by many dikes of red granite.

Mic. This rock differs from No. 1724 in the following points: The old feldspars were all small and have nearly disappeared; hornblende is abundant and is arranged in sheets of greater and of less abundance; a powder of *hematite* is sprinkled everywhere in the slide; quartz is almost wanting. One section.

Age. Archean (Keewatin).

N. H. W.

NO. 1733. MICA SCHIST.

Sec. 24, T. 64-9, shore of Snowbank lake.

Ref. Annual Report, xxi, page 157.

Meg. The conglomerate grades into this; fine grained.

Mic. With a strong schistose structure this rock consists of *biotite*, *quartz*, feldspar, in which last are included *microcline* and *oligoclase*. Microcline encloses the biotite and the quartz and interlocks with itself, while the biotite was earlier or cotemporary with the quartz. There are but slight traces of the original clastic grains, still in many places some of the old grains are visible in the presence of dirty and minutely finely crystalline spots, in which frequently many globular feldspars appear along with *sericite*.

Judged by its contents and its crystalline grain this might be called a granite, but it is distinctly schistose. One section.

Age. Archean (Keewatin).

N. H. W.

Dioryte. Greenstone. Syenyte.]

No. 1734. DIORYTE. (*Camptonite?*)

Secs. 29, 30, T. 64-8, north shore of Snowbank lake.

Ref. Annual Report, xxi, page 157.

Meg. Seems to be a portion of No. 1733; dark gray, fine grained, sparingly interspersed with some crystalline red grains.

Mic. The *hornblende* (which is abundant) is partly porphyritic. The *feldspars* have central areas decayed, but marginal zones of fresh growth. A second development of feldspar is also dispersed throughout the rock, with *quartz*. *Epidote* is not abundant. Differs much from No. 1733. One section.

Age. Archean.

Remark. This rock has the appearance of being a massive crystalline one, and as such it cannot be a part of No. 1733 except by reason of more intense metamorphism.

N. H. W.

No. 1735. DIORYTE (*with quartz*).

Forms the coast eastward from No. 1734, and also dikes in No. 1733.

Ref. Annual Report, xxi, page 157.

Meg. Rather dark, with hornblende.

Mic. Much of the feldspar is zoned and so altered at the centre, and over most of the grain, that it cannot be determined. The later feldspars are *oligoclase* (?) and *microcline*. *Quartz* is interlocked with the later feldspars. The hornblende is varied, sometimes but little polychroic, apparently *actinolite*, and sometimes simply green *hornblende*, but more absorptive and more polychroic. *Epidote*, *magnetite*, *chlorite* are more or less associated with this varying hornblende. One section.

Age. Archean.

N. H. W.

No. 1736. GREENSTONE.

S. W. $\frac{1}{4}$ sec. 20, T. 64-8, Snowbank lake.

Ref. Annual Report, xxi, page 157.

Meg. Dark greenstone, cut by the next.

Mic. *Hornblende*, *chlorite* and *biotite*, with a little *magnetite* give the rock its dark color. The rest is feldspar in two stages, viz., much altered and fresh, with a little *epidote*. The grains are all small and roundish. The aspect is that of a clastic rock regenerated. One section.

Age. Archean.

N. H. W.

No. 1737. SYENYTE. (*Red.*)

Cuts rock No. 1736 as dike.

Ref. Annual Report, xxi, page 157.

Meg. Weathers red.

Mic. The rock consists almost solely of *microcline* and micropertthitic feldspar. Some of the feldspar is near *andesine-oligoclase*. There is very little hornblende. One section.

Age. Archean.

N. H. W.

No. 1738. CONGLOMERATE. (*Greenstone.*)

At the outlet of Snowbank lake.

Ref. Annual Report, xxi, page 157.

Meg. Apparently like a graywacke.

Mic. The rock is composed of *feldspar* fragments, often conspicuously twinned, never interlocking, usually much decayed, and similar fragments of *hornblende*. Both the feldspar and the hornblende are slightly zoned and enlarged by growths at different epochs, though this feature is not conspicuous. Some *quartz*, apparently in original clastic condition, occurs in the midst of these coarser grains. The groundmass that surrounds these larger elements consists in part of fine feldspars, but mostly of fine interlocking quartz and feldspar of secondary origin, the arrangement and variation in fineness of which often show that this replacement occupies the areas of some older mineral which has disappeared entirely. The rock is exactly like many described about Kekequabic and Ogishke Muncie lakes, belonging to the Ogishke conglomerate: One section.

Age. Archean (Keewatin).

N. H. W.

No. 1739. AUGITE-SYENYTE.

East side of sec. 31, T. 64-8, Snowbank lake.

Ref. Annual Report, xxi, page 157.

Meg. Coarse, presenting the so-called bedded structure of much of that about Bassimenan lake.

Mic. The augite has a negative elongation and is hence *agyrrine*. It is twinned on 100. The feldspar is much ingrown as a microperthite, twinned, zoned and interlocked, several different orientations frequently appearing in the same crystal, each one occupying but a small area interlocking with the general crystal and with the other small areas. These feldspars are *oligoclase*, *orthoclase*, *anorthoclase* and a little *microcline*. *Biotite*, *apatite* and *sphene* are also in the slide. One section.

Age. Archean.

N. H. W.

No. 1742. GABBRO. (*Much altered.*)

At the great Knife Lake headland, southwest corner of the headland, at the water level.

Ref. Annual Report, xxi, page 157.

Meg. Rather coarse grained and gray, with evident quartz.

Mic. *Quartz*, *hornblende*, *augite*, *leucoxene*, *biotite* and an altered *feldspar* compose this rock, so far as represented by the slide at hand. One (thick) section.

Age. Cabotian(?)

Remark. In connection with Nos. 1742 to 1751, compare Nos. 798G and 799G, which are somewhat similar coarse-grained diabases from the vicinity of Knife lake.

N. H. W.

Gabbro. Quartz, calcite, etc.]

NO. 1743. GABBRO. (*Much altered.*)

Same place as No. 1742, having a flint film or inclusion.

Ref. Annual Report, xxi, page 157.

Meg. The same rock as No. 1742.*Mic.* The *quartz* has entered the *feldspar* in a micropegmatitic manner. The feldspar, which had an ophitic structure with reference to the original augite, is indeterminable in the section at hand. One (thick) section.*Age.* Cabotian(?)*Remark.* Although originally ophitic this great mass has the color, action and outward aspect of gabbro. N. H. W.NO. 1744. GABBRO. (*Much altered.*)

Same place as No. 1742.

Ref. Annual Report, xxi, page 157.

Meg. Same rock, but having a different grain.*Mic.* So far as can be seen from the section at hand this is exactly the same as No. 1743. One (thick) section.*Age.* Cabotian(?)

N. H. W.

NO. 1745. QUARTZ, CALCITE, ETC. (*Vein matter, altered.*)

Same place as No. 1742.

Ref. Annual Report, xxi, page 157.

Meg. One foot thick, running straight in the rock of the headland for at least twenty-five feet, when it becomes hidden under the water at one end and under soil at the other.*Mic.* The section is so poor that it is only possible to say that the vein consists of *calcite*, *quartz* and apparently of some *feldspar*, stained and colored nearly black by *magnetite* and *leucoxene*, involving pieces of diabase. One (thick) section.*Age.* Cabotian(?)

N. H. W.

NO. 1746. GABBRO. (*Much altered.*)

North side of Knife lake headland.

Ref. Annual Report, xxi, page 157.

Meg. Apparently a conglomeratic or brecciated portion of the rock of the hill, with many pyrite cubes. The rounded masses that are dislodged are from three inches to eight inches in diameter, charged with pyrite, same as the rock itself. The pyritiferous character gradually fades out upward and is entirely wanting at forty-five feet above the lake.*Mic.* The section is from the pyritiferous rock, and with cubes of *pyrite* shows much *calcite* and a little *quartz* with fine needles of *sericite*, clusters of grains of *zoisite* and remnants of an indeterminable feldspar. One (thick) section.*Age.* Cabotian.*Remark.* This is evidently the rock of the hill in an altered condition. N. H. W.

NO. 1747. GABBRO. (*Much altered.*)

North side of the headland, twenty-five feet above the water.

Ref. Annual Report, xxi, page 157.

Meg. A much-decayed, coarse diabase or gabbro.

Mic. Quartz, diallage, leucoxene and a much-changed feldspar, are the only identifiable minerals. One (thick) section.

Age. Cabotian(?)

N. H. W.

NO. 1748. GABBRO. (*Much altered.*)

North side of the headland, at fifty feet above the lake.

Ref. Annual Report, xxi, page 157.

Meg. Similar to the last.

Mic. Diallage, uralite, leucoxene, quartz and an indeterminable, much-altered feldspar, with zoisite, etc. One (thick) section.

Age. Cabotian(?)

N. H. W.

NO. 1749. GABBRO. (*Much altered.*)

North side of the headland, at the northern crest of the hill.

Ref. Annual Report, xxi, page 157.

Meg. Resembling gabbro.

Mic. As in the foregoing from this rock, the feldspar is entirely destroyed, as well as the olivine. There remain leucoxene, and a form of pyroxene (apparently in some cases diallage), as the only relics of the original minerals. Quartz has entered, most of the pyroxene is converted to uralite, and the spaces of the original feldspars are filled with a variety of decomposition products, which unfortunately, on account of the great thickness of the slides made from this rock, cannot be differentiated, but in which zoisite plays a leading part. One section.

N. H. W.

Age. Cabotian(?)

NO. 1750. GABBRO. (*Much altered.*)

Top of the headland, perhaps 250 feet above the lake, near the centre of the promontory.

Ref. Annual Report, xxi, page 157.

Meg. Gabbro-like.

Mic. In this slide the structure is sufficiently preserved to show that it was ophitic. The leucoxene shows a coarse sagenite structure of rutile, but is still only sub-translucent. One (thick) section.

Age. Cabotian(?)

N. H. W.

NO. 1751. GABBRO. (*Much altered.*)

Near the southern crest of the headland.

Ref. Annual Report, xxi, page 157.

Meg. Similar to the last.

Conglomerate. Diabase.]

Mic. This does not differ essentially from the foregoing, but shows *pennine* as well as the other alteration products. One (thick) section.

Age. Cabotian(?)

N. H. W.

NO. 1757. CONGLOMERATE.

West Twin peak, southeast from Ogishke Muncie lake, northern slope; about section 33.
Ref. Annual Report, xxi, page 158.

Meg. Greenstone, pebbly.

Mic. The rock shows the characters of much of the Ogishke conglomerate. With a green tint, due to the fine dissemination of *hornblendic* shreds, modified by *leucoxene* and *hematite*, there are numerous large *quartzes*, angular and sub-rounded, and remnants of fragmental grains of *feldspar*. The most interesting feature is the different degree of alteration that these old feldspars have suffered. Some are wholly lost and some still show the albite twinning, while many are preserved sufficiently to serve barely for proof that they once were perfect. This alteration consists chiefly in the development within the areas of the feldspars of a microgranulitic mass which encroaches from the borders toward the centre. This microgranulitic substance consists largely of new feldspars and of quartz. It is nearly free from hornblende or other coloring matter, but the areas are set in a surrounding, greenish mesh which contains much debris of hornblende. Hence there is an aspect as of pebbles. In some cases this micro-granulitic structure is very fine, but in others it can be separated into its constituents by the higher power of the microscope, when it appears to consist very largely of granular interlocking feldspars. One section.

Age. Keewatin (Ogishke).

N. H. W.

NO. 1758. DIABASE. (*Uralitic.*)

Northern slope of West Twin peak.
Ref. Annual Report, xxi, page 158.

Meg. Shows evident igneous characters.

Mic. This rock was originally semi-ophitic, but now consists almost wholly of *uralite* and plagioclase, with a small amount of *magnetite* and less of *hematite*. One section.

Age. Archean (Keewatin).

Remark. It is only rarely that a true igneous rock is encountered among the elastic strata of the northern slope of this mountain.

N. H. W.

NO. 1759. DIABASE. (*Uralitic.*)

North slope of West Twin peak.
Ref. Annual Report, xxi, page 158.

Meg. A coarse uralitized diabase, similar to, but coarser grained than, No. 1758.
No section.

Age. Archean (Keewatin).

U. S. G.

NO. 1760. DIABASE. (*Uralitic.*)

From the top of West Twin peak. The country rock.

Ref. Annual Report, xxi, page 158.

Meg. Fine grained, without boulder forms.

Mic. This rock consists, like No. 1758, of *uralite* and *plagioclase*, but was originally not ophitic. On the other hand the augites were earlier than the feldspars and were small. One section.

Age. Archean (Keewatin).

N. H. W.

NO. 1761. DIABASE. (*Uralitic.*)

Same locality as No. 1760.

Ref. Annual Report, xxi, page 158.

Meg. A medium-grained, uralitized diabase. No section.

Age. Archean (Keewatin).

U. S. G.

NO. 1762. DIABASE (*with olivine*).

West Twin peak, central part of a dike ten feet wide, cutting No. 1760, running northwest.

Ref. Annual Report, xxi, page 158.

Meg. Evidently diabasic.

Mic. With the ophitic structure are preserved also remnants of the *augite* and of the *olivine*. Some of the augite was as early as the feldspar and some of it is largely uralitized. The olivine shows the alteration to *bowlingite*. One section.

Age. Dike in the Keewatin.

N. H. W.

NO. 1763. DIABASE (*with olivine*).

West Twin peak, near the edge of the same dike as No. 1762.

Ref. Annual Report, xxi, page 158.

Meg. Dense and dark colored.

Mic. Like the last, but finer grained. The rock can hardly be called ophitic, since the *augites* are small and as early as the *feldspars*. This rock has more *magnetite*, less *olivine*, and is preserved better, showing, however, a little *biotite*. One section.

Age. Dike in the Keewatin (possibly Cabotian).

Remark. Being a part of the same dike as No. 1762, this slide shows an interesting contrast, in having its *augites* earlier than the feldspars, or cotemporary with them, never revealing an ophitic structure. It is apparent hence that the ophitic structure is not necessarily an intrusive character, nor the absence of it a character of massive rock. From the slides examined, not including Nos. 1762 and 1763, it is apparent that the central mass and summit of the West Twin peak consists of igneous rock. It is believed to represent the oldest rock known in the state, and to have been a part of the original crust of the earth, the Kawishiwin of the Keewatin.

N. H. W.

Esterellyte. Porphyry.]

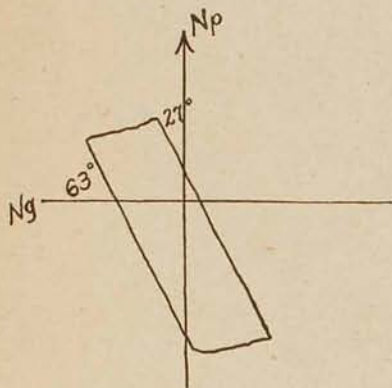
NO. 1767. ESTERELLYTE (*inclusions in*).

Corner of sec. 29, T. 65-6, Kekequabic lake, on the porphyritic knob. (Compare Nos. 1094, 1398, 1400.)
Ref. Annual Report, xxi, page 159.

Meg. Pebbles from the porphyry.

Mic. Three slides were made from these pebbles, viz.:

1. Granitic esterellyte. In this slide the rock differs from the normal condition of the porphyry (Nos. 1062 and 1095) in having very little of the fine groundmass



surrounding the larger crystals. One portion is, however, distinctly micro-granulitic, and in that fact the pebble is allied to the normal porphyry. The augite, so-called, has a negative elongation, n_p being nearer the vertical axis, with which it makes an angle of 27° , as in the accompanying diagram. Dr. Grant shows that it may be 22° (Twenty-first Annual Report, page 46). This character shows that the augite approaches ægyrine.*

FIG. 46. ÆGYRINE-AUGITE IN NO. 1767.

2. Is composed entirely of amphibole, often showing a zoned enlargement, and also often in fine fibres placed at random in the slide. As inclusions the larger crystals contain much *magnetite* in fine powder and as small crystals.

3. Is so fine that it cannot be described exactly, but with a little *feldspar* it consists largely of some *amphibole*, and hence is allied to No. 2. Three sections.

Age. Archean (Keewatin).

Remark. These inclusions might all be styled *dioryte*, or No. 3 perhaps more correctly *amphibolyte*. They were collected with others, of which no sections were made, as pebbles in a supposed conglomerate. If, however, the rock in which they lie be considered an igneous rock they should rather be called inclusions. Such pebbly forms are distributed throughout this knob of porphyry, but are most numerous on the northeastern slope. They all appear to have been caused to approach the characters of the rock in which they lie.

N. H. W.

NO. 1768. PORPHYRY. (*Pebbly.*)

From the same porphyry knob at the northeast extension.
Ref. Annual Report, xxi, page 159.

Meg. Not porphyritic, fine grained, not evidently fragmental, graduates into the porphyritic portion.

Mic. One section made is "porphyritic," like the rock of the knob, having fragments of crystals of the usual much twinned *feldspar* and of *ægyrine*, in a finer ground-

* *Minéralogie de France*, vol. 1, p. 568.

mass; the other is destitute of such crystals, very fine grained, and is a part of the schist or greenish conglomerate of the region. The feldspars in the latter have been eaten up by replacement by a micro-granulitic encroachment, leaving only remnants of the original crystals. *Hornblende* is in small crystals (after augite) and as irregular shreds, running down to very fine particles. As a secondary product it appears that *actinolite* needles have been developed. These are not connected with the hornblendes as borders or secondary growths, but are scattered through the fine-grained matrix. Several grains of *sphene* are evident in this slide. Two sections.

Age. Archean (Keewatin).

Remark. The relation of this rock to the porphyry of the knob is problematical, *i. e.*, whether it is anterior or posterior to the porphyry. The feldspars have the same much twinned appearance, so far as they are preserved. If the field observation is correct that there is a gradual passage from this to the porphyry, there is a genetic relationship which, while in accord with the field observations at the time they were made, seems also to be in accord with the microscopic features. The only difference between this rock and the porphyry prevalent on the knob is the different conditions of the feldspar crystals. Compare No. 1770.

N. H. W.

No. 1769. PORPHYREL. (*Conglomeratic.*)

From the north side of the narrows of Zeta lake.

Ref. Annual Report, xxi, page 159.

Meg. Conglomeratic.

Mic. The slide does not vary in a manner characteristic of a conglomerate, but it is more like a volcanic tuff. It consists of the peculiar *feldspars* and of *uralite* from *ægyrine* like the porphyry of Kekequabic lake, including some *sphene* and *magnetite*. These are generally entirely distinct, but occasionally a grain of *ægyrine* is wholly enveloped in a feldspar. There are also round small feldspars within the *ægyrine*. The surrounding matrix is composed of the same materials, but in a finer state of comminution. There is here visible none of the secondary micro-granulitic encroachment on the feldspars. The hornblende is frequently conspicuously zoned, but does not show the fibrous additions seen in some of the schists at Kekequabic lake. One section.

Age. Archean (Upper Keewatin).

Remark. The name porphyrel was applied to this rock in the prosecution of the field examination by Dr. A. Winchell. It is a rock like the Kekequabic Lake porphyry, but here plainly and abundantly conglomeratic.

N. H. W.

No. 1770. PORPHYREL. (*Conglomeratic.*)

South side of the narrows of Zeta lake.

Ref. Annual Report, xxi, page 159.

Meg. Conglomeratic.

Graywacke. Gneiss. Conglomerate.]

Mic. This rock is like the last, but somewhat more decayed, showing areas of *calcite*, and some of the feldspar grains are affected by a micro-granulitic alteration. Such alteration of feldspar grains is not uncommon in the Ogishke conglomerate, as already noted. One section.

Age. Archean (Upper Keewatin).

N. H. W.

NO. 1772. GRAYWACKE. (*Tuff?*)

N. W. $\frac{1}{4}$ S. W. $\frac{1}{4}$ sec. 31, T. 65-5, north shore of Gabemichigama lake.

Ref. Annual Report, xxi, page 159.

Meg. Pebbly, no strike or dip visible, though there is a dim appearance of strike northeast.

Mic. Angular *quartzes* are sparsely distributed with fragmental *feldspars* and *hornblendes* through this rock. At the same time there are many areas of micro-granulitic structure which were formerly occupied by feldspars, a feature which is recognizable in much of the Ogishke conglomerate. This slide has more the structure of a fine agglomerate or tuff than of conglomerate. One section.

Age. Archean (Upper Keewatin).

N. H. W.

NO. 1773. GRAYWACKE. (*Tuff?*)

One hundred yards north of the last, on a low, sloping surface.

Ref. Annual Report, xxi, page 159.

Meg. Has no evident dip or structure.

Mic. Similar to the last, but with more abundant micro-granulitic structure. The larger (and fresher) feldspars and the *quartzes* lie in a general matrix of micro-granulitic structure in which it is not possible to distinguish the forms of older grains, but which still must be supposed to have originated in the same way, but from finer original material. One section.

Age. Archean (Upper Keewatin).

N. H. W.

NO. 1775. GNEISS. (*Biotitic.*)

From the older formation, near the gabbro, on the east side of the northeastward bay, Gabemichigama lake; S. W. $\frac{1}{4}$ sec. 29, T. 65-5 W.

Ref. Annual Report, xxi, page 159.

Meg. Fine grained.

Mic. Feldspar and biotite make up the most of this rock, but small globular *diopsides*(?) are also common, with a little *magnetite* and *pyrite*. It has no schistose structure, but was produced by a regeneration of a fine fragmental rock, probably some part of the Ogishke conglomerate. One section.

Age. Archean (Upper Kewatin).

N. H. W.

NO. 1776. CONGLOMERATE. (*Finer portion.*)

N. E. $\frac{1}{4}$ S. E. $\frac{1}{4}$ sec. 30, T. 65-5, Gabemichigama lake. From a hill rising 150 feet.

Ref. Annual Report, xxi, page 159.

Meg. Collected as a doubtful muscovadyte.

Mic. This rock shows all the characters of the finer portions of the Ogishke conglomerate, angular *quartzes* and *feldspars*, with shreds of *hornblende* and occasionally of *biotite*, in a micro-granulitic matrix like that which has been frequently mentioned. This matrix occasionally takes on forms that suggest the former existence of old feldspars, or pebbles of *glass*. Owing to the comparatively good preservation of the evident feldspar grains, and the completely micro-granulitic structure of these pebble-like areas, there seems to be good reason to consider them as originally of glass. *Actinolite* fibres are scattered throughout the slide. One section.

Age. Archean (Keewatin).

N. H. W.

NO. 1777. GNEISS (*with biotite.*)

From the long point in the northeast part of Gabemichigama lake, near the centre of W. $\frac{1}{2}$ sec. 32, T. 65-5 W.

Ref. Annual Report, xxi, page 159.

Meg. Gneissose. (Compare No. 1350.)

Mic. This is a more coarsely micro-granulitic condition of the same formation as No. 1776, with a more profound recrystallization. *Quartz*, *biotite*, *feldspar* form a mutually interlocking crystalline rock, penetrated by fine needles of *actinolite*. There are evident remnants of the old feldspars. These areas are less coarsely micro-granulitic, and they are also distinguished by fine brightly-polarizing scales that resemble *sericite*. The secondary feldspar gives an extinction angle on n_v of 64° , and n_e is in the acute optic angle, indicating *andesine*. In this rock the biotite was, in general, earlier than the quartz, but there are noticeable exceptions. One section.

Age. Archean (Upper Keewatin).

Remark. It appears from this and other slides that, petrographically, the Ogishke conglomerate grades into the gneiss of the northeastern part of Gabemichigama lake, into the "greenstone" of the region, and into the green schists of Kekequabic lake, as well as into the muscovadyte at Disappointment lake and the porphyrel of Zeta lake.

N. H. W.

NO. 1778. MUSCOVADYTE.

N. E. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 34, T. 65-5 W., near the junction of two branches of the creek. From the top of the cliff facing north.

Ref. Annual Report, xxi, page 159.

Meg. Fine grained, gabbro-like.

Mic. The elements are all fine, and consist of some plagioclase, which was about cotemporary with the *pyroxene*, of *magnetite* and of *biotite*. One (thick) section.

Age. Cabotian (recrystallized Keewatin).

N. H. W.

Quartzite. Greenstone. Muscovadyte.]

No. 1779. QUARTZYTE.

Same place as the last, on the north slope of the same hill.

Ref. Annual Report, xxi, page 159.

Meg. Some of this appears micaceous. Underlies the muscovadyte-gabbro (No. 1778).

Mic. The *quartz* is in coarse interlocking grains. It is accompanied by *actinolite* and *magnetite*, and has numerous inclusions. One section.

Age. Keewatin (recrystallized jaspilyte), or perhaps Animikie. N. H. W.

No. 1780. GREENSTONE. (*Regenerated.*)

Just across the creek, north from the foregoing, in the eastward extension of the greenstone and gneissic greenstone seen at the northeast corner of Gabemichigama lake.

Ref. Annual Report, xxi, pages 148, 149, 159.

Meg. Greenish gray, massive.

Mic. A pyroxene, probably *augite*, is abundant in this rock, forming ragged crystals that embrace not only *magnetite*, but also many globular pyroxenes and secondary *feldspars*, but *biotite* was later than some of the small globular pyroxenes, and *hornblende* sometimes replaces them. The rock shows numerous remains of the original old *feldspars*, now granulitized. It also contains a little hypersthene. One (thick) section.

Age. Archean (Keewatin).

Remark. The muscovadyte-gabbro No. 1778, which here immediately overlies the Pewabic quartzite, is essentially the same as the regenerated greenstone which underlies it. They are both of the muscovadyte type. The nearness of one to the other topographically, and this close petrographic alliance, compel to the assumption that they are the same rock, and that the quartzite is embraced in that rock. There seems to be here almost a demonstration that the Pewabic quartzite and its ferruginous qualities result from an alteration of masses of jaspilyte in the greenstones of the Keewatin.

N. H. W.

No. 1781. MUSCOVADYTE. (*Granulitic gabbro.*)Lies below the same quartzite. N. E. $\frac{1}{4}$ sec. 35, T. 65-5, a little east of No. 1780.

Ref. Annual Report, xxi, pages 148, 149, 159.

Meg. When collected this was supposed to be a part of the greenstone of the Archean.

Mic. But it is a form of the gabbro, constituting the well-known "muscovado rock," which pertains to the "basal" parts of the gabbro. It has essentially the structure of No. 1780, but the pyroxenes have more the color and habit of *augite*, earlier than the *feldspars*. There is considerable *magnetite* in fine grains scattered throughout the slide, some *quartz* and some *biotite* and a little *uralite* and brown

hornblende. There are visible none of the remains of any old feldspars, and in that respect, as well as in the manner of the pyroxenes, this muscovadyte is different from the less regenerated greenstones. One section.

Age. Cabotian (regenerated Keewatin).

Remark. In the annual reports there was some confusion in the use of the term muscovadyte, and an effort was made in the Twenty-first Annual Report, (pages 143-152) to define it more exactly and to assign it to a phase of the gabbro, supposed to be due to shattering of the grains about the periphery of the gabbro mass. The name is based wholly on the mineralogic structure and the prevalent color.

It has since appeared, however, both in field examination and in the microscopical study, that the muscovadyte is altered both to the gabbro and to the greenstone of the Keewatin, being an intermediate stage in the transformation of the great Keewatin greenstone mass into the great irruptive gabbro mass. Compare the description of rock No. 2197; also the discussion in Part I.

N. H. W.

NO. 1782. QUARTZYTE.

Top of the ridge at the same locality as No. 1781.

Ref. Annual Report, xxi, page 159.

Meg. Vitreous quartzyte, varying from coarse to fine grained. Similar to No. 1779. No section.

Age. Pewabic.

U. S. G.

NO. 1783. MAGNETITE.

From a cliff at the southeast end of Paulson lake, S. E. $\frac{1}{4}$ S. E. $\frac{1}{4}$ sec. 25, T. 65-5 W.

Ref. Annual Report, xxi, page 159.

Meg. Rather fine-grained, crystalline magnetite. No section.

Age. Pewabic.

U. S. G.

NO. 1784. MUSCOVADYTE.

North side of Muscovado lake.

Ref. Annual Report, xxi, pages 150, 160; Annual Report, xxiii, pages 212, 214.

Meg. Heavily jointed, nearly horizontal, slides in sheets into the lake toward the southeast, the sheets being from one-half inch to six inches thick. Prevails about the shores of Muscovado lake, and on the shores of the north half of the Bashitanequeb lake, forming hills north of the latter.

Mic. It has the elements of a gabbro, the *augite* being earlier or cotemporary with the feldspar, with considerable *magnetite* and *hypersthene*; no quartz, the grains being of even size, all rather fine and affecting a roundish habit. Very frequently the augites and hypersthene are embraced wholly within the feldspars. Two sections.

Age. Cabotian (altered Keewatin).

Muscovadyte. Camptonite.]

Remark. This rock is now believed to be a metamorphic condition of the Keewatin greenstone. A chemical examination by Meeds gave a strong test for titanium.

N. H. W.

NO. 1785. MUSCOVADYTE.

North shore of Bashitanequeb lake.

Ref. Annual Report, xxi, pages 150, 160.*Meg.* Fine grained.*Mic.* Identical with No. 1784, but with less magnetite. One section.*Age.* Cabotian (metamorphosed Keewatin).

N. H. W.

NO. 1786. CAMPTONYTE.

Branching conspicuous dike, or bleb, which crosses, in part at least, the townsite of Ely, in the highest portion of the town, cutting the bouldery graywacke near the Catholic church.

Ref. Annual Report, xxii, page 5.*Meg.* Coarsely granular or sub-porphyrific.

Mic. Idiomorphic crystals of dark *hornblende* are the most conspicuous part of this rock. They were older than the feldspars, as they sometimes cut across the feldspars. They are also generally slightly zoned, giving different colors of double refraction in a manner similar to the hornblendes in the dike of Stuntz island (No. 872), but this feature is much less noticeable. Occasionally can also be seen a green hornblende, which is doubtless a secondary development, since the brown(?) hornblendes have occasionally green borders and fibrous appendages. Throughout the slide are also numerous irregular grains of *epidote*, which are enclosed uniformly, and often numerous, in the feldspars. They are also enclosed within the large phenocrysts of pyroxene. They are usually, but not invariably, absent from the idiomorphic hornblendes. They have the peculiarity of presenting different colors and different angles of extinction within the same grain.

Pyroxene, probably augite, exists as skeletons of phenocrysts, which have been replaced in a micro-pegmatitic manner by *feldspar*(?) and by a growth of hornblende. These are larger than any of the feldspars, and evidently date from the first consolidation. The feldspar has extinction on n_g (acute bisectrix) at 19° to 20° , indicating *albite* or *andesine*. *Zoisite* is common, and *sphene* is rare. *Pennine* also fills some irregular spaces which were probably once occupied by an older feldspar. One section.

Age. Archean (dike).

Remark. The appearances suggest that this rock in its present state is not only altered by weathering, but that the magma from which it was formed suffered some change before it finally consolidated. There were at first some augites and some feldspars. These are now largely replaced and in their stead are epidote, calcite

and hornblende, with another feldspar species. There may have been an accession of acid matter or such elements that the whole tone and tendency of the magma in consolidation was altered, resulting in a rock quite different from that which would have been produced had no such change supervened. Rock like this is found at Vermilion lake, in form of dikes. (Compare Nos. 872 and 877. Also compare No. 2102.)

However, the appearance of this rock is that of one crystallized from a debris rather than from a magma.

N. H. W.

NO. 1787. GREENSTONE.

"Amygdules, or pipe-like tubes, in the boulders or bombs of the agglomerate at Ely, filled with silica, which appears to be 'chalcedonic' or minutely granular. This new feature is found sparsely in the rock toward the southwest from the cut at the railroad already described."

Ref. Annual Report, xxii, page 5. Compare Nos. 1510 and 1511.

Meg. Specimen lost. No section.

Age. Archean (Keewatin).

U. S. G.

NO. 1788. GREENSTONE.

Southwest from the railroad cut at Ely, toward the Lockhart property, this rock abuts against a bouldery mass of the graywacke, or agglomerate, and its grain and substance seems to enter the bouldery mass, and to surround the bombs, at the same time becoming finer, forming the dark-green scale which envelops them.

Ref. Annual Report, xxii, page 5.

Meg. When collected this was considered a representative of the rock No. 1786.

Mic. It may be a representative of that rock, but it is much more decayed, showing a considerable *calcite*. There are no porphyritic hornblendes, but a fine and often fibrous *actinolite* or other amphibole is abundant, especially in the areas of the old pyroxenes. There is also a wide distribution of small, irregular grains of epidote like those mentioned in the description of No. 1786. There are multitudes of little feldspars, much smaller than in No. 1786, and there are remnants of old feldspars now mostly occupied by a micro-granulitic mass of fresh feldspar grains, the original orientation being sufficiently preserved, in some cases, to show the change that has taken place. A small amount of *quartz* can be seen to surround, occasionally, the small epidotes. Two sections.

Age. Archean (Keewatin).

Remark. If this is a representative of rock of No. 1786, and if that be camptonite, then camptonite is not entirely a dike rock. Again, this rock is quite similar to much of green rock which has been included under the name greenstone, and is allied to the tuffaceous greenstones.

N. H. W.

NO. 1789. ESTERELLYTE(?)

About three-fourths of a mile west of Ely.

Ref. Annual Report, xxii, page 5.

Meg. A knob rising irregularly in the midst of the greenstone, presenting a nearly white color, contrasting with the dark tint of the greenstone. It extends

Greenstone.]

eastwardly somewhat in the manner of a dike for a quarter of a mile, and can be seen along the northern slope of the hill. (Compare No. 2095.)

Mic. In a fine interlocking groundmass of feldspar and (apparently) of quartz are phenocrysts of altered *hornblende* and of *feldspar*, the former evidently derived from some augite (as they have frequently the forms of augite) and remnants of a more highly refractive mineral. Throughout the whole are many *sericite* scales. One section.

Age. Archean (dike?).

Remark. Except that the feldspars are not much twinned, this rock resembles the estereltyte of Kekequabic lake, and it apparently occurs in much the same manner. It is, unfortunately, as seen in the slide examined, much altered by weathering.

N. H. W.

NO. 1790. GREENSTONE.

North from the Chandler mine, Ely.

Ref. Annual Report, xxii, page 5.

Meg. Appearing rather massive, but pitted with depressions, like amygdules, filled with a dark-green mineral.

Mic. The supposed amygdule cavities are altered *pyroxenes*. They are not wholly changed, but retain enough of their original substance to show their orientation, which is negative, according to Lacroix's distinction (*Minéralogie de France*, vol. I, page 568), *i. e.*, the axis n_p is nearer the vertical axis than is n_e , in that respect being like the augite of the porphyry at Kekequabic lake, approaching *agyrrine*. These conspicuous phenocrysts are largely altered to *hornblende* and to *chlorite*, and hornblende spicules and shreds are disseminated through the whole rock, giving it the green color. The feldspathic element is fine, mostly microlitic albite twins, but also interlocking-granular. There is no certainty of any old feldspars absorbed by micro-granulitic encroachment, as the groundmass is evenly constructed of the feldspars already mentioned and the fine hornblendes. There is, however, much *calcite* showing a disengagement of lime. One section.

Age. Archean (Keewatin).

Remark. There is a narrow toothed border of hornblende, as seen in many other instances, projecting beyond the partially altered pyroxenes, while the general form of the pyroxene remains. It suggests that the so-called zoned hornblendes as of the porphyry at Kekequabic lake, are not truly zoned because of secondary growths, but that the difference of polarization colors, and all the contrasting characters are due probably to the difference of surroundings during the single development of a hornblende crystal, *viz.*, that the darker, usually central portion is the space of the original augite, but that beyond the bounds of the original augite

the continued growth of the hornblende was free from the effect of the augite, and took a more perfect hornblende color. All the irregularities of coloration are explicable on this hypothesis, there being allowance made for irregularities and imperfections in the original augites. If this be a correct interpretation, it would follow that such contrasts of color, called "frayed" ends, by G. H. Williams, due to supposed dynamic action, and "secondary enlargements," by Van Hise, are only evidence that the hornblende is derived from an original augite crystal or fragment of a crystal, and that there was but a single period of growth. N. H. W.

NO. 1792. MARBLE.

Near the same place as the last.
Ref. Annual Report, xxii, page 5.

Meg. In the conglomeratic portions of the greenstone, particularly in the matrix surrounding the boulders, is seen coarse quartz with *calcite*, mingled in which are also isolated pieces of some green shale or scale.

Mic. The slide only contains granular *calcite*, a kind of marble. One section.

Age. Archean (Keewatin). N. H. W.

NO. 1793. CONGLOMERATE. (*Irony pebbles.*)

Virginia.
Ref. Annual Report, xxii, page 6. See, also, chapter on the Virginia plate in volume iv.

Meg. "Basal conglomerate, from the bottom of the supposed preglacial gorge, at Virginia. This is of ferruginous pebbles, mingled with dust and dirt of the iron-bearing rocks. It may be of Cretaceous origin. It has a later infiltration of white silica which now forms its principal cementing bond." No section.

Age. Probably the basal beds of the Cretaceous. N. H. W.

NO. 1797. GABBRO (*with orthoclase*).

Duluth.
Ref. Annual Report, xxii, page 6. Compare Nos. 1B, 5, etc., 854G and 854(A)G.

Meg. The rock in general contains numerous small masses of augite syenite, and is therefore accompanied by numerous crystals of orthoclase.

Mic. The section shows both rocks. Along with reddish *orthoclase*, in one portion, are *quartz* and *hornblende*, with idiomorphic apatites of large (microscopic) dimensions, which show distinctly two cleavages, viz.: that transverse to the crystals and that parallel. The other part consists almost wholly of a single feldspar crystal. This also contains similar apatite. It is approximately parallel to 010, having n_c obliquely visible in the interference figure, and showing scant traces of albite maclation, as well as pericline. Its extinction is at 10° on the albite lines (*i. e.*, the cleavage 010) and 55° on the pericline. Neither cleavage is observable, as

Claystones. Gabbro.]

such, and it is impossible to decide the species. It is assumed that the red feldspar in the other portion is mainly orthoclase, but some of the smaller grains are twinned like the albite or Carlsbad type, and may be triclinic. One section.

Age. Cabotian.

N. H. W.

No. 1798. CLAYSTONES (?)

"Siliceous pebbles or claystones from the Keewatin schists or slates about a mile and a half northeast of Otter Creek station, Carlton county, at the highway north of the St. Paul and Duluth railroad."

Ref. Annual Report, xxii, page 6.

Meg. Oval, dark, slate-like masses, which in weathering stand out above the the surrounding schists and are of darker color than these schists on fresh fracture. They may be pebbles or they may be concretions. No section.

Age. Archean (Keewatin).

U. S. G.

No. 1799. GABBRO.

Duluth, at No. 1013 Michigan street.

Ref. Annual Report, xxii, page 6.

Meg. "Pebbles of disintegration."

Mic. The *feldspar* grains are fractured as by dynamic action, and the most of the *augite* is changed to *uralite*; otherwise this seems to be a normal gabbro of the region. One section.

Age. Cabotian.

Remark. There is a thickness of twenty-five feet, visible in the bluff by the street, in which the gabbro is in a state of pebbly disintegration. It may have been caused, as indicated by the condition of this slide, by crushing under dynamic strain, rather than by normal disintegration.

N. H. W.

No. 1801. GABBRO.

Duluth; taken at a point back of Rice's point, where the grand boulevard (running approximately on the upper beach) crosses a small creek, on the west side of the creek.

Ref. Annual Report, xxii, page 6.

Meg. The rock has a gneissic structure.

Mic. There is preserved an ophitic structure, and the feldspar, probably labradorite, is well preserved. The *augite* contains many small grains of *magnetite*, which also forms larger grains elsewhere. *Sphene* in small grains is distributed generally, and *zoisite* in aggregated fine grains is general in the feldspar. A small amount of *hornblende* has taken the place of some of the *augite*. One section.

Age. Cabotian.

N. H. W.

No. 1802. GABBRO.

Duluth; same place as the last.

Ref. Annual Report, xxii, page 6.

Meg. Spotted with dark green, and with red-weathering.

Mic. The dark-green spots are caused by changed *augite*, which has given place to *hornblende* in fine interlacing fibres, which sometimes ramify in a *calcite* matrix. This hornblende is earlier in date than a second highly refractive mineral, which occurs often in the greenstones and in the gneisses, already noted, which much resembles *epidote*. It is light yellow in color, or almost colorless. It not only enters within the hornblende mesh, filling it in a measure similar to that of calcite, but it occurs as small grains within the altered feldspars, accompanying *zoisite*, *calcite* and *sericite*.* A little *apatite* is seen in the feldspars. One section.

Age. Cabotian.

N. H. W.

No. 1805. GNEISS (*with cordierite?*)

Duluth; at a point midway between the dam of the above-mentioned creek and the station of the elevated railway. A large surface exposure of some old metamorphic rock. It is below the crest of the gabbro range, and on the southern slope, but within the general gabbro area. Some of the rock is red and some is blue, or gray, sometimes appearing like a conglomerate holding boulders of quartz and of granite. In some cases the red color shades into the blue, even on the surface.

Ref. Annual Report, xxii, page 7.

Meg. Represents the fine-grained, gray rock.

Mic. The slide is colored by *magnetite*, *hornblende* and by *diopside*, in very fine, roundish grains. The remainder consists of interlocking *feldspars* and probably with *cordierite*. These are all secondary minerals, due to the action of the gabbro on some clastic. There is a capricious distribution of these minerals, especially the magnetite, bunching up in certain areas, or being very fine or nearly absent in others, indicating an irregular, perhaps a pebbly, structure in the original rock. This rock resembles the gneiss of Gabemichigama lake, Nos. 1089, 1090, 1350, 1351. One section.

Age. Animikie(?)

N. H. W.

No. 1806. GNEISS (*with cordierite.*)

Same place as the last.

Ref. Annual Report, xxii, page 7.

Meg. Spotted with small, green areas, appearing amygdaloidal, coarser grained than No. 1805.

Mic. The green areas are *hornblendic* nests. With a little *biotite* and more evident *cordierite*, this rock is not essentially different from No. 1805. One section.

Age. Animikie(?)

N. H. W.

*In order to distinguish between epidote and diopside, as in this slide, it is necessary to find a section which lies perpendicular to the optic plane, *i. e.*, one in the zone of symmetry. The coloration of such a section is very different from the highly colored conspicuous grains. Indeed, when the section is perpendicular, at the same time, to an optic axis, the color disappears entirely, and a dull gray takes its place as viewed between the nicols. It is only by noting the high refractive index that such a grain would be supposed to belong to the same substance. Either a bisectrix or an optic axis is always visible in sections perpendicular to the optic plane, either in pyroxene or in epidote. When found, such an interference figure will show the direction of the optic plane with respect to the longitudinal cleavage, which is then also visible. In case the optic plane is perpendicular to such cleavage the mineral is epidote, as in this instance. If it is parallel with the longitudinal cleavage the mineral is a pyroxene. In this case a peculiar distribution of the high colors of double refraction also shows these grains to be *epidote*. The same surface is at the same instant red, green or yellow, this peculiarity being connected with the powerful dispersion of epidote.

Diabase. Gabbro.]

NO. 1811. DIABASE.

From the vertical cliff forming the west shore of Sickle (Chicago) bay, north shore of lake Superior; S. W. $\frac{1}{4}$ sec. 20, T. 62-4 E.
Ref. Annual Report, xxii, page 7.

Meg. A black, rather coarse-grained diabase (or gabbro), resembling the Beaver Bay diabase. No section.

Age. Cabotian (Beaver Bay diabase?) U. S. G.

NO. 1813. GABBRO.

West side of Double bay, at the point; N. W. $\frac{1}{4}$ sec. 15, T. 62-4 E.
Ref. Annual Report, xxii, page 7.

Meg. A coarse-grained, dark-gray gabbro, possibly containing olivine, with large crystals of augite. No section.

Age. Cabotian (Beaver Bay diabase?) U. S. G.

NO. 1814. GABBRO. (*Ophitic.*)

From the hill range at Double bay, at the west end of the near hills.
Ref. Annual Report, xxii, page 7.

Meg. Rather coarse grained and gabbro-like.

Mic. Owing to considerable alteration, due, apparently, to long weathering, this rock presents some interesting features. While a part of the *augite*, in large plates, showing an ophitic relation to the feldspar, is perfectly preserved, other grains have been changed entirely, and, along with an accompanying alteration in the olivine, there have resulted considerable *prehnite*, *epidote* and *antigorite*. The *feldspars* have also lost their integrity and some interstitial parallel growths have formed, some being apparently new feldspars, and others an undetermined zeolite(?). At the same time the titanite present has taken the *sagenite* structure of *rutile*, and within the mesh, as well as elsewhere throughout the slide, appears *leucoxene*. The *prehnite* encloses the *epidote* ophitically, the latter being in form of small idiomorphic crystals. One section.

Age. Cabotian. N. H. W.

NO. 1814A. GABBRO.

"White-weathering lumps and patches in No. 1814."
Ref. Annual Report, xxii, page 7.

Meg. Rock in general similar to No. 1814. The feldspars are white, perhaps saussuritized. No section.

Age. Cabotian. U. S. G.

Remark. Nos. 1814 and 1814A illustrate the manner of segregation of the feldspars from the rest of the rock into irregular masses and groups, causing a remarkable petrologic variation, indicating the possible origin of all the "anorthosite" masses.

N. H. W.

NO. 1824. BASALT. (*Zirkelyte.*)

Within the bay next east of Red Rock point, on the coast of lake Superior.
Ref. Annual Report, xxii, page 8.

Meg. Shaly looking, thin bedded.

Mic. The fine feldspars, which are somewhat altered, containing *sericite* scales, lie in a matrix consisting largely of devitrified glass, which is darkened by fine *magnetite* and by *leucoxene*, and contain, also, *augite*(?) and *calcite*, with a little quartz. One section.

Age. Cabotian lava.

N. H. W.

NO. 1825. BASALT. (*Zirkelyte with olivine.*)

Same place as the last.
Ref. Annual Report, xxii, page 8.

Meg. The same rock as No. 1824, but having a spotted aspect.

Mic. This differs from No. 1824 only in having fine *olivine* phenocrysts which, however, are entirely altered to a fine, greenish substance, which is probably some variety of *antigorite*. One section.

Age. Cabotian.

N. H. W.

NO. 1826. BASALT. (*Amygdaloidal.*)

Phase of No. 1824; same place.
Ref. Annual Report, xxii, page 8.

Meg. Rock like No. 1824, but containing numerous amygdules. These have a bluish-green coating, and inside of this coating are at times several minerals and at times only one. The common minerals are quartz, calcite, laumontite and thomsonite. No section.

Age. Cabotian.

U. S. G.

NO. 1826A. AMYGDULES.

From No. 1826.
Ref. Annual Report, xxii, page 8.

Meg. A collection of amygdules from No. 1826, most of them being of quartz. No section.

Age. Cabotian.

U. S. G.

NO. 1827. QUARTZYTE. (*Contact of gabbro.*)

Southern face of mount Josephine, 500 feet above lake Superior.
Ref. Annual Report, xxii, page 8.

Meg. Reddish, quartzitic.

Mic. The most of the rock is *quartz* in large grains that interlock with each other, though having in general a roundish outline. There is no trace of clastic characters, but nearly every grain is thickly sprinkled with minute spicules, like

Diabase. Gabbro. Quartz-porphyrty.]

double-pointed needles, which are visible in high power as tiny scales by reason of their brightness when not parallel with either nicol. They cannot be determined specifically, but if they be not impurities in the balsam, they may be some form of *mica*. The *feldspar* is reddened by hematite, but is in part a triclinic form. *Sphene*, *hornblende*, *biotite* and *pennine* are accessory. One section.

Age. Wauswaugoning quartzyte, of the Animikie.

N. H. W.

NO. 1828. DIABASE.

Concerned in the metamorphism of No. 1827; same place.

Ref. Annual Report, xxii, page 8.

Meg. Dark, basic, intrusive.

Mic. *Augite* is ophitic in its relation to the feldspars. The same is true of the olivine, which is abundant. This rare feature has been noted several times before (compare Nos. 258, 512, 560, 1275, 1829, and others). The olivine, however, is somewhat altered to *antigorite*, while *magnetite*, *quartz*, *biotite* are more or less accessory. One section.

Age. Cabotian.

N. H. W.

NO. 1829. GABBRO.

"Average rock of the top of mount Josephine, north shore of lake Superior, near the west side of sec. 2, T. 63-6 E."

Ref. Annual Report, xxii, page 8.

Meg. A rather fine-grained, gray gabbro, composed of feldspar, augite and magnetite, with perhaps olivine.

Mic. This rock resembles No. 1828 in having both *augite* and *olivine*, ophitic in relation to the feldspars, but the slide contains no quartz. The *augite* occasionally shows indications of being later than the olivine, which, having n_p in the acute optic angle has the diagnostic character which distinguishes *fayalite* from ordinary olivine. Round the borders of the magnetite is occasionally a brown *biotite*, and some of the feldspar is penetrated along its planes of albite twinning by a microperthitic alteration of another mineral having rather high double refraction and a refractive index higher than the original feldspar, whose nature is undetermined. The relation of the olivine and feldspar is shown by figure 1, plate V. One section.

Age. Cabotian.

N. H. W.

NO. 1830. QUARTZ-PORPHYRY.

"Redrock,' kind of quartz-porphyrty, from a hill northwestward from mount Josephine, where it forms an irregular patch elongated about east and west; visible on the southern slope of the gabbro range."

Ref. Annual Report, xxii, page 8.

Meg. A gray rock, with a fine-grained, granitic groundmass and porphyritic crystals of quartz and pink feldspar. Intimately associated with the quartz-porphyrty

is a fine grained, dark, greenish-black rock looking like a diabase. From the hand specimen it would seem as if this dark rock was included as fragments in the quartz-porphyry, but it may possibly cut the porphyry as an irregular dike. No section.

Age. Cabotian.

U. S. G.

NO. 1831. CONGLOMERATE.

Northeast side of Grand Portage island, north shore of lake Superior; S. E. $\frac{1}{4}$ sec. 10, T. 63-6 E.

Ref. Annual Report, xxii, page 8. See, also, American Geologist, vol. xiii, pages 437-439; vol. xvi, pages 150-162.

Meg. A coarse sandstone, containing many pebbles, the most important of which are quartz, red granitic rock, quartzite and gray and greenish slaty rock. No section.

Age. Puckwunge or Potsdam (bottom conglomerate).

U. S. G.

NO. 1832. TUFF.

East side of Grand Portage island; the upper portion of the same sandstone which is intercalated between trap beds.

Ref. Annual Report, xxii, page 8.

Meg. Darker and finer-grained portion of the sandstone.

Mic. The *quartz* grains are entirely angular; and are mingled with a few grains of *feldspar* and of devitrified *glass*. These all lie in a brown, rusty background which itself is apparently a devitrified glass of varying grain.

Age. Manitou.

N. H. W.

NO. 1833. ZIRKELYTE.

From the very top of No. 1832, where it is in contact with the overlying trap sheet.

Ref. Annual Report, xxii, page 8.

Meg. Nearly black, fine grained.

Mic. The specimen seems to have been taken actually from the bottom part of the trap sheet, as it contains no fragmental stuff. It is wholly of the igneous material. It is either glassy and very dark with magnetite, or finely sub-crystalline with the elements of a diabase, amongst which feldspars are distinct, but the augite and olivine have been almost entirely replaced by *uralite*, *calcite* and *limonite*. One section.

Age. Manitou.

N. H. W.

NO. 1834. BASALT. (*Globular.*)

From the top of Grand Portage island, north shore of lake Superior; S. E. $\frac{1}{4}$ sec. 10, T. 63-6 E.

Ref. Annual Report, xxii, page 8.

Meg. Same as No. 544. No section.

Age. Manitou.

U. S. G.

Basalt. Quartz-porphyr. Quartzite.]

NO. 1834A. BASALT.

Same place as No. 1834.

Ref. Annual Report, xxii, page 8.

Meg. A collection of the spherical masses from No. 1834. See under No. 544.
No section.

Age. Manitou.

U. S. G.

NO. 1834C. QUARTZ-PORPHYRY.

From a hill rising about 600 feet above lake Superior, about a mile and a half from Grand Portage village and on the west of the Grand Portage trail. Perhaps in sec. 31, T. 64-6 E.

Ref. Annual Report, xxii, page 9.

Meg. Red, fine-grained, granitic rock, with phenocrysts of quartz and red feldspar. The specimen resembles closely the porphyritic phase of the "red rocks" found on Pigeon point. No section.

Age. Cabotian.

U. S. G.

NO. 1838. QUARTZYTE. (*Metamorphic.*)

Foot of mount Josephine, head of Wauswaugoning bay.

Ref. Annual Report, xxii, page 9.

Meg. Upper portion of the Wauswaugoning quartzite, gray, fine grained, somewhat colored like the slates, spotted with light red, pink, or even green, depending on the character of the incipient re-crystallization.

Mic. Consists very largely of *quartz*, which has lost its elastic characters under the influence of the basic intrusives of the place, only showing the original outlines of the grains by curving bands of opaque inclusions. The red material is *feldspar*, as shown by an occasional interference figure of a biaxial character. This material composes perhaps one-fifth part of the whole, while *hornblende*, *pennine* and *epidote* are occasional, the first most common. Two sections.

Age. Animikie.

N. H. W.

NO. 1839. QUARTZ-PORPHYRY.

Same place as Nos. 1837 and 1838, appearing in patches in No. 1838.

Ref. Annual Report, xxii, page 9.

Meg. Very fine-grained, reddish rock, with phenocrysts of quartz and pinkish feldspar. No section.

Age. Cabotian.

U. S. G.

NO. 1841A. QUARTZYTE. (*Spotted.*)From the beach near the head of Morrison bay, Pigeon point; N. E. $\frac{1}{4}$ sec. 32, T. 64-7 E.

Ref. Annual Report, xxii, page 9.

Meg. There are several specimens, varying somewhat, but in general they are fine-grained, hard, gray quartzites, with spherical areas, one-fourth to one-half inch

in diameter, which are green, rather soft and weather out more rapidly than the rest of the rock. No section.

Age. Animikie.

U. S. G.

NO. 1842. QUARTZYTE. (*Metamorphosed.*)

Pigeon point, one-half mile west of Little Portage bay (*i. e.*, where Pigeon point is narrowest).
Ref. Annual Report, xxii, page 9.

Meg. At this point the axis of the peninsula is composed of a dark-greenish, but spotted, modified quartzite, the spots being coincident with or caused by poikilitic crystals of some rock-making mineral, apparently some feldspar.

Mic. While interlocking quartz makes up the greater portion of the slide, a considerable area is also occupied by *delessite*, by *feldspar (orthoclase)*, by *actinolite*, and by a yellowish-brown mineral which has the form represented by the figures attached. This mineral has an irregular cleavage or lamello-fibrous structure in the plane of which lies the axis n_g . It affects hexagonal outlines when entire, but is frequently elongated in the direction of n_g . Its absorption is faint but distinct, and is greatest when the lower nicol coincides with n_g . In the identifiable optic characters, except coloration, it well agrees with the usual characters of *biotite*.

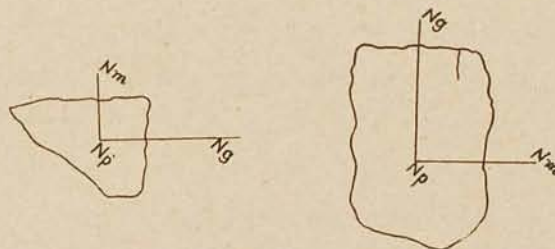


FIG. 47. YELLOWISH-BROWN BIOTITE IN NO. 1842.

Quartz is sometimes in micro-pegmatitic relation with the feldspar, and the latter in large reddened crystals sometimes embraces all the other minerals poikilitically. One section.

Age. Animikie.

N. H. W.

NO. 1845. QUARTZYTE. (*Metamorphosed.*)

From the red knob rising near the south shore of Pigeon point a little west of Little Portage bay.
Ref. Annual Report, xxii, page 9.

Meg. Quartz keratophyre (Bayley). The knob exhibits various conditions of this quartzite.

Mic. The section shows granular *quartz* and spherulites of *orthoclase*, with *hornblende* and *delessite*. One (thick) section.

Age. Cabotian.

Remark. This is a phase of the "red rock," and acts like a Cabotian intrusive, and at other places forms lava flows under favorable conditions.

N. H. W.

Calcite. Pseudamygdaloid.]

NO. 1846. CALCITE. (*Cone-in-cone.*)

From the slates on the south side of the tongue which divides Pigeon bay into north and south arms.
Ref. Annual Report, xxii, page 9.

Meg. Septaria-like masses, weathering from the slates, having a cone-in-cone vertical structure.

Mic. The *calcite* stands with its vertical axis about in agreement with the directions of the cone structure, but it is clouded by dark impurities which are abundant along the cleavages and are much thickened along the undulating or mammillated planes of separation between the individual cones. Two (thick) sections.

Age. Animikie.

Remark. When collected this substance was presumed to show possibly some trace of organic structure. It was submitted to Profs. John M. Clark and G. F. Matthew, and they concur in the opinion that no organic structure is visible.

N. H. W.

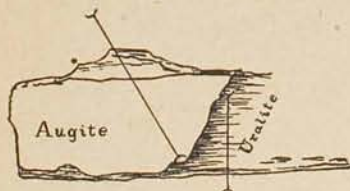
NO. 1847. PSEUDAMYGDALOID.

At the eastern end of the outer and eastern of the Lucille islands (Magnet island).
Ref. Annual Report, xxii, page 9; Final Report, vol. iv, page 516.

Meg. The green spots give this rock an amygdaloidal aspect. It is rather coarse grained.

Mic. It is due to alteration that this rock has acquired conspicuous *delessite* areas and a partial uralitization of the *augite*. This *uralite* appears as a sharp fringe, with fine fibrous structure, growing out from the *augite* in precisely the same manner as the fringes of secondary growth, so-called, in the hornblendes of the porphyry at Kekequabic lake, and in several other similar hornblendic rocks. It is particularly well illustrated in the description of some dikes on Stuntz island (Nos. 380, 872), where some figures may be seen. It has already been suggested that these fringes are neither "frayed out" ends of the hornblende as suggested by Williams, nor secondary growths as supposed by Van Hise, but that they show the growth of the hornblende beyond the original limits of the *augite* grains, the difference of absorption and of polarization colors being due in some way to the effect of the *augite* form in the body of the resultant hornblende.

In rock No. 1847 this hypothesis is demonstrated, for many of the *augites* have



Growth of Hornblende upon Augite.
 FIG. 48. HORNBLENDIC FRINGE ON AUGITE.

this fringe, while they are not yet wholly converted into hornblende, each mineral having its characteristic extinction, angle and colors of double refraction, as illustrated by the diagram below. This shows that a fringe of hornblende is formed about the *augite* before the *augite* is changed materially, and that the fringe is older than the hornblende which later replaces

the augite itself, and that instead of being later formed, as presumed by either of the above hypotheses, it is really first formed. At the same time the augites in this rock are occasionally somewhat zoned. One section.

Age. Cabotian(?)

N. H. W.

NO. 1848. GABBRO.

Same place as the last.

Ref. Annual Report, xxii, page 9.

Meg. Massive, pyroxenic rock, apparently in form of a dike cutting No. 1847.

Mic. This rock is quite like the last, which indicates it was cotemporary with it. The *augite* is partly altered to *hornblende*, showing narrow fringes of the latter extending beyond the augite boundaries. There are also small areas of hornblende isolated wholly from all augite. Such are frequently ensconced in a patch of green alteration products which may be *delessite*, and narrow needles are scattered in the same material, accompanied by *epidote*. The augite is frequently twinned on 100. *Olivine*, which is wholly changed, remains only in the shape of sub-rounded masses of green (*antigorite?*), which are often wholly surrounded by a single augite crystal. The feldspars are likewise so altered that they can hardly be discerned. It is apparent that there were no feldspars of the first consolidation, the only feldspathic forms visible being quite small, and mingled with the alteration products. As the augites are substantially idiomorphic, embracing only the older olivines, and impinging only on each other, they seem to have been earlier to form than any feldspars, which gives the rock one of the characters which, by some, has been considered essential to the rock gabbro. It certainly was not ophitic. One section.

Age. Cabotian(?)

N. H. W.

NO. 1849. GABBRO.

Dike cutting the same island diagonally.

Ref. Annual Report, xxii, page 10.

Meg. Porphyritic with feldspar.

Mic. The older *feldspars* are not abundant, and the small *augites* were about cotemporary, or slightly earlier than, the second generation of feldspar. In the older crystals, sections perpendicular to n_x have an angle of extinction on the basal cleavage of 9° to 12° , n_x being the acute bisectrix, indicating an *andesine*, with a tendency toward labradorite. Such crystals are in general clouded by alteration, and occasionally indistinctly zoned. The small feldspars, however, are almost without exception zoned, the central parts being charged with *sericite*. The *augite* is very largely uralitized and the *olivine* serpentized, and magnetite accompanies these alteration products. This rock was in part ophitic, as now revealed by the distribution of the alteration products of the augite, showing also two periods of formation of augite. One section.

Age. Manitou(?)

N. H. W.

Quartzite and black slate. Red granite.]

NO. 1852. QUARTZYTE AND BLACK SLATE.

Governor's island, at the mine (or shaft) of the Pigeon Point Silver and Copper Mining company; south side of the island.

Ref. Annual Report, xxii, page 10.

Meg. Quartzite and slate in sedimentary succession. It is apparent that while the shaft started in hardened slate at the surface, the excavation struck red quartzite and finally red granite.

Mic. The quartzite is wholly recast into an interlocking, almost granitic, reddish rock, largely composed of *quartz*, but holding, in the interstices between the grains, occasionally a dirty feldspathic element, which probably is accountable for the reddish color of the rock. This element composes in some places nearly one-quarter of the rock, and it is interlocked with the secondary quartz grains. It is so crowded with fine inclusions that it cannot be determined specifically. Its extinctions are vague and not to be measured. Its inclusions are *hematite*, fine and dust-like, *actinolite*, *tourmaline* and a highly refractive, glassy-transparent mineral in isolated occasional grains resembling sphene in all respects, so far as determinable, except in having a double refraction much lower than that of sphene. One of the larger grains, giving an axis of elasticity perpendicular, thus showing the direction of the axial plane, indicates *epidote*. Still other scattered grains are undoubtedly *sphene*. These characters appertain to the quartzite portion of the rock.

The "black slate" portion is colored by very fine *biotite*, but also contains *sericite*. These lie in a very fine background of micro-granulitic feldspar which is only occasionally discernible by reason of the great number of the little biotites. With the biotites are seen occasionally *tourmalines* almost equally small, distinguished easily between crossed nicols by their lower birefringence, and with the upper nicol removed by their greater absorption in a direction the opposite of that of the biotites. Two sections.

Age. Animikie.

Remark. This rock is wholly recrystallized, the sandstone is a quartzite granitized, and the black slate is a mica schist.

N. H. W.

NO. 1853. RED GRANITE.

From the bottom of the shaft, same place as No. 1852.

Ref. Annual Report, xxii, page 10.

Meg. Red granite, medium grained.

Mic. This rock is like the quartzitic portion of the last, except in being more coarsely crystalline, and hence more easily examined. The feldspar is prevailingly of *orthoclase*, and zoned, but some of it shows both albite and pericline twinning. The central portions of the larger crystals are frequently more affected by alteration

than the peripheral, and in the peripheral portion quartz shows itself in vermicular outlines. The slate shows no tourmaline, but there is a little *sphene*, *leucoxene* and *epidote*. One section.

Age. Cabotian.

Remark. In this red granite, as is frequent, there are visible traces of the elements of the basic intrusives (gabbro, etc.). These consist of sphene, leucoxene and the triclinic feldspars, and this fact seems to illustrate the principle which is common in these contact rocks that the acid elements of the clastic rocks permeate and easily destroy the elements of the gabbro, while the gabbro elements are more slow to enter the acid rock.

N. H. W.

NO. 1855. GABBRO.

About one mile west of the west point of Grand Portage bay. From a dike forming a little point at the Lake Superior shore.

Ref. Annual Report, xxii, page 10.

Meg. Evidently a basic and diabasic rock.

Mic. The *augites* and *olivines* were earlier than the *feldspars*. The rock has somewhat decayed, so that the olivine is principally changed to a yellowish serpentine or *antigorite*, and *leucoxene* appears in small quantity, while *calcite* and *quartz* have entered, the latter in form of a somewhat vermicular micro-pegmatyte in the feldspar. One section.

Age. Manitou(?)

N. H. W.

NO. 1856. AMYGDALOID.

Cut by the dike No. 1855.

Ref. Annual Report, xxii, page 10.

Meg. Over large areas this rock shows a distinct cellular structure.

Mic. The slide shows simply a much altered diabase, in which the augite which was ophitic in its relation to the small *feldspars* has been entirely changed to a greenish, isotropic so-called chloritic, substance, while much calcite has been isolated in abundant, irregular bunches, and larger, irregular spaces are occupied by a finely granular material which cannot be completely separated, but apparently consists of the same chloritic substance in large part, through which are disseminated minute polarizing grains resembling *feldspar* and *quartz*, with *leucoxene* and *magnetite*. One section.

Age. Cabotian(?)

N. H. W.

NO. 1860. APORHYOLYTE. (*Amygdaloidal.*)

South town line of T. 62-1 E., where the new road from Grand Marais crosses it.

Ref. Annual Report, xxii, page 10.

Meg. Porphyritic with quartz, and also amygdaloidal.

Aporhyolyte. Diabase.]

Mic. A part of the slide is occupied by interlocking fine *quartzes*, or quartz and *feldspar*, through which are disseminated a few small areas in which a multitude of fine polarizing spicules are grouped—altered hornblendes or feldspars. In this part appear the bipyramidal quartzes of the first consolidation. This part is encroached on by a spherulitic arrangement which is more stained by *hematite*, and in which is a more evident rhyolitic structure. In this part were originally phenocrysts of feldspar (and one of *sphene*) and amygdaloidal cavities, evinced by the forms now left. These forms are now occupied by secondary products, or are empty, owing to the extreme thinness of the slide. This part is wholly rusty with iron oxide, which, however, is so disposed as to reveal numerous minute skeleton crystals whose nature is unknown, as they are now evident only by the peculiar but regular distribution of the iron oxide in varying amounts. There are also lines of iron oxide which were formed by the accumulations concentrating in cracks as the glassy substance rapidly cooled. One section.

Age. Cabotian.

Remark. It is an interesting fact that here the "red rock" series, porphyritic with quartz and feldspar, probably comparable with the rock of the "Great Palisades," exhibits both porphyritic and amygdaloidal structures, showing that it flowed as a lava at the surface. The source from which the red rock supply was derived was hence a large one, and the clastic materials which supplied it were probably from a deep source, involving formations older than the Animikie.

N. H. W.

NO. 1863. DIABASE. (*Basaltic?*)

North side of Brulé lake, at the portage north to Lost lake.

Ref. Annual Report, xxii, pages 10, 11.

Meg. Dark gray or reddish weathering, holding phenocrysts of feldspar.

Mic. The groundmass in general and especially the small feldspars are reddened by iron oxide, and the augite is wholly altered to *hornblende*, but these hornblendes are long and needle-shaped, without any preservation of the ophitic structure, if such ever existed. At the same time many rather large spicules of *magnetite* unite with the *feldspars* and the hornblendes in giving the rock a decidedly "radiated" structure. At the same time the large phenocrysts of feldspar are so altered to kaolin that they are wholly unidentifiable specifically. One section.

Age. Cabotian.

N. H. W.

NO. 1864. DIABASE. (*Basaltic?*)

South shore of Brulé lake; S. W. $\frac{1}{4}$ sec. 13, T. 63-3 W.

Ref. Annual Report, xxii, page 10.

Meg. Porphyritic.

Mic. This rock is quite like the last, but the *magnetite* needles are arranged rather uniformly in one direction, as if due to a prevalent original structure. This

and the characters of the hornblendes, as well as the confused aspect of all the minerals interstitial between the large phenocrysts, carries the impression that this rock at first was largely composed of zirkelyte. There is no evidence of orthoclase in the rock, but the old feldspars are wholly triclinic and quite likely of labradorite. They enclose considerable epidote. One section.

Age. Cabotian.

N. H. W.

NO. 1867. GABBRO (*with orthoclase*).

S. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$ sec. 24, T. 63-3 W.; south of Brulé lake.

Ref. Annual Report, xxii, page 10.

Meg. A medium-grained, gray, granitic rock, composed of whitish to reddish feldspar, augite, hornblende and magnetite. No section.

Age. Cabotian.

U. S. G.

NO. 1869. GABBRO (*with orthoclase*).

South side of the island in N. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$ sec. 24, T. 63-3 W.; Brulé lake.

Ref. Annual Report, xxii, page 11.

Meg. A rock similar to No. 1867, but considerably finer grained.

Age. Cabotian.

U. S. G.

NO. 1870. GABBRO.

East end of the island, S. W. $\frac{1}{4}$ N. E. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 13, T. 63-3 W.; Brulé lake.

Ref. Annual Report, xxii, page 11.

Meg. Medium-grained rock, rich in feldspar.

Mic. The *augite* preceded or was cotemporary with the *feldspars*. *Olivine* is nearly lost in a serpentinous decay, and the feldspars, which are coarse and compose the most of the rock, are also much altered. One section.

Age. Cabotian.

N. H. W.

NO. 1874. GABBRO.

South side of a small lake, N. E. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 17, T. 63-2 W., near Brulé lake.

Ref. Annual Report, xxii, page 11.

Meg. Dark porphyry.

Mic. The large feldspars, by their extinctions, seem to approach *andesine*, but the rock is not noticeably different from No. 1870. One section.

Age. Cabotian.

N. H. W.

NO. 1876. KERATOPHYRE (?)

N. E. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 20, T. 63-3 W., Brulé lake.

Ref. Annual Report, xxii, page 11.

Meg. Dark, compact, fine grained, with a tendency to reddish color. Small dark areas of crystalline material, surrounded by a vein of red which grades into the rest of the rock, are common.

Basalt. Diabase.]

Mic. Fine, angular *quartz* grains, sometimes interlocking, and occasionally rising to larger size, representing bipyramidal crystals, lie in a finer matrix of about the same materials. There are roundish spots of larger size, with iron-stained peripheries, now occupied with *pennine* which may have the nature of amygdaloidal cavities. A few small crystals and parts of crystals of a triclinic feldspar are disseminated through the fine matrix. There are visible in the slide a few small grains of *sphene*, also others of *ilmenite*, partly altered to *leucoxene*, and of *epidote* and *apatite*. One section.

Age. Cabotian(?)

Remark. The nature and origin of this rock it is difficult to establish by the microscope alone. It may be, however, composed of a mingling of the basic and acid elements.

N. H. W.

NO. 1879. BASALT.

On a small island in N. W. $\frac{1}{4}$ S. E. $\frac{1}{4}$ sec. 18, T. 63-3 W., Brulé lake.

Ref. Annual Report, xxii, page 11.

Meg. Black rock, so-called.

Mic. The structure of this rock is very dense and indistinct, and is further obscured by alteration, while considerable *magnetite* is a cause of its dark color. It seems to have been to some extent a basic *glass*. With the exception of some traces of the early *feldspars*, nothing of its original composition remains, but *hornblende*, *epidote*, *sericite*, *chlorite*, have taken its place. One section.

Age. Cabotian.

N. H. W.

NO. 1880. BASALT.

Western outlet of Brulé lake, N. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$ sec. 18, T. 63-3 W.

Ref. Annual Report, xxii, page 11.

Meg. Spotted phase of the rock No. 1879.

Mic. This rock is more altered to *epidote*, which appears in the areas formerly occupied by the supposed basaltic glass, and hornblende is almost wanting. One section.

Age. Cabotian.

N. H. W.

NO. 1881. DIABASE. (*Coarse.*)

In a low ridge crossing the trail from Brulé lake, S. W. $\frac{1}{4}$ N. W. $\frac{1}{4}$ sec. 18, T. 63-3 W., apparently in the form of a dike.

Ref. Annual Report, xxii, page 11.

Meg. Apparently fine-grained, "pepper and salt" rock.

Mic. The *augite* is in large ophitic crystals embracing both olivine and feldspar, while the olivine in a few instances gives place to the feldspar, and is also occasionally altered to serpentine. One section.

Age. Cabotian.

N. H. W.

NO. 1882. SYENYTE.

From the precipitous cliff on the eastern side of the hill rising at the southwest corner of sec. 8, T. 63-3 W., Brulé lake.

Ref. Annual Report, xxii, page 11.

Meg. Fine-grained, red, granitic rock, with some sub-porphyrific feldspars and hornblendes. No section.

Age. Cabotian.

U. S. G.

NO. 1883. DIABASE.

N. E. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 17, T. 63-3 W., Brulé lake.

Ref. Annual Report, xxii, page 11.

Meg. Fine grained, dense, nearly black.

Mic. In a fine, much changed groundmass of secondary consolidation are a few phenocrysts of feldspar of the primary consolidation. It is only possible to say that the rock is a phase of the basic eruptives of the region, rather than a clastic, for which purpose the collection was made. One section.

Age. Cabotian.

N. H. W.

NO. 1884. DIABASE.

N. W. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 16, T. 63-3 W., Brulé lake.

Ref. Annual Report, xxii, page 11.

Meg. Similar to the last, but weathering reddish.

Mic. Somewhat coarser and fresher, yet having considerable *calcite* and *epidote* and *zoisite* as products of alteration. One section.

Age. Cabotian.

N. H. W.

NO. 1885. DIABASE.

From an island in Brulé lake, lying off the easternmost point in S. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$ sec. 10, T. 63-3 W.

Ref. Annual Report, xxii, page 11.

Meg. Resembling amygdaloid, the spots sometimes being one-half an inch in diameter. The rock is also porphyritic with feldspar.

Mic. Still coarser than the last, the feldspars of the second consolidation being divergent. This rock was at first probably in part glassy, but the *glass* has been replaced by products of alteration, such as *hornblende*, *calcite*, *epidote*, *magnetite*, *hematite* and *chlorite*. One section.

Age. Cabotian.

N. H. W.

NO. 1888. BASALT.

N. E. $\frac{1}{4}$ sec. 18, T. 63-3 W., Brulé lake, in the hills west of the lake.

Ref. Annual Report, xxii, page 12.

Meg. Black, fine, apparently with fine quartz grains, slaty.

Mic. This rock is similar to several others collected about Brulé lake, but was evidently more quickly cooled, and at first must have contained a considerable glass, which is now replaced by some of the minerals enumerated under No. 1885. One section.

Age. Cabotian.

N. H. W.

Basalt. Diabase. Graphic granite.]
Quartzite.

NO. 1889. BASALT.

At the Temperance river outlet of Brulé lake.*
Ref. Annual Report, xxii, page 12.

Meg. A dark, heavy, fine-grained rock, with pseudamygdaloidal spots.

Mic. The dark-greenish spots are occupied by the well-known "chloritic substance," mingled with which is more or less of *magnetite*, *calcite*, *epidote*, *sphene*; epidote sometimes constituting the largest part. One section.

Age. Cabotian.

N. H. W.

NO. 1890. DIABASE.

Same place as No. 1889. Cut by veins of red granite.
Ref. Annual Report, xxii, page 12.

Meg. A rather fine-grained diabase, with a little pinkish feldspar. No section.

Age. Cabotian.

U. S. G.

NO. 1891. GRAPHIC GRANITE.

At the spur of the Port Arthur, Duluth and Western railroad, near the camp of the Gunflint Iron mine at the cut near Cross river; S. W. $\frac{1}{4}$ S. E. $\frac{1}{4}$ sec. 27, T. 65-4 W.
Ref. Annual Report, xxii, page 12.

Meg. Forms veins and patches in the gabbro.

Mic. The large crystals of quartz and of an altered feldspar form a coarse pegmatyte. The feldspar is an acid plagioclase. Illustrated by plate V, figure 2. One section.

Age. Cabotian.

N. H. W.

NO. 1892. DIABASE.

From an eighteen-inch dike cutting the gabbro on the railroad; S. E. $\frac{1}{4}$ N. W. $\frac{1}{4}$ sec. 27, T. 65-4 W.
Ref. Annual Report, xxii, page 12.

Meg. The specimen shows nearly half the width of the dike. The rock is a black, dense diabase, which at the edge of the dike is very fine grained, almost glassy. No section.

Age. Cabotian.

U. S. G.

NO. 1895. QUARTZYTE. (*Garnetiferous.*)

At the Gunflint iron mine (Paulson's camp).
Ref. Annual Report, xxii, page 12.

Meg. Cinnamon-colored mineral, is connected with the pyrite.

Mic. The section consists of granular *quartz* and *garnet*, the former being a part of the well-known iron-bearing quartzite (Pewabic) underlying the gabbro, and the latter an accidental accompaniment. There are secondary minerals, but the garnet surrounds the quartz, and composes nearly one-half of the slide. It is also fresh,

*Brulé lake has an outlet at each end, one passing to Brulé river and one to Temperance river. At the time of our visit, in midsummer, they were both flowing. Compare *American Geologist*, xix, pp. 407-411, 1897.

glassy, but tinted with a faint tint of rose red. It has no cleavage nor optical anomalies, but irregular fissures cross it in all directions. Apparently one crystal mass extends continuously over the whole slide. There are also a few small spherules of *delessite* or *thuringite*. One section.

Age. In the Pewabic(?) quartzite.

Remark. It is impossible to distinguish the species of this garnet, but its most obvious characters seem to indicate either *pyrope* or *almandine*. Chemical analysis only will determine the species.

N. H. W.

NO. 1896. BLACK SLATE.

S. W. $\frac{1}{4}$ sec. 21, T. 65-4 W., near Paulson's camp.

Ref. Annual Report, xxii, page 12.

Meg. Fine grained, magnetited, much crumpled, bedded, or sheeted. This is an isolated ridge of the Animikie(?) separated from the main mass by a high greenstone range of Keewatin rocks.

Mic. In a background of fine interlocking quartz and feldspar are much *magnetite*, and considerable *cummingtonite*,* these all being in fine grains, having a tendency to globular shapes. At the same time occasional crystals of some pyroxene of much larger size embrace all the foregoing, poikilitically, including also numerous globules that appear to be of the same pyroxene, though having independent orientation. One section.

Age. Perhaps jaspilitic slate of the Keewatin.

Remark. While this rock is supposed to be a part of the Animikie, and grades petrographically into the iron-bearing quartzite at the mine about a mile further south, which is the ore of the region, yet it grades into the rocks (in the field work often called muscovado) that resemble muscovadyte, and apparently into the true muscovadyte which is a phase of the gabbro. Further study is needed in order to separate, in this case, the modified Animikie from the modified Keewatin. N. H. W.

NO. 1898. DIABASE.

From the hill at the west side of the outlet from South Fowl lake.

Ref. Annual Report, xxii, page 12.

Meg. From the central part of the well-known dike which cuts the hill vertically, visible in the cliff.

Mic. The original *augites*, which preceded the feldspars, have been altered in large part to a greenish, obscure, hornblendic substance. In general, however, throughout the slide, there is a curious intergrowth of *hornblende* and *pyroxene*, each having its characteristic extinction angle, the pyroxene being most frequently plainly enveloped by the hornblende, as described in No. 1899. One section.

Age. Manitou(?)

N. H. W.

* This is the mineral frequently known as *grünerite*, after the determination of Lane and Sharpless, but which, according to the comparative analyses, as given by Hintze, should be called *cummingtonite*.

Zirkelyte. Diabase. Conglomerate.]

NO. 1899. ZIRKELYTE.

At the west side of the outlet of South Fowl lake, from the hill at the creek.
Ref. Annual Report, xxii, page 12.

Meg. From the margin of the conspicuous dike which cuts vertically the trap hill.

Mic. The section consists largely of devitrified magma *glass*. But, arranged in a divergent manner, are fine, elongated crystals of a feldspar and of a composite element, which, according to its extinction angles, consists of *hornblende* and *pyroxene*. These fine elongated crystals, when viewed with high power, have two angles of extinction, viz., the central portion, which is somewhat dimmed by decay, at 5° to 10°, and the peripheral portion, which is fresh, at about 45°. The elongation and general habit are amphibolic, and it may be supposed that after the formation of the hornblendes, which was about cotemporary with that of the feldspars (as they mutually cut each other), a change in the environment and in the composition of the magma caused a zone of pyroxene to envelop them. On the other hand the hornblentic cores may be due to alteration of original pyroxene. One section.

Age. Manitou(?)

N. H. W.

NO. 1900. DIABASE.

Same place as the last.
Ref. Annual Report, xxii, page 12.

Meg. Sample representing the rock of the hill, remote from the dike.

Mic. The ophitic structure is evident in some parts, but at the same time some of the *feldspars* were later than the final crystallization of the *augite*, for they are broken about their margins by the *augite*. There is no visible *olivine*, probably because of alteration by weathering, which is apparent in all the minerals. One section.

Age. Cabotian(?)

Remark. This is called diabase, because of the ophitic structure, but it is supposed to be a portion of the great gabbro mass of the Cabotian, which frequently does not show the ophitic structure.

N. H. W.

NO. 1901. DIABASE.

Same place as the last.
Ref. Annual Report, xxii, page 12.

Meg. Sample of the rock of the cliff near the dike.

Mic. This rock is much finer grained than No. 1900, but is not essentially different. It is likewise much weathered. One section.

Age. Cabotian.

N. H. W.

NO. 1902. CONGLOMERATE. (*Quartzose.*)

Valley of the Puckwunge, about at the centre of the N. W. $\frac{1}{4}$ sec. 25, T. 64-4 E.
Ref. Annual Report, xxii, page 12. Compare No. 2069.

Meg. Rather fine, quartzose, but containing some colored pebbles and grains.

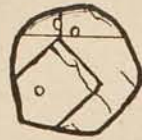


FIG. 49. ZIRCON.

Mic. The rounded *quartzes* are not supplied with an interlocking border, but they frequently show a shadowy extinction due to dynamic fracturing, as well as lines of inclusions. *Microcline*, as shown by the characteristic twinning, is not uncommon. Other grains are of orthoclase. A single grain of *zircon*, cut perpendicular to its vertical axis, shows two sets of cleavages, as shown in the figure. In the spaces between the *quartzes* is a finer debris, largely of quartz, but also containing *hornblende* and *mica*. There are also quite a number of pebbles consisting of quartzite, of which the constituent grains are interlocking in a manner similar to much in the bottom of the Animikie. These grains vary in size, in some of the pebbles being very fine, as in the taconyte, and in others as coarse as in the Pewabic quartzite.

The slide represents the finer portion of the conglomerate. One section.

Age. Bottom of the Potsdam.

N. H. W.

NO. 1905. ZIRKELYTE.

From the top of the same hill as No. 1902, lying about 200 feet above the gritstone No. 1902.

Ref. Annual Report, xxii, page 13.

Meg. A nondescript rock of green color. Compare No. 2066.

Mic. In a groundmass of microlitic devitrified glass are numerous idiomorphic fine feldspars and amygdaloidal spaces. The groundmass is mostly chloritized and the amygdaloidal spaces are occupied principally by *quartz*, some of which shows the optic elongation of *quartzine* and some of *chalcedony*, and by *calcite*. One section.

Age. Manitou.

N. H. W.

NO. 1906. GRAYWACKE. (*Grit.*)

"A fine-grained member of the gritstone, from an exposure further east [than Nos. 1902 to 1905]."

Ref. Annual Report, xxii, page 135.

Meg. Fine-grained, compact, hard graywacke. No section.

Age. Potsdam.

U. S. G.

[NOTE. Nos. 1907 to 1941, inclusive, were collected outside of Minnesota. Of these only those of which there are thin sections are here described. Notes on these rocks, Nos. 1907 to 1941, can be found in the Twenty-second Annual Report, pages 13-15.]

NO. 1915. GREENSTONE.

Sample of the more massive portions of the greenstone, Lower Quinnesec falls, Menominee river, Michigan.

Ref. Annual Report, xxii, page 13.

Meg. Apparently a massive rock.

Mic. *Hornblende*, composing the larger part, in overlapping, angular, confused fragments, is abundantly mingled with *epidote*, *magnetite* (in larger grains), partially altered to *leucoxene*, some *chlorite*, some *quartz*. These lie in a groundmass of fine interlocking secondary feldspar, in which quartz also takes some part.

Diabase. Amphibolyte. Tuff.]

These are all (except magnetite) secondary minerals, derivable from a decay and rearrangement of the elements of a basic rock, or from basic volcanic tuff, as often illustrated in Minnesota. One section.

Age. Keewatin.

N. H. W.

NO. 1918. DIABASE.

Lower Quinnesec falls; excavated for the channel for running logs; forms the barrier of the falls.
Ref. Annual Report, xxii, page 13.

Meg. Coarse, gabbro-like, but much altered, often spotted with white; perhaps as a dike.

Mic. The rock shows an ophitic relation between the *hornblende* (altered from augite) and the original *feldspars*, the latter being too much decayed for specific determination. There were some larger feldspars, but they are altered to *zoisite* and *calcite*, and otherwise obscured so that they cannot be determined. A part of the amphibolic mineral is fibrous *actinolite*. *Apatite* is in crystals of the first consolidation. One section.

Age. Keewatin (dike in?)

N. H. W.

NO. 1919. AMPHIBOLYTE. (*Garnetiferous.*)

At a point in the first hill just south of the Republic mine, Michigan.
Ref. Annual Report, xxii, page 13.

Meg. Structure dips north about 75°. So-called actinolite-magnetite schist, from the "lower Huronian."

Mic. Many of the grains of the amphibole are multiple-twinned, but not all of them. Mingled with them is much *garnet*. The *magnetite* in the slide is so small in amount as to be negligible in giving name to the rock, there being but two or three insignificant grains. One section.

Age. (?)

Remark. Named actinolite-magnetite-schist and anto-phyllite-schist, the predominant mineral of this rock was carefully examined by Lane and Sharpless, and pronounced grünerite, and it has latterly been called grünerite-schist. Yet, according to the analysis of Lane and Sharpless, it is placed recently by Hintze under cumingtonite. (*Handbuch der Mineralogie*, II, page 1230.)

N. H. W.

NO. 1939. TUFF.

From the dump of the Palms mine, Gogebic iron range, Michigan.
Ref. Annual Report, xxii, page 15.

Meg. A rather fragile, greenish-gray rock, with quartz.

Mic. A *chloritic*, isotropic substance forms the cement and background of this rock. It has a varied aspect as to light and dark because of apparent small fragments of different composition, with varying amounts of iron oxide. Sometimes a rusty

mesh of a spongy appearance is filled with a reciprocal mesh of this greenish chloritic material, but most usually the greenish material predominates largely over the rusty. These two, and a little *hornblende*, and numerous sub-angular *quartz* grains, compose the rock. One section.

Age. "Upper Huronian," *i. e.*, Taconic.

N. H. W.

NO. 1940. QUARTZ SCHIST.

South of the Aurora mine, Gogebic iron range, Michigan. Contact of the granite.
Ref. Annual Report, xxii, page 15.

Meg. Siliceous, slaty.

Mic. Interlocking *quartzes*, with a few feldspars (*microcline*), compose the most of this rock, but between the quartzes, running in more or less continuous sheets, and sometimes not in sheets, is an *actinolitic* schist which gives a prevalent structure to the rock. As an inclusion in the granite, or as a schist at an intrusive granite contact, it is perfectly explicable, but as the bottom of the upper iron-bearing series at the place where it occurs it would be an anomaly. One section.

Age. Archean (Keewatin).

Remark. The bottom of the iron-bearing series at the Aurora mine is a rather crumbling sandstone, which forms the foot-wall of the mine (or runs through the mine east and west), which is but a few feet thick. The hard, grayish-green, siliceous slates lying to the south of the mine, having a thickness of several hundred feet (Twenty-sixth Annual Report, page 58), belong to the Keewatin; and it is on these slates that the granite forms an intrusive contact, as in many places along the Mesabi range in Minnesota. Still, these green slates have been included frequently in the Penokee-Gogebic series.

N. H. W.

NO. 1942. DIABASE.

Short Line park, St. Paul and Duluth railroad. At the east end of the first cut in the gabbro.
Ref. Annual Report, xxi, page 15.

Meg. Some of the most coarsely crystalline portions of the "gabbro" as seen at this place. Evidently ophitic.

Mic. The augite, which formerly was in very large crystals, has been weathered to a *uralite*, and then almost wholly chloritized, but the ophitic structure is perfectly preserved. One section.

Age. Cabotian (Beaver Bay diabase).

N. H. W.

NO. 1949. DIABASE. (*Amygdaloidal.*)

From a detached amygdaloidal mass, lying on the ancient flood plain of the St. Louis, between the depot and the river at Cloquet.

Ref. Annual Report, xxii, page 15.

Meg. Coarsely crystalline, amygdaloidal, and spotted with red, as if by orthoclase derived from contact on the clastics as at Duluth.

Diabase. Breccia. Feldspar schist.]

Mic. The slide only shows a coarsely ophitic diabase or gabbro, like that at Short Line Park. Owing to weathering decay, numerous secondary minerals of the usual species have been developed, in which *epidote* is most conspicuous. Red hematitic spots are loosely disseminated, but there seems to be no difference in the essential mineral composition. One section.

Age. Cabotian (boulder).

N. H. W.

NO. 1951. DIABASE.

First hill range of gabbro, *i. e.*, most westerly, at Short Line park, at the railroad cut of the St. Paul and Duluth railroad.

Ref. Annual Report, xxii, page 15.

Meg. Intended to show the average amygdaloidal structure.

Mic. The green spots supposed to be due to amygdaloidal structure are occupied by chloritic and actinolitic fine aggregate, or by this aggregate more or less replaced by fine interlocking secondary feldspars (or quartz). One section.

Age. Cabotian (probably Beaver Bay diabase).

N. H. W.

NO. 1952. DIABASE.

"One of the narrow amygdaloidal dikes cutting this hill, with contact on the gabbro; same place."

Ref. Annual Report, xxii, page 15.

Meg. The country rock, with which the dike is in contact, is a rather fine grained, gray diabase with white feldspars. The dike rock is a very fine-grained, dark-gray diabasic rock. No section.

Age. Dike cutting Cabotian (Beaver Bay diabase?).

U. S. G.

NO. 1956. BRECCIA.

"A breccia, embracing some green fragments of the schist." West Breitung mine, Soudan.

Ref. Annual Report, xxii, page 16.

Meg. A rough breccia of green schist and hematite cemented by hematite. No section.

Age. Archean (Keewatin).

U. S. G.

NO. 1957. FELDSPAR SCHIST. (*Calcareous.*)

North side of Ely island, Vermilion lake.

Ref. Annual Report, xxii, page 16.

Meg. Light colored, nearly white, not very siliceous.

Mic. The slide is very largely composed of *feldspar* and *calcite*, with only one small *quartz* grain, so far as discoverable. This feldspar is in two conditions, viz., old crystals now almost entirely lost by alteration, and fragments of crystals. These are thickly strewn with calcite and with feldspar of the second form, viz., microgranulitic interlocking grains. This feldspar seems to have formed *pari passu* with

the decay and disappearance of the older grains of the other feldspar. Fine *sericite* scales also are abundant, but they are uniformly distributed, without forming any schistosity. One section.

Age. Archean (Upper Keewatin).

Remark. With the exception of a little argillyte at the west end of this island, the whole north shore of Ely island consists of rock of this kind. N. H. W.

NO. 1959. FELDSPAR SCHIST. (*Chloritic.*)

On the mainland southeast from Ely island.

Ref. Annual Report, xxii, page 16.

Meg. Fine grained, slightly greenish. At the "contact" or transition to jaspilyte.

Mic. This rock differs from No. 1957 in having better-preserved old *feldspars* (though still replaced by the same micro-granulitic alteration) and a notable amount of a green isotropic substance which is the same as frequently appears in the green-wackes, and also large grains of quartz. One section.

Age. Archean (Keewatin).

N. H. W.

NO. 1960. JASPILYTE.

North side of the North ridge at Soudan.

Ref. Annual Report, xxii, page 16.

Meg. Showing a distribution of iron ore in such a manner as to give the appearance of squeezed pebbles of different colors.

Mic. While the rock consists essentially of interlocking *quartz* grains in the well-known manner of jaspilyte, it is colored by *magnetite* in such a manner as to bring out more or less roundish outlines. Where the iron ore is abundant, or even present in any amount, the fineness of the quartz grains is greater. One section.

Age. Archean (Lower Keewatin).

Remark. The variation in the size of the quartz grains where the iron ore appears, indicates that the ore was present in some form at the date of formation of the quartz, and has not been infiltrated since, and hence that it is not the result of later concentration. N. H. W.

NO. 1961. JASPILYTE.

Same place as the last.

Ref. Annual Report, xxii, page 16.

Meg. Apparently pebbles, pressed, enclosed in hematitic jaspilyte.

Mic. The pebble-like appearance is due, as in the last, to the peculiar manner of distribution of iron ore in the siliceous mass. This slide, being more abundantly supplied with iron ore, does not exhibit the same variation in the fineness of the quartz grains. It shows, however, that the iron was present even before the micro-granu-

Greenwacke.]

litic structure was taken by the quartz, and that it also crystallized as hematite before that structure was acquired. Thus, within a triangular space filled otherwise by interlocking grains of quartz, surrounded by what appears to be amorphous iron ore, there are several crystals of hematite standing on the surrounding hematite border. These crystals are sufficiently long to reach about half way across the triangular space, and they cut through the quartz grains idiomorphically, each crystal thus penetrating from two to four of the quartz grains. In the slide are a number of illustrations of this priority of the hematite. One section.

Age. Archean (Lower Keewatin).

Remark. This priority of the iron ore, in its present form, over that of the quartz, in its present form, may be united with notes on the condition of the jaspilite where it has been modified by the gabbro contact at Disappointment lake (Nos. 2199-2201).

N. H. W.

NO. 1962. GREENWACKE.

North slope of the North ridge, Soudan.

Ref. Annual Report, xxii, page 16.

Meg. The rock has an approach toward argillyte.

Mic. The slide, however, shows a rock much too coarse for argillyte. It is essentially made up of basic debris, perhaps tuffaceous, in which great decay has taken place. The old feldspars (and augites, if any existed) are hardly discernible, but a *chloritic* and *amphibolic* and *epidotie* confused secondary product has taken their places, showing a sprinkling also of *hematite*. One section.

Age. Archean (Lower Keewatin).

N. H. W.

NO. 1966. GREENWACKE (*with cordierite?*)

Crossing of Lake street and Piedmont avenue, Duluth.

Ref. Annual Report, xxii, page 16. (Compare Nos. 44 and 1708.)

Meg. Typical homogeneous specimen of the "black rock," so-called. Appearing like a basalt.

Mic. The rock is very fine grained, but in high powers it is seen to be composed of the same elements as a greenwacke, *i. e.*, *amphibole*, old *feldspars* nearly destroyed, *magnetite* (or *hematite*) *quartz* in angular and subangular grains, all more or less enshrouded in an isotropic mantle of *chlorite*. The rock might pass for an Archean greenwacke, or even for a volcanic tuff. One section.

Age. Animikie.

Remark. The supposed "old feldspars" are possibly not feldspar, but *cordierite*. They frequently have parallel extinction and are crowded with inclusions, but being very small and indefinite, it is not safe to rely on them as *cordierite*.

N. H. W.

NO. 1967. GREENWACKE. (*Tuff?*)

Same place as No. 1966.

Ref. Annual Report, xxii, page 17.

Meg. Sample of the roughly conglomerate-appearing portion of the same rock mass as No. 1966.

Mic. There are certain spots in which the green *amphibole* prevails over all the other minerals, even to their entire exclusion, and others in which *magnetite* plays the same rôle. The former are sometimes irregularly angular, and bordered by a band of greater abundance of granular magnetite; in other places the magnetite simply fades out and leaves a somewhat roundish area in which none is found. On the other hand magnetite sometimes suddenly increases in innumerable fine grains, forming a *tache* something like lapillitic magnetited fragments seen in old volcanic ash. One section.

Age. Animikie(?)

N. H. W.

NO. 1968. APORHYOLYTE.

Same place as the last but a short distance further west, near the creek crossed by Piedmont avenue, Duluth.

Ref. Annual Report, xxii, page 17.

Meg. Red rock, associated with the foregoing black rock.

Mic. Poikilitic *quartz* spreads irregularly throughout the fine mass, embracing the red (feldspathic?) material. It consists of numerous crystal orientations. *Magnetite*, *hornblende* and *epidote* are likewise more or less abundant, the hornblende being quite scant. One section.

Age. Cabotian.

N. H. W.

NO. 1976. PEBBLES.

Pebbles from the crumbling red conglomerate which overlies the green shale (No. 1974) and the quartzose conglomerate, at the mouth of the creek entering the St. Louis river on S. W. $\frac{1}{4}$ sec. 1, T. 48-16 W.

Ref. Annual Report, xxiii, pages 239, 240.

Meg. The pebbles are not usually more than an inch in diameter. They are of various kinds of rocks, among which are: greenish-gray shale; gray, flinty rock; reddish, banded, flinty rock; pyrite; vein quartz; fine-grained, red granite; red quartzite; fine-grained, decayed, reddish, igneous rocks.

Age. Potsdam conglomerate.

U. S. G.

NO. 1980. GRANITE.

Ortonville, near Big Stone lake. Much used for construction.

Ref. Annual Report, xxiv, page 1.

Meg. Rather coarse, reddish, sometimes porphyritic.

Mic. *Microcline* and *orthoclase* form large crystals. *Quartz* is abundant; *biotite* is rather sparse but preceded both feldspars. The orthoclase sometimes enters the

Granite.]

microcline in a pneumatolitic manner, and also itself is converted to a *microperthite* by the intergrowth of a secondary feldspar along its cleavages. In small amount a vermicular micropegmatyte and other inclusions are formed by the quartz in the microcline, but generally the quartz is grouped by itself in roundish interlocking grains.

The rock is quite fresh, but that it is a reconstructed rock is indicated by the remains of "old feldspars," though not so evidently as in the granite of Kekequabic lake. These remains are of three sorts: (1) Decayed areas isolated in the midst of otherwise fresh feldspar (quite rare in this rock); (2) Remains of a triclinic feldspar in the midst of orthoclase. These consist of scattered grains having their extinction directions the same and simultaneous; (3) Lines of iron rust (limonite) as inclusions running parallel through the orthoclase, simulating albite twinning bands of a triclinic feldspar from which everything is lost except these lines, which were probably accumulated along the planes of separation between the albite macles, or within the macles themselves. The microperthite itself may be mentioned as a fourth trace of an older state of the feldspars of this granite. Two sections.

Age. Archean granite.

N. H. W.

NO. 1986. GRANITE.

Menan island, Vermilion lake. The older of two granite dikes.
Ref. Annual Report, xv, pages 288-290; Annual Report, xxiv, page 1.

Meg. Two granite dikes, one cutting the other.

Mic. The rock is made up of "old feldspars," much broken and corroded by the surrounding matrix, lying in a micro-granulitic groundmass, quite resembling the granite already described at Kekequabic lake. These old *feldspars* never interlock with each other, but they are intimately interlocked about their borders by the secondary fine interlocking groundmass. If two are in contact they have the appearance of having been brought accidentally into that position, and sometimes a broken line of glassy small feldspars, or perhaps only one or two grains or a few scales of mica, have been developed along their contact edges. These old feldspars also frequently have isolated, small, fresh and glassy feldspars and *quartz* scattered irregularly through them, having independent orientations. The most of them are plainly triclinic and approach *oligoclase*. Extinction on n_p is about 85° , n_e being apparently the bisectrix, thus indicating *oligoclase-albite*. *Microcline* appears as one of the fresh feldspathic growths. The small granular and interlocking feldspars are mingled with interlocking quartz; it is impossible from the slide at hand to determine them specifically, for they show no crystallographic characters on which to measure extinction. The section contains a little *epidote* and *sphene* and a few scales of *mica*, but is nearly free from the colored silicates. One section.

Age. Archean dike.

N. H. W.

NO. 1987. GRANITE.

Same place as the last.

Ref. Annual Report, xxiv, page 1.

Meg. A later granite dike, cutting No. 1986.

Mic. This rock is like the last, but having less contrast as to size between the old and the fresh feldspars, the latter also being more numerous as compared with the interstitial new growths, and thus coming occasionally into contact; but such contacts are characterized, as in No. 1986, by the same appearance of apposition rather than crystalline intergrowth, except that usually a fresh deposition of clear glassy feldspar or of *quartz* cements them by a continuous line or by several nearly adjacent grains. Quartz also enters the old feldspars as a vermicular micropegmatyte. One section.

Age. Archean dike.

Remark. There is no way of knowing whether much or little time separated the dates of formation of these dikes. They are petrographically so similar that they seem to have had nearly the same date and the same origin. N. H. W.

NO. 1990. GRANITE.

Menan island, near the last.

Ref. Annual Report, xxiv, page 1.

Meg. This is a light-gray, rather fine-grained dike six inches wide, showing contact on schist, apparently the youngest of the dikes.

Mic. The larger old *feldspars* are quite scarce in this rock, but very many of the grains in the finer matrix are surrounded by a rim of secondary growth which interlocks with rims that likewise surround adjacent grains, the centres of the grains being crowded with mica scales and sometimes containing secondary silica. *Epidote* is quite common, and is lodged within the old feldspars, or in the finer groundmass. Green *hornblende* also forms a conspicuous part of the slide, being later than the few *biotite* scales which it encloses. One section.

Age. Archean dike.

N. H. W.

NO. 1991. GRANITE.

N. W. $\frac{1}{4}$ S. E. $\frac{1}{4}$ sec. 26, T. 63-17, northern part of Vermilion lake, where the canoe route turns north on the east side of the channel.

Ref. Annual Report, xxiv, page 1.

Meg. Resembling outwardly the rock No. 1990, this forms a laccolith or spreading mass in the midst of the schists and granites, constituting the highest part of a knob a little back from the lake, supposed to be of the same origin and age as No. 1990.

Mic. This rock shows well the contrast between the old feldspars and the new. The old form cores which are surrounded by fresh rims, as already mentioned, and

Granite.]

the rims interlock with their neighbors, but the old forms are seldom so thickly set as to come into contact with each other. Some *biotite*, *epidote*, *sphene* and *hornblende* are scattered through the slide, while *quartz* is abundant. One section.

Age. Archean.

N. H. W.

NO. 1992. GRANITE.

Same place as No. 1991.

Ref. Annual Report, xxiv, page 2.

Meg. Coarse, granitic or pegmatitic, vein-like rock, enclosing areas of No. 1991, much lighter colored than No. 1991.

Mic. The large feldspars have a micro-perthitic structure, the later feldspar having insinuated itself along the cleavages and in other irregular fissures or points of weakness. From this microscopic form the secondary growth spreads into larger patches, and in several such it shows the *microcline* quadrillage. Microcline is also in independent larger grains. It thus appears that microcline forms a refilling for a semi-decayed or crushed feldspar. Frequently thus an old feldspar, with ragged remnants, is filled in and surrounded by a microcline border, about one-half of the area showing the quadrillage and the other not. Still it is not always plainly microcline which forms the secondary ingrowths, but a fine, thread-like feldspar scattered in minute films which become visible because of their different orientation. They extinguish simultaneously and lie approximately parallel, in two series, one of which is in the direction of the basal cleavage. The older crystal, in this case, is apparently *andesine-oligoclase*, having an extinction of 3° on n_g . The slide is entirely free from the colored bisilicates. The quartz has been much fractured and has a shadowy extinction. One section.

Age. Archean.

Remark. The old feldspars here are not so much decayed, but crushed and recemented.

N. H. W.

NO. 1994. GRANITE. (*Red.*)

N. W. $\frac{1}{4}$ sec. 23, T. 63-17, north part of Vermilion lake.

Ref. Annual Report, xxiv, page 2.

Meg. Dike, three inches wide, cutting mica schist.

Mic. The rock shows but little contrast between old and new feldspars, but the whole is an interlocking mass of *feldspar* and *quartz*, with a trifling amount of chloritized *hornblende*. The feldspar is slightly colored by hematite, by weathering, and consists of *microcline*, *oligoclase* and *orthoclase*. One section.

Age. Archean dike.

N. H. W.

NO. 1995. GRANITE. (*Granitized schist.*)

Same place as No. 1994.

Ref. Annual Report, xxiv, page 2.

Meg. This rock, as observed in the field, is a mica schist permeated by granitic elements.

Mic. It is not distinguishable from the last, except that it contains more chloritized hornblende. One section.

Age. Archean (granitized schist).

N. H. W.

NO. 1996 $\frac{1}{2}$. MICA SCHIST. (*Subgranitized.*)

Same place as the last.

Ref. Annual Report, xxiv, page 4.

Meg. With many granitic segregations within the mica schist, there are also intermediate rocks, or stages of transition from schist to gneiss, and apparently to granite. This represents one of the intermediate stages.

Mic. The rock is completely crystalline, but not with a new interlocking structure; on the other hand the grains are subround and small, though exactly fitting and filling all the spaces in which they lie. The *feldspars* are much decayed by weathering, but the decay has attacked their borders first, leaving the central portions fresh, when any portion is left unaltered. In general, this decay is uniform throughout the whole grain. Thus their appearance in this respect is the reverse of that presented by the "old feldspars" already mentioned in several granites. The rock contains much *quartz* and a considerable quantity of chloritized *hornblende*. One section.

Age. Archean (schist).

N. H. W.

NO. 1997. ALBITE AND MICROCLINE.

Same place as No. 1994.

Ref. Annual Report, xxiv, page 4.

Meg. Coarse pegmatyte, consisting of pink and white feldspars and of quartz.

Mic. In a zig-zag course forms a vein in the schist, ascending a bluff twenty feet high. The pink feldspar is clearly *microcline*, and extinction on the basal cleavage of the white is 3° . Specific gravity being 2.61, in Thoulet's solution, may be somewhat increased by micaceous inclusions. It is probable, however, that the white feldspar is either *albite* or *oligoclase albite*. The long, fine, twinning striations are more like those of oligoclase than those of albite. One section.

Age. Archean (pegmatyte).

N. H. W.

NO. 1998. GNEISS.

N. E. $\frac{1}{4}$ sec. 22 (north side), T. 63-17, Vermilion lake, near the same place as No. 1994, about four rods west of the north-south section line between sections 22 and 23.

Ref. Annual Report, xxiv, page 4.

Meg. Forms a knoll at the lake shore, a dark gneiss, dipping north, evidently a more massive condition of the schists of the vicinity.

Mic. The darker color is due to the presence of more *hornblende*, which is also accompanied by *epidote*. The alteration of the mostly non-interlocking *feldspars*,

Granite. Diabase.]

which is prevalent, spreads irregularly over their surfaces, as exposed by the section, but still it is frequently mostly confined to the central parts, and occasionally a grain shows a distinct bordering secondary growth. The abundant *quartz* has a shadowy extinction and forms the cement for the feldspars. One section.

Age. Archean.

N. H. W.

NO. 1999. GRANITE.

Same place as No. 1998.

Ref. Annual Report, xxiv, page 5.

Meg. Granitic boss underlying No. 1998, its structure rudely conformable with it, having inclusions of schist and gneiss.

Mic. The *feldspars* are mostly distinctly interlocked with each other, but the *quartz*, which is of later origin, fills the angles and often isolated spaces within the feldspars. The weathering effect is spread uniformly through the feldspars. *Epidote*, *sphene* and *hornblende* are in small amounts. One section.

Age. Archean.

Remark. Some discussion of the structural relations of the granites and schists at this point, on Vermilion lake, may be found on pages 2-11 of the Twenty-fourth Annual Report, based on the facts of field observation.

N. H. W.

NO. 2001. DIABASE.

From a dike, sec. 14, T. 63-18, two and a half feet wide, cutting the face of the bluff and running E. N. E., Vermilion lake.

Ref. Annual Report, xxiv, page 8.

Meg. Fine grained near the centre of the dike.

Mic. The *augite* has so small an optic angle that the interference figure in convergent light has an action and appearance resembling that of a uniaxial mineral, thus allying this diabase with some of the gabbros of the Keweenawan (Nos. 291, 297). It gives the positive sign with the mica plate, n_e being in the acute optic angle, but its elongation is negative, *i. e.*, n_p forms a smaller angle with the vertical crystallographic axis than n_e , a fact which shows that it is allied to *ægyrine*.* This *augite* is rarely ophitic with respect to the feldspars of the second generation, the first feldspars having evidently also preceded, but being so few as to not come into contact with the *augite*. *Magnetite* in scattered grains, *sphene* in a few irregular grains, calcite and *pennine*(?) filling large idiomorphic crystal spaces which may have been once occupied by olivine, are the only other ingredients. One section.

Age. Keweenawan(?)

Remark. The slide presents the appearance of a rock whose individual crystals, probably once in ophitic relation, have been broken up into many angular individuals with varying orientation, this being due apparently to the exigencies of flowage

* *Minéralogie de France*, vol. 1, p. 568.

in a narrow fissure. The angularity of these individual grains is in marked contrast with the roundness of the grains in muscovadyte or noryte, which have been attributed to the peripheral flowage and contact of the gabbro on the older rocks.

N. H. W.

NO. 2002. ZIRKELYTE.

From the contact edge of the same dike as No. 2001.

Ref. Annual Report, xxiv, page 8.

Meg. Fine, dark, somewhat rusty on the contact surface.

Mic. The grain is so fine that much of it appears to be simply a devitrified glass. The *augites* are separated into several parts, though lying adjacent, the parts having separate orientations, and similar parts, though smaller, and globular, are thickly disseminated everywhere in the slide, so fine that their united marginal reflections produce the darkness that the slide presents between the nicols. One section.

Age. Keweenawan(?)

N. H. W.

NO. 2005. GNEISS.

N. E. $\frac{1}{4}$ sec. 13, T. 63-18, opposite the two small islands at seventy-five feet above Vermilion lake, near the shore.

Ref. Annual Report, xxiv, page 9.

Meg. Gray gneiss.

Mic. With a sprinkling of *biotite* and *hornblende*, this rock consists of considerably altered *feldspars* and of *quartz*, the distribution of the alteration being irregular, due in large part to recent weathering. There is no general distinction between old and new feldspars, though some are much more decayed than others. One section.

Age. Archean.

N. H. W.

NO. 2006. AMPHIBOLYTE.

Associated with No. 2005.

Ref. Annual Report, xxiv, page 9.

Meg. Hornblendic, dark.

Mic. More than one-half of this rock is composed of green *hornblende*. The rock is composed essentially of a feldspathic element which is so crowded with impurities that its crystalline structure is wholly lost. This substance fills the angles between the hornblendes and occasionally enters them after the manner of corrosion bays in quartz of a quartz-porphry. There are several pieces of *sphene* and one corroded crystal of a *pyroxene*. One section.

Age. Archean.

N. H. W.

NO. 2008. AMPHIBOLYTE.

From large boulders, evidently derived from rock in place not far distant. N. E. $\frac{1}{4}$ sec. 13, T. 63-19, same place as No. 2005.

Ref. Annual Report, xxiv, page 10.

Quartz-porphry.]

Meg. Dark, coarse, the conspicuous hornblendes lying in a sparse, fine, pinkish feldspathic matrix.

Mic. The *hornblende* is so abundant as to interlock with itself and with the *microcline*. It embraces grains of *epidote* and of *sphene*, and a small amount of crumpled *biotite*. One section.

Age. Archean(?) (boulder).

N. H. W.

No. 2010. QUARTZ-PORPHYRY. (*Esterellyte?*)

Small island, east side of sec. 20, T. 62-15, south side of Vermilion lake.

Ref. Annual Report, xxiv, page 12.

Meg. Two pebbles (Nos. 2010 and 2011) in the conglomerate forming this island, lying adjacent, have different outward appearance, this being finer than the other.

Mic. In a fine groundmass lie large crystals of *feldspar* and a few of *quartz*. The feldspar crystals are uniformly triclinic and conspicuously twinned on the albite and pericline plans, and on the Carlsbad (?), the last consisting of the connection of one or two small crystals apparently on the plane 010 of a larger one, in a manner similar to the twinning of some of the feldspars in the schist of Kekequabic lake. These feldspars are all much and evenly decayed, and are thickly sown with particles of *calcite* and of *sericite*. They frequently have their own crystalline forms, but there are many parts of crystals of all sizes, running down to the matrix, and in the matrix can be seen forms that show a gradual disappearance of some of the smaller feldspars by the growth of a fine granular secondary substance identical with that seen in the schists of Kekequabic lake, but usually somewhat less observable. This secondary growth has slightly affected the borders of the larger feldspars, giving them a differently extinguishing narrow fringe which is interlocked with the contiguous fine groundmass; and it is evident that the groundmass or finer cement consists very largely, if not entirely, of this secondary generation of a granulitic matrix, as it is intimately and universally interlocked, the small grains not being round altogether, but sometimes elongated in a feldspathic manner. It contains very little if any quartz; indeed, it is impossible to affirm that it contains any quartz. The larger grains of quartz, comparable with the larger feldspars, are quite evident, but quite few. One section.

Age. Upper Keewatin (pebble in).

N. H. W.

No. 2011. QUARTZ-PORPHYRY. (*Esterellyte?*)

Same place as the last.

Ref. Annual Report, xxiv, page 12.

Meg. Granular, coarser than No. 2010.

Mic. This rock is coarser, has larger and more numerous *quartzes*, and larger feldspars, and a finer cement, but in all other respects it is quite similar to rock No.

2010. The large quartzes are much broken and the fragments lie adjacent, while a wavy extinction passes over them all. Between these parts is a granular cement appearing to be of quartz or quartz and feldspar, but a little coarser than the cement of the rock at large. This pebble, as seen in the thin section, has a distinct schistosity in the direction in which the fragments of the broken quartzes are separated from each other, and it has more abundant and coarser scales of *sericite*. One section.

Age. Upper Keewatin (pebble in).

Remark. These rocks may be compared with others of the Stuntz conglomerate, Nos. 2017 and 2018. These are pebbles that lie in and form parts of that conglomerate. They have a strong resemblance (especially No. 2010) to rocks Nos. 1789 and 2095 (seen at Ely), which are intrusives in the Lower Keewatin. No. 2011 itself appears to be a clastic rock.

N. H. W.

NO. 2012. "QUARTZ-PORPHYRY." (*Graywacke.*)

From the extremity of the point nearest the same small island, Vermilion lake. The rock in general is a conglomerate.

Ref. Annual Report, xxiv, page 12; Final Report, vol. iv, pages 530-532.

Meg. Fine grained, light colored, apparently "quartz-porphry."

Mic. This rock is like No. 2011, except that it contains much more *calcite*, through greater alteration of the *feldspars*. It also shows remnants of *hornblende* in form of *actinolite* in fibrous, lengthened shreds, and some brightly polarizing scales of *sericite*. Fine particles, and groups of particles, resembling dark *leucoxene*, are visible in ordinary light. One section.

Age. A stratum of the Stuntz conglomerate.

N. H. W.

NO. 2013. QUARTZ-PORPHYRY. (*Sheared.*)

On the point, in section 20, a little further west than No. 2012, Vermilion lake.

Ref. Annual Report, xxiv, page 12; Final Report, vol. iv, page 531.

Meg. In contrast with No. 2014, the two being pebbles in the conglomerate.

Mic. Owing to shearing pressure the feldspars and quartzes are considerably broken and separated. There seems to have been formerly a hornblendic element in this rock, but it is lost by the dynamic action to which the conglomerate has been subjected, only traces remaining in the form of elongated chloritic streaks which are isotropic. These are frequently associated with greater amounts of *sericite*. *Leucoxene* appears in formless clusters of particles as in the foregoing. One section.

Age. Pebble in Upper Keewatin.

N. H. W.

NO. 2014. FELDSPAR SCHIST.

Same place as No. 2013.

Ref. Annual Report, xxiv, page 12; Final Report, page 531.

Meg. This pebble lies in contact with No. 2013. It is finer grained than No. 2013 and schistose.

Graywacke. Quartz-feldspar schist.]

Mic. This is so micaceous and fine and so charged with *calcite* that it might almost be styled a sericitic schist. Still there are crystal forms of feldspar as well as quartz well preserved. One section.

Age. Pebble in Upper Keewatin.

N. H. W.

NO. 2016. GRAYWACKE.

From the same place as No. 2013, but further south on the point.

Ref. Annual Report, xxiv, page 12.

Meg. From the country rock at large.

Mic. This is a clastic made up of small pebbles of rock like the foregoing pebbles, and of feldspar and *quartz* crystals, embraced in a finer debris of the same kind, the whole much altered. This rock presents an interesting contrast with the foregoing pebbles which have a general similarity and can be referred to the same general source. This is plainly a composite rock. One section.

Age. Upper Keewatin.

Remark. The feldspars in this fragmental are obscured and often nearly lost by the introduction of fine granular substances. This change is akin to that seen in the alteration of feldspars in the Ogishke conglomerate.

N. H. W.

NO. 2017. QUARTZ-FELDSPAR SCHIST.

From the same place as No. 2016.

Ref. Annual Report, xxiv, page 13.

Meg. A pebble from the conglomerate.

Mic. This slide is like No. 2013, etc. The feldspars, however, are not so well preserved. The rock is evidently of the same nature and origin. Appears to be a clastic rock. One section.

Age. Pebble in Upper Keewatin.

N. H. W.

NO. 2018. QUARTZ-FELDSPAR SCHIST.

Same place as No. 2016.

Ref. Annual Report, xxiv, page 13.

Meg. Pebbles from the same.

Mic. This pebble has considerable *quartz* in the fine matrix surrounding the *feldspars*, and the feldspars are nearly destroyed. There are areas evidently once occupied by feldspars that are hardly separable from the surrounding rock material. They show sometimes a greater or a smaller number of microlitic secondary particles, or the particles are larger, or arranged in lines at variance with the surrounding rock; and sometimes such secondary particles appear as if somewhat dependent on the direction of original cleavages in the feldspar which has been lost. One section.

Age. Pebble in Upper Keewatin.

N. H. W.

NO. 2019. PEBBLES.

"Pebbles in contact near the lake, on the east side, showing remarkable differences; one lot (a) are coarse and specked by white feldspars in a greenish matrix, and another lot (b) are very fine grained." Near the same place as No. 2016.

Ref. Annual Report, xxiv, page 13.

Meg. "The first specimen (a) appears to be a quartz-porphiry with small porphyritic quartzes and numerous feldspars. The matrix is very fine grained and dark colored. The second specimen (b) is a very fine-grained, gray, siliceous rock. No section.

Age. Pebbles in Upper Keewatin.

U. S. G.

NO. 2020. GRAYWACKE.

Same place as No. 2016.

Ref. Annual Report, xxiv, page 14.

Meg. Fine grained layer ten feet thick, overlying a bed of conglomerate conformably.

Mic. Even grained assemblage of *feldspar* and *quartz* fragments, lying in a scant matrix of *sericite* and debris of the same sort. Much of the apparent matrix has resulted from a granulitic alteration of some of the finer feldspars, as in No. 2018. One section.

Age. Upper Keewatin.

N. H. W.

NO. 2021. GRAYWACKE.

The same place.

Ref. Annual Report, xxiv, page 14.

Meg. At ten feet from the conglomerate. Forms a bed ten feet thick.

Mic. Essentially the same as No. 2020; more evidently some of the feldspar fragments have taken on the fine granulitic alteration structure seen in many cases in the feldspar grains of the Ogishke conglomerate, thus resembling devitrified glass. One section.

Age. Upper Keewatin.

N. H. W.

NO. 2022. GREENWACKE. (*Sheared.*)

Same place as No. 2016.

Ref. Annual Report, xxiv, page 14.

Meg. Forms a conformable layer two feet thick. Greenish, slightly fibrous, but containing pieces or pebbles of rock like No. 2013, etc.

Mic. This is one of the sheared, altered fragmentals which at first must have contained a considerable amount of some ferromagnesian mineral which now is altered to a chloritic mineral. In the midst of this are some evident feldspar forms and many not so evident, since they are replaced by the usual finely granulitic secondary growth already mentioned, and at the same time very much *calcite* has been deposited. One section.

Age. Upper Keewatin.

N. H. W.

Argillyte and graywacke.]

No. 2023. GRAYWACKE.

Same place as No. 2016.

Ref. Annual Report, xxiv, page 14.

Meg. Overlies No. 2022; one of the series of clastic material.*Mic.* This is also slightly greenish, much altered, sheared and calcified. It contains a few old feldspar forms, but in general the whole rock is darkened between the nicols by chloritic alteration. One section.*Age.* Upper Keewatin.

N. H. W.

No. 2024. GRAYWACKE.

Same place as No. 2016.

Ref. Annual Report, xxiv, page 14.

Meg. Overlies No. 2023; twenty or more feet thick.*Mic.* This rock is like No. 2020, a rather even-grained graywacke, but there were evidently pebbles of feldspar that have disappeared as feldspar by the formation of the same granulitic fine secondary substance (micro-granulitic) seen in numerous cases in the Ogishke conglomerate. One section.*Age.* Upper Keewatin.

N. H. W.

No. 2025. ARGILLYTE AND GRAYWACKE.

Across the little bay in sec. 20, T. 62-15 (*i. e.*, on the east side of the bay), Vermilion lake. Sinuous alternations of black slate with graywacke, a little southwest from the cliff near the extremity of the point.

Ref. Annual Report, xxiv, page 15.

Meg. Black slate, rigid, and graywacke in contact.*Mic.* The graywacke consists, as usual, of a rather uniform grain of feldspar and quartz, the former much altered, lying in a finer debris of the same, which debris is now changed, with much of the larger feldspar grains, to an interlocking fine plexus. There are a few of the larger grains of this feldspathic material embraced within the slaty portion of the slide near the line of separation. The slaty portion is quite different when viewed in natural light. While it is apparent that there is a small amount of the same feldspathic material running through this dark mass, even including a few scales of *sericite*, the slate consists essentially of a single other substance, which it is difficult to determine. It has a high refractive index, and being very fine and granular, it gives a darkness to the microscopic field which, with low power, is almost that of an isotropic substance. It may be a mixture of *epidote*, *chlorite* and *hornblende* with *leucoxene*. One section.*Age.* Upper Keewatin.*Remark.* This "black slate" was supposed, when collected, to be allied to the jaspilyte, and to be a large fragment from the Lower Keewatin involved with the graywackes of the Upper Keewatin, but its composition is rather like the graywackes, and it is hence a portion of the Upper Keewatin, considerably broken and folded. It has not a single element of the jaspilyte.

N. H. W.

NO. 2026. GRAYWACKE.

Stuntz island, Vermilion lake.
Ref. Annual Report, xxiv, page 15.

Meg. Pebble from the conglomerate, lying in contact with No. 2027.

Mic. This rock is like that numbered 2016, and the description need not be repeated. One section.

Age. Pebble in Upper Keewatin.

Remark. This being a pebble in the Stuntz Island conglomerate, and itself apparently a clastic rock, is an indication that the Stuntz Island conglomerate is nonconformable on some graywackes.

N. H. W.

NO. 2027. GRAYWACKE.

Stuntz island, Vermilion lake.
Ref. Annual Report, xxiv, page 15.

Meg. Pebble lying in contact with No. 2026.

Mic. This pebble is a graywacke and consists almost entirely of distinct coarse fragments of *feldspar* of different kinds and of *quartz*, the cement between them being *calcite* and *sericite*, with less of the debris that appears in the graywacke on the point in section twenty, which is simply a downward gradation in size of grains like the coarser fragments. In that respect it is like No. 2026. One section.

Age. Pebble in Upper Keewatin.

N. H. W.

NO. 2030½. TUFF.

On the International boundary, at the ridge over which the trail passes between Otter Track and Oak lakes.
Ref. Annual Report, xxiv, page 18.

Meg. Green, coarse, appearing somewhat like a graywacke. This ridge prevents Hunter's island from being an island. It is apparently only a variation of the rock that forms the shores of Knife lake and Otter Track lake, but differs from ordinary graywacke.

Mic. This interesting rock has an alliance with the tuffs of Kekequabic lake, but it is more characteristically a tuff than any yet seen from that region. It contains large pieces (microscopic) of zirkelyte, in which, however, are idiomorphic crystals of green *hornblende*, faintly zoned by a narrow rim visible occasionally, and of *pyroxene*. Throughout the slide, in which is also much zirkelyte, are isolated pyroxenes (*augite*) and *quartzes*, and occasionally an area of feldspar in which there is plainly a coarse fibrous and radiated structure, the elongation being negative, *i. e.*, parallel to n_p . There are also sub-round masses apparently of diabase porphyryte in which the little feldspars stand in divergent positions. One section.

Age. Archean (Upper(?) Keewatin).

N. H. W.

Graywacke.]

No. 2031. GRAYWACKE. (*Arkose.*)

N. E. $\frac{1}{4}$ sec. 24, T. 66-6, Oak Lake portage to Saganaga lake.
Ref. Annual Report, xxiv, page 18.

Meg. Coarser-grained portion of the rock near the landing at Saganaga lake. Appears like granite, but varies from coarse to fine in not very evident alternations. Greenish gray and gray. (Compare No. 322.)

Mic. *Feldspar* and *quartz* in a mixture like a graywacke with a cement like that of No. 2027, *i. e.*, largely of *sericite* and *calcite*. One section.

Age. Archean (Upper Keewatin).

N. H. W.

No. 2032. GRAYWACKE. (*Arkose.*)

Same place as No. 2030.
Ref. Annual Report, xxiv, page 18.

Meg. Some of the finer portion of the same rock.

Mic. This rock differs from the last in having fewer of the entire crystals, or large fragments, and a very abundant supply of the finer detritus. One section.

Age. Archean (Upper Keewatin).

Remark. The rock at this portage has been mentioned as granite by several geologists.

N. H. W.

No. 2033. GRAYWACKE.

Apparently as fragments in rock like Nos. 2031 and 2032. In Ontario, about two rods north of the portage (which is in S. E. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 24, T. 66-6 W.) between Oak and Saganaga lakes.
Ref. Annual Report, xxiv, page 19.

Meg. Apparently similar to Nos. 2031 and 2032, but very much finer grained. The rock is of a light yellowish-green color, but weathers to a brown. One side of one of the specimens shows a small area of coarse-grained rock. No section.

Age. Archean (Upper Keewatin).

U. S. G.

No. 2035. GRAYWACKE.

About five rods east of No. 2034; in Ontario. From a surface which appears to be ripple marked.
Ref. Annual Report, xxiv, page 20.

Meg. Similar to No. 2032, but more weathered and consequently yellowish in color. No section.

Age. Archean (Upper Keewatin).

U. S. G.

No. 2037. GRAYWACKE.

Below the ripple marks; same place as No. 2035.
Ref. Annual Report, xxiv, page 20.

Meg. Similar to the general rock here (Nos. 2031 to 2036), but somewhat finer grained than usual, and showing rusty specks. No section.

Age. Archean (Upper Keewatin).

U. S. G.

NO. 2038. CONGLOMERATE.

East shore of Oak lake, in Ontario, and about 200 paces north of the portage mentioned under No. 2033.
Ref. Annual Report, xxiv, page 20.

Meg. Coarse, gritty rock, similar to No. 2031, but containing a few sub-rounded quartz pebbles about half an inch in diameter. No section.

Age. Archean (Upper Keewatin).

U. S. G.

NO. 2043. GRAYWACKE. (*Slaty.*)

East side of the little bay in sec. 24, T. 66-6, Saganaga lake.
Ref. Annual Report, xxiv, page 21.

Meg. Fine grained, gray, weathering yellowish, in conformable contact with recomposed granite, and interstratified with it, appearing slaty.

Mic. A fine fragmental slate or graywacke. With a few angular grains of quartz is much of *calcite* and still more of an ill-defined, dirty-gray substance whose nature it is difficult to determine, but which is a common product of fine trituration of the debris of crystalline rocks, embracing apparently more of the ferromagnesian elements than the lighter colored strata adjacent. In higher power this is somewhat resolved into *quartz*, *mica*, *calcite* and apparently some iron oxide, the last giving color to the rock. One section.

Age. Archean (Upper Keewatin).

N. H. W.

NO. 2044. GRANITE.

Northeastward from the last across the strike; N. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$ sec. 19, T. 66-5.
Ref. Annual Report, xxiv, page 21.

Meg. In a ridge of granite, evidently the source of the debris of Nos. 2032 and 2043.

Mic. The grains all interlock, but the feldspars are all much altered by weathering. It is noticeable that this decay is uniform throughout the large crystals, and consists in the formation of myriads of scales of mica and irregular forms or clusters of *calcite*. This decay thus contrasts with the decay seen in the "old feldspars" seen in the granite of Kekequabic lake. Still there is occasionally a narrow zonal band about some of these feldspars which is less affected by the prevalent decay. One section.

Age. Archean (granite).

N. H. W.

NO. 2045. GRANITE. (*Weathered.*)

Same place as the last, but nearer the graywacke.
Ref. Annual Report, xxiv, page 22.

Meg. Granite, which shows the ferromagnesian mineral altered to a straw yellow, laminated nacreous mineral.

Greenstone and granite. Quartzite.]

Mic. This mineral is not pleochroic perceptibly, and has n_p perpendicular to the lamellæ, which are numerous and not entirely parallel, some of them being hardly transparent. It seems to be *muscovite* altered from *biotite*, a condition of the dark element of the granite. One section.

Age. Archean (granite).

N. H. W.

NO. 2046. GRANITE (*with fluor*).

From Fluor island, in Saganaga lake, near the centre of sec. 14, T. 66-5. On the east side of the island, south of the large quartz vein.

Ref. Annual Report, xxiv, page 22.

Meg. Blue *fluorite* is disseminated more or less in the mass of the granite, which is red, some of the cubes being half an inch on the side. The cubic form does not, however, generally appear.

Mic. The section does not happen to cut any of the large fluorite grains, but a few small irregular ones are visible. The rock in general is highly feldspathic and contains *hornblende* and *quartz*. The feldspars have been much altered and reconstructed by secondary feldspars, both in the form of zonal and of micropegmatitic interpositions, and occasionally by *micropertitic*, accompanied by the development of some *microcline*. Later a weathering decay has developed *calcite* and *muscovite*. The small *fluorite* grains are of a faint amethystine color, and frequently are included within the feldspars in specks and in spreading, spider-like forms. A few grains of *sphene* are also in the feldspars. One section.

Age. Archean (granite).

N. H. W.

NO. 2047. GREENSTONE AND GRANITE.

Greenstone ridge on the south side of West Sea Gull lake, N. W. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 17, T. 65-5 W. The greenstone is cut by granite dikes.

Ref. Annual Report, xxiv, page 23. See, also, Annual Report, xx, page 83, Nos. 648G to 650G.

Meg. The hand sample shows the contact between the greenstone country rock and the granite dike. The two rocks are firmly cemented. The greenstone is a compact rock appearing like a fine-grained diabase. The granite is a white, fine-grained aphyte, composed of quartz and feldspar with a very little biotite and probably also muscovite. No section.

Age. Lower Keewatin cut by granite.

U. S. G.

NO. 2048. QUARTZITE. ("Chalcedonic.")

At the portage in sec. 12, T. 65-4, Saganaga lake.

Ref. Annual Report, xxiv, page 23; American Journal of Science, series 3, vol. xli, pages 386-390.

Meg. So-called chalcedonic silica; appearance like that at Tower, embraced in the granite.

Mic. The quartz grains are very fine, but they have a structure of elongation, so that the mass has a roughly fibrous aspect. Within the quartzite mass, however, are a few feldspathic grains, one being distinctly of *microcline*, while other grains are of *calcite*. The appearance of elongation is due not so much to the elongation of the individual *quartz* grains as to their rather uniform orientation in belts that run roughly parallel, causing light and dark to alternate in belts on rotation. One section.

Age. Inclusion in the Archean granite of Saganaga lake. N. H. W.

NO. 2049. QUARTZ. (*Vein.*)

Within a few feet of No. 2048, in the Saganaga granite.

Ref. Annual Report, xxiv, page 23.

Meg. Vitreous quartz from a vein.

Mic. This has a remarkable contrast with No. 2048, being in large plates that have the characteristic uniform polarization and extinction. One section.

Age. Vein in Saganaga granite.

Remark. The differences which these quartzes present indicate different origins or different histories, and perhaps both. No. 2049 is plainly from an ordinary vein of quartz, and so it appears in the rock in place. No. 2048 has not the form nor manner of a quartz vein in the rock, but rather of an irregular patch, and under the microscope it has none of the characters of vein quartz. N. H. W.

NO. 2050. GRANITE.

Same place as Nos. 2048 and 2049.

Ref. Annual Report, xxiv, page 23.

Meg. Granite in which occur the foregoing quartzes.

Mic. This is an ordinary, but considerably altered, granite, containing *epidote* (included occasionally within the feldspars), *hornblende*, *sphene*, with the usual *feldspars* and *quartz*. One section.

Age. Archean (granite). N. H. W.

NO. 2051. DIABASE. (*Porphyritic.*)

S. E. $\frac{1}{4}$ sec. 24, T. 65-4 W., west from Gunflint lake. From the high, isolated hill north of the railroad: forms a sill.

Ref. Annual Report, xxiv, page 26. (Compare Part I, page 66.)

Meg. Diabase with coarse, sporadic feldspar crystals and with larger groups of finer crystals which form feldspar rock or anorthosite.

Mic. The *pyroxene* is converted mostly, but not wholly, to *hornblende*, which shows still the ophitic relation to the smaller feldspars. The large feldspars are considerably affected by the development of mica. The specimen collected is illustrated by plate IV, figure 2. One section.

Age. Cabotian. N. H. W.

Siderite. Actinolite.]

No. 2052. SIDERYTE.

From the prominent hill near the centre of sec. 24, T. 65-4 W.; west of Gunflint lake.
Ref. Annual Report, xxiv, page 27.

Meg. A medium-grained, gray rock, in places showing fine bandings; effervesces freely in cold hydrochloric acid; weathers rusty. Is apparently composed of siderite, calcite and actinolite, the first in large amount and the last in fine star-like rosettes. Compare Nos. 437 and 1289.

Mic. A thin section made by Dr. Otto Kuntze shows this rock consists apparently only of *siderite* and *actinolite* (or *cummingtonite*). In the former are many globular grains of siderite, a feature that has been seen to characterize several of the secondary minerals generated by metamorphism. The latter mineral is prevailing in sheaves that spread at each end, but sometimes from one end a ramifying lot of fibres extend further and make connection with similar extension from some other sheaf. The rock is like No. 1289, and is allied to No. 437, and both are from the iron-bearing member of the Animikie. *Magnetite* dust is thick in spots, rendering some of the siderite nearly opaque.

Age. Animikie (iron-bearing member).

N. H. W.

No. 2053. ACTINOLYTE. (*Rock: zirkelyte.*)

N. W. $\frac{1}{4}$ S. E. $\frac{1}{4}$ sec. 24, T. 65-4 W.; west of Gunflint lake.
Ref. Annual Report, xxiv, page 27.

Meg. The rock is full of spherical masses which vary from one-eighth to one-half inch in diameter. They are very distinct on weathered surfaces, but on fresh fractures are hardly discernible. The spherical masses resist the effects of weathering much better than the interstitial material. The whole rock is quite fine grained and is greenish-gray in color, the spherical masses being a little darker colored than the rest of the rock. There is some carbonate present, probably calcite, as the rock effervesces a little in cold hydrochloric acid, and probably also siderite, as the rock on weathering turns yellowish with iron oxide. This rock is developed in the Animikie in connection with a horizontal fault plane or slip in which is a coarse breccia.

Mic. In ordinary light the spherical masses in the slide are quite distinct, and sometimes they are partially outlined by an area which contains considerable yellow iron oxide. The interstitial material, which is not abundant, is lighter colored than the spherical masses, and seems to have lost considerable in the grinding of the slide. Under crossed nicols the spherical masses are not very distinct, and the whole section breaks up into a closely matted mass of minute amphibole fibres, which appear to be grünerite-cummingtonite. One section.

Age. Animikie (iron-bearing member).

U. S. G.

Remark. In some parts this rock is finely scoriaceous; indeed, the interstitial areas between the spherical masses are uniformly porous. The balls that present

their outlines on the weathered surfaces resemble the balls that weather out from the lava sheet seen on Grand Portage island (No. 544), which is more or less glassy. There seems more reason to refer this rock to the igneous parts of the Animikie than to the fragmental. Its intimate connection with the iron-bearing member of the Animikie, into which it passes, is very significant. The spherical masses in this rock, consisting largely of actinolite, are comparable to the rosettes of actinolite in No. 2052.

Two additional sections of this rock were made by Dr. Otto Kuntze, one (a) from the balls, in such a manner as to cut two or three balls, showing at the same time some of the intervening rock-matter, and (b) from a part of the rock forming a thin layer (one-fourth of an inch) not embracing the balls, but immediately in contact with the balls. The former shows the intervening rock-matter is isotropic, with a few isolated grains that are evidently rusty siderite, greenish and apparently resulting from devitrification and alteration of a basic glass; the latter (b) is in part of the same material as that intervening between the balls but also contains a notable amount of siderite, and apparently fibres of some amphibole. The glassy part of (b) is in detached masses, which are so crowded with iron oxides as to be nearly opaque. These detached glassy masses also contain a few minute translucent spots that, so far as determinable, appear to be of siderite.

It hence appears that the balls are globules originating in a basic lava at the time of cooling, and the material that embraces them is a devitrified part of the same lava. It is also plain that this lava has become charged with iron, chiefly in the form of siderite. It appears also that this altered lava contains darker masses of opaque finer lava which are charged with oxide of iron rather than the carbonate. Thus the iron-bearing member of the Animikie at Gunflint lake is intimately associated with and grades into a basic devitrified lava. Compare Part III. N. H. W.

NO. 2054. GABBRO.

Same rock mass as No. 2051.

Ref. Annual Report, xxiv, page 27.

Meg. Presenting large, dark, crystal surfaces.

Mic. The rock, though from the same mass as No. 2051, can here hardly be said to be ophitic, and deserves hence the name gabbro. It is not porphyritic with earlier feldspars, but all the feldspars and the augite seem to have formed nearly simultaneously. *Magnetite* forms large and conspicuous tabular crystals. Pyroxene is changed to *uralite*. One section.

Age. Cabotian.

N. H. W.

NO. 2055. MICA SCHIST (*with cordierite.*)

From the west end of Loon lake (south of Gunflint); face of an obliquely ascending cliff which faces north, at two-thirds the distance toward the top.

Ref. Annual Report, xxiv, page 27.

Quartz schist. Quartzyte. Gabbro.]

Meg. Fine-grained, siliceous, supposed to be a portion of the Animikie.

Mic. The groundmass is of fine interlocking *quartz*. There are two micas, viz., *biotite* and *muscovite*, the latter of later origin than the *biotite* and the *quartz* which form inclosures within it. The *muscovite* forms larger plates than the *biotite* and by its colorlessness and its high double refraction is easily remarked. The *biotite* is usually older than the *quartz*. *Pyrite* in scattered small grains is quite abundant. Among the interlocking *quartzes* is occasionally a grain of a striated *feldspar*, while larger grains of low birefringent power have characters that show *cordierite*. One section.

Age. Animikie.

N. H. W.

NO. 2056. QUARTZ SCHIST.

Same place, same bluff, but higher up, toward the gabbro.

Ref. Annual Report, xxiv, page 27.

Meg. Siliceous, but fine grained.

Mic. Mostly *quartz*, but much coarser than in the last. There are many feldspathic grains indistinctly triclinic, but so much weathered that they are completely dimmed by microscopic inclusions. They sometimes lie within the *quartzes*, but usually they share in the interlocking plexus. *Biotite* is not very conspicuous, but varies from brown to greenish gray in small scales. One section.

Age. Animikie.

N. H. W.

NO. 2057. QUARTZYTE.

Same place, same cliff, still higher, 150 feet \pm above the lake, near the top of the ridge, dipping 60° to 70° southerly.

Ref. Annual Report, xxiv, page 28.

Meg. Fine grained and gray, siliceous.

Mic. *Quartz*, principally, but mingled with *plagioclase* and with *biotite*, composes this rock, including also a little *pyrite*. The *feldspars* are decayed by weathering. One section.

Age. Animikie.

N. H. W.

NO. 2058. GABBRO. (*Ophitic.*)

Same place, 150 feet south of the foregoing, but not much higher.

Ref. Annual Report, xxiv, page 28.

Meg. Coarse, gray.

Mic. The *magnetite* in one instance is surrounded by a fringe of brown *biotite* which penetrates the surrounding *feldspars* as if it were of older date. The *olivine* is quite fresh, about cotemporary with the *feldspars* and apparently *fayalite*. The *augite* shows a diallage structure in a few grains, and frequently surrounds the *olivines*. One section.

Age. Cabotian.

N. H. W.

NO. 2059. QUARTZYTE.

Same place as No. 2057.

Ref. Annual Report, xxiv, page 28.

Meg. Another phase of the fragmental rock.

Mic. As in the other contact rocks at this place the original *quartz* is entirely re-wrought, so that no clastic structure remains. There are a few *feldspars*, but dimmed by inclusions presumed to be due to weathering, and a subordinate amount of *biotite*. One section.

Age. Animikie.

Remark. It is worthy of remark that the clastic structure of the quartz has given place universally, as in the Pewabic quartzite, to an interlocking granular plexus, in which are a few grains of triclinic feldspar. Instead of pyroxenic minerals the contact here has produced mica. Whether at points near the gabbro the same or similar ferromagnesian minerals would make their appearance at this place, there is no means of stating, as the immediate contact was not seen.

N. H. W.

NO. 2060. QUARTZYTE. (*Gneissic.*)

Same place.

Ref. Annual Report, xxiv, page 29.

Meg. A coarser rock, presenting a gneissoid aspect.

Mic. The rock is essentially the same as the foregoing, but it exhibits a greater variation in size amongst the *quartz* grains. The same is true also of the *feldspars*. Thus the rock approaches a perfect granitic structure. In this slide the *biotite* is associated intimately with *pennine*. One section.

Age. Animikie.

N. H. W.

NO. 2061. MICA SCHIST.

At a point a little further east (southwest end of Loon lake).

Ref. Annual Report, xxiv, page 29.

Meg. A part of the less siliceous portion of the Animikie, but very fine grained; "black rock."

Mic. The rock is in all respects like the foregoing except being finer. The *biotite* micas are older than the interlocking *quartz*, but the *muscovite* is later. One section.

Age. Animikie.

Remark. It is evident that these clastic beds belong to the upper part of the Animikie.

N. H. W.

NO. 2064. GABBRO (*with olivine*).

The rock of the great sill at mount Reunion, forming the summit, Rove lake.

Ref. Annual Report, xxiv, page 30.

Meg. Medium grained, from one of the fallen blocks.

Gabbro. Diabase. Zirkelyte.]

Mic. The *augite*, *olivine* and *feldspar* were formed about simultaneously, but occasionally the *augite* surrounds the *olivine*. There is considerable *magnetite*, which was later than the *feldspars* and *olivine*. While most of the *augite* is granular, some is ophitic, as if there had been two dates at which it was generated. There is also some *quartz* which enters the *feldspar* in a granophyric manner (Plate V, figure 6). One section.

Age. Cabotian.

Remark. This is one of the largest known sills and can be traced, with interruptions, as far as to Arrow river, where it seems to have its strike into Canada, although it appears (as supposed) in similar hills further east along the boundary. Its thickness is about 100 feet at mount Reunion.

N. H. W.

NO. 2065. GABBRO.

Eastern part of Rove lake. From a sill near the water on the south side; one and one-half miles east of mount Reunion.

Ref. Annual Report, xxiv, page 31.

Meg. Fine grained.

Mic. So far as concerns structure and composition, this rock is like that of the great sill of mount Reunion, except in being finer grained, and in having decayed so much that no *olivine* is preserved and the *augite* is mostly uralitized.

Age. Cabotian.

N. H. W.

NO. 2066. DIABASE. (*Amygdaloidal.*)

Summit of hills just south of the conglomerate (Nos. 1902, 1903 and 1904). Probably in N. E. $\frac{1}{4}$ sec. 25, T. 64-3 E.

Ref. Annual Report, xxiv, page 35.

Meg. A fine-grained, dark-gray, diabasic rock, with chalcedonic amygdules. No section.

Age. Manitou.

U. S. G.

NO. 2067. ZIRKELYTE. (*Basalt glass.*)

Near the same place as No. 2066.

Ref. Annual Report, xxiv, page 36.

Meg. A fine-grained, light-gray, rather soft rock, looking like a decayed basic eruptive. Compare No. 1905 which somewhat resembles this rock.

Mic. The slide shows a rock that consisted very largely of basic *glass*, but now contains, along the numerous fissures by which it is parted into somewhat perlitic areas, much *calcite*, and frequent minute *feldspar* crystals which have lost their power of individual polarization by the substitution of kaolinic products of alteration. These fissure-lines are more transparent than the glass itself, which is brown, and in them are nearly all the crystal forms visible. Sometimes these fissure-lines take shapes and directions that suggest a fluidal origin at the commencement of flowage.

The brown glass, where it surrounds the little feldspar crystals, seems to be converted into a transparent glass in the immediate vicinity of the little feldspars, forming a halo of light about the crystal form, visible on the removal of one nicol, but invisible between crossed nicols. Also throughout the brown glass, when the section is quite thin, the same phenomenon is apparent, viz., the brown glass is thickly sown with spots or globules which are transparent with one nicol, and invisible with both. In both cases it is probably due to incomplete crystallization, from the glassy substance, the initial crystals or points of crystallization going no further than the globular form and remaining mono-refrangent. One section.

Age. Manitou.

N. H. W.

NO. 2068. DIABASE. (*Porphyritic and with zirkelyte.*)

Near the same place as No. 2066; a little further south.

Ref. Annual Report, xxiv, page 36.

Meg. Fine-grained, dark, diabasic rock, containing numerous large porphyritic plagioclases.

Mic. This rock is qualitatively the same as No. 2077, but its crystallization is so far advanced that as a whole it is worthy of a different name.

If it ever embraced augite, it was in coarse, ophitic crystals, but no trace of augite remains. There is, however, a nearly isotropic, greenish substance which occupies such relation to the feldspars, and may be the result of alteration of such augite. When highly magnified in strong light this green substance is resolved into a mesh of fine fibres, which are in bunches or bundles, but occasionally acquire a spherulitic radiated arrangement, with parallel extinction and positive elongation and low double refraction, all suggesting *pennine*. It is also slightly pleochroic.

The *zirkelyte* of this slide is not brown, but is blackened by segregation of specks of iron ore. One section.

Age. Manitou.

N. H. W.

NO. 2069. TACONYTE. (*Pebbles.*)

Pebbles from the conglomerate in the hill-range south side of Puckwunge valley, south from South Fowl lake. Compare Nos. 1903 and 1904.

Ref. Annual Report, xxiv, page 36.

Meg. Reddish and somewhat taconitic in fine structure.

Mic. Two of the slides are of the peculiar quartzite described as taconyte. The rounded pebbles that compose the main pebble are stained with *hematite*, and they vary in the fineness of the grain of the quartz of which they are composed, often seeming to be of devitrified glass or like the feldspars replaced by a fine micro-granulitic growth seen in the conglomerate of Ogishke Muncie lake. In two or three of the constituent granules are seen apparently remains of the green

Graywacke. Quartzite.]

substance (*glauconite?*) from which the iron oxide and in part the silica are by Mr. Spurr supposed to be derived. In this case, however, these green particles are of fine *actinolite* fibres. In other cases the little rounded pebbles take elongated shapes almost inconsistent with the idea that they are of detrital beach-worn derivation. Still, the larger pebble, of which these are the minuter units, is unquestionably a pebble of such origin, constituting a part of a siliceous conglomerate.

Two other slides are of a quartz from some vein being coarsely fibrous and of positive elongation. Four sections.

Age. Pebbles in the base of the Potsdam, *i. e.*, Puckwunge conglomerate. N. H. W.

NO. 2071. GRAYWACKE.

In the valley of the Puckwunge, north of the stream, perhaps 200 feet below the conglomerate above.
Ref. Annual Report, xxiv, page 38.

Meg. Forms low outcrops on the level land. A gritty, gray rock.

Mic. *Quartz*, originally in rounded clastic grains, now made angular by secondary enlargement, and *feldspar* grains of about the same size, sometimes a plagioclase like *oligoclase*, and sometimes *microcline*, but generally unidentifiable as to species, constitute the most of this rock. These feldspars are frequently composed of a micro-granulitic mosaic (quartz and feldspar) substituted for the original feldspar, and thus resemble the feldspars of the Ogishke conglomerate, from which they may have been derived as pebbles. Besides the debris, of the nature of the grit itself, the cement consists largely of *calcite*, but also with a little secondary quartz, some *sericite* (or other mica) and a few spicules of *actinolite*. One section.

Age. Animikie.

Remark. There is a general resemblance between this grit and some portions of the Ogishke conglomerate, in its microscopic characters, but it is supposed to be a portion of the Animikie. It is occasionally in outcrop along the Grand Portage trail where it is cut, as here, by the great dikes of that region, and it has been named *Grand Portage graywacke*. Compare vol. iv, page 510. N. H. W.

NO. 2073. GRAYWACKE.

On the Grand Portage trail about a mile from the (north or) west end.
Ref. Annual Report, xxiv, page 39.

Meg. Similar to Nos. 2070 and 2071.

Mic. The same characters as seen in No. 2071, except that calcite plays no part in the cement. One section.

Age. Animikie. N. H. W.

NO. 2074. QUARTZYTE.

Grand Portage island; near contact with a trap sheet.
Ref. Annual Report, xxiv, page 39.

Meg. A coarse, compact, greenish quartzite or conglomerate with a dark, fine-grained cement in which are numerous rounded fragments of quartz, feldspar, quartzite and "red rock." No section.

Age. Potsdam.

U. S. G.

NO. 2078. GRANITE. (*Porphyritic.*)

St. Cloud; used for the new water-power dam at Minneapolis; also for monuments.

Ref. Annual Report, xxiv, page 39.

Meg. Coarse, often reddish, usually gray.

Mic. The large crystals are of *orthoclase*, but are closely ingrown with secondary *albite*(?) making a *micropertite*. The extinction angle of the former, on a section cut perpendicular to the axis n_z , which is perpendicular to the cleavage 010, is 5° ; but on the associated albite measured on the same cleavage is 10° . In the same section these albite intergrowths are narrow, interrupted and yet substantially parallel with themselves, making an angle with the same cleavage of about 70° . Other triclinic feldspars are probably of *oligoclase*, but there is no favorable section for specifying them in the slide. In one of the orthoclases is a minute vermicular micropegmatyte of *quartz*. At the same time quartz in large grains constitutes an important portion of the rock. The dark element is mostly *biotite*, which has numerous inclusions of *apatite* and a few of *magnetite*, and others of *zircon*, about which are formed conspicuous dark aureoles. *Hornblende*, of which there is but little in the rock, is in some degree converted to *chlorite*. Within the feldspars are distributed irregularly multitudes of minute scales of *muscovite*. One of the feldspars presents a coarse, irregular structure characteristic of *microcline*, but it is cut quite obliquely. Within this crystal is also seen the same albitic intergrowth, constituting the *microcline micropertite*, of Brögger. One section.

Age. Archean (granite).

N. H. W.

NO. 2090. DIABASE.

Fair sample of the "gabbro" at Short Line park, near Thomson, cut by a dike sixty feet wide.

Ref. Annual Report, xxiv, page 40.

Meg. A rather coarse-grained, diabasic rock, much altered and now composed largely of hornblende which in places is in areas which give a lustre-mottled aspect to the specimen.

Mic. The rock has a distinctly ophitic structure with uralitized augite and small feldspars. It also seems to have contained originally a considerable amount of zirkelyte, and at the same time some of the feldspars are so decayed that they consist of a confused lot of crystalliths, *magnetite*, *epidote*, *mica*(?), and probably others, which gives them a resemblance to the zirkelyte as now devitrified.

Age. Beaver Bay diabase. Cabotian.

Remark. It is supposed that the alteration seen in this rock took place after consolidation, but prior to cooling.

N. H. W.

Greenstone. Conglomerate. Porphyrel.]

NO. 2099. GREENSTONE. (*Matrix of conglomerate.*)

Small island in Long lake near the west side of S. W. $\frac{1}{4}$ sec. 29, T. 63-12 W.
Ref. Annual Report, xxiv, page 41.

Meg. Rather light green, schistose, fine grained and rather soft. Some small hornblendes are scattered through the rock.

Mic. The most conspicuous and also the largest of the ingredients is *feldspar*. It appears to have been enlarged by secondary growths, as it interlocks with the grains adjacent, and its original (central) portions are altered, containing many *sericite* scales and *calcite*, which are wanting in the peripheral portions. *Quartz* is also secondary, forming some areas as large as the feldspars. Shreds of *hornblende* give a green cast to the rock. These are but slightly pleochroic. Running across the slide is a microscopic vein of fresh minerals. These are *quartz* and *striated feldspar*. These minerals interlock in the adjoining rock mass. There is much *calcite* and *sericite* in the adjoining rock, but none (or almost none) in the vein. One section.

Age. Upper Keewatin, probably of the age of the Stuntz conglomerate.

Remark. This is a wholly crystalline rock, even in its interlocking structure, and would pass for an "altered diabase," were it not for the field relations, which demonstrate beyond question that it was at first fragmental.

N. H. W.

NO. 2101. CONGLOMERATE.

West shore of Long lake; S. E. $\frac{1}{4}$ sec. 30, T. 63-12 W.
Ref. Annual Report, xxiv, page 42.

Meg. The three specimens collected vary from rock resembling No. 2099 to a fine, almost flinty greenstone. These specimens evidently represent the matrix of the conglomerate. No section.

Age. Upper Keewatin.

U. S. G.

NO. 2102. PORPHYREL. (*Sheared.*)

Same place as No. 2101 and rising in the midst of No. 2101.
Ref. Annual Report, xxiv, page 42.

Meg. Gray, feldspathic and evidently siliceous. Crushed and deformed, medium grained, appearing suddenly in the midst of No. 2101 in the manner of an isolated mass or intrusive, but not determinable as to its extent. Holds some pyrite and was originally interspersed with large feldspars, as if porphyritic.

Mic. The large feldspars, which are polysynthetically twinned, seem to be *albite*, as they have n_g in the acute angle of the optic axes and an extinction angle of 76° in a section nearly perpendicular to n_p , and $15\frac{1}{2}^\circ$ on a section nearly perpendicular to n_g . They show much fracturing and alteration, being filled with fine grains of *calcite* and *sericite*, the latter sometimes taking the form of semi-rosettes. They grade downward through fragmentary grains to small sizes. There is a com-

paratively small amount of *hornblende* in ragged shapes, and of *chlorite*. The most of the rock is composed of an interlocking network of finer grains of *quartz*, calcite, sericite, feldspar whose specific determination is impossible, and shreds of hornblende and of chlorite, with occasional cubes of *pyrite*. These minerals are certainly all of secondary generation, and are due to the stresses of pressure and of heat, with underground moisture, to which the originals were subjected. It is not likely that this rock was ever truly molten, but was a debris which has taken on a recrystallization, the large feldspars being the only original minerals whose forms can now be identified; and it is probable that they also were at first not albite. One section.

Age. "Intrusive" amongst the Upper Keewatin.

N. H. W.

No. 2104. DIORYTE.

Small island near the west shore of Long lake, N. W. $\frac{1}{4}$ S. W. $\frac{1}{4}$ sec. 29, T. 63-12 W. Apparently a condition of the prevalent greenstone.

Ref. Annual Report, xxiv, page 42.

Meg. Clean, gray, medium grained, composed essentially of white feldspar and hornblende, not showing schistose structure, but having slight, irregular cloudings of darker tint.

Mic. The minerals are *hornblende*, feebly pleochroic, with sharp fibres that extend beyond the average outlines of the grains and pierce the *feldspar* and *quartz*, and also sometimes run in the same way into the fibrous portions of other hornblendes. These fibres are certainly of secondary growth and polarize less highly than the body of the grain to which they belong. The color in the same grain may run downward from blue, or the first "sensitive" violet, through all the colors to white, the last being at the terminations of the fibres. In the same way secondary growths of hornblende appear scattered throughout the grains themselves, as shown by the white areas resembling the fibrous terminations, and occasionally the sharp fibres of one hornblende pierce the older portions of another, the structure being somewhat interrupted in its passage, but on emerging on the other side such fibres extinguish in unison with the same fibres in the parent mass. It is apparent that such penetrating fibres made their way through the older hornblende at a time of general metasomatic rearrangement, more or less complete. In their passage through the body of the old hornblende they did not perfect their crystalline structure, for they are marked by light streaks that do not wholly extinguish in an entire revolution. There are also multitudes of little hornblendes more or less globular or club-shaped scattered through the matrix.

The feldspars, which are *plagioclase*, are so darkened between crossed nicols that they cannot be determined specifically. They are frequently angular and lie in a fine matrix, much fresher, of the same materials. They are not porphyritic, but imperfect or fragmentary, and they also show narrow rims of secondary growth.

Dioryte.]

There is a little secondary *quartz* which embraces and interlocks with the feldspars, and apparently *leucoxene*, which is nearly opaque, but in reflected light is white and similar to the feldspars. One section.

Age. Keewatin.

Remark. This rock in its recrystalline condition is comparable with the granites of Kekequabic and Snowbank lakes.

N. H. W.

NO. 2120. DIORYTE.

About 200 feet above Long lake, and from the very top of the hill west side of sec. 18, T. 63-12 W.

Ref. Annual Report, xxiv, page 43.

Meg. Medium-grained, greenish gray.

Mic. This rock exhibits an ophitic relation between the feldspars and the hornblendes, showing that its constituents crystallized from a magma, and that the *feldspar* formed first. These have suffered a complete transformation, being permeated by fine, granular elements, such as *sericite*, *zoisite*, *epidote*, so that their optic characters are wholly obliterated. Subsequently they have suffered a regeneration, and have fresh, narrow veins of secondary feldspar, and inter-lamellar growths in an imperfect micro-pegmatitic form.

The *hornblende* has secondary fibrous enlargements in a manner similar to that described in No. 2104, but far less marked. The slide also contains several small areas of *quartz* which appears to be secondary. One section.

Age. Keewatin.

Remark. In all respects, except in having an ophitic structure, this rock resembles that of No. 2104.

N. H. W.

NO. 2125. DIORYTE. (*Probably fragmental.*)

N. E. $\frac{1}{4}$ S. E. $\frac{1}{4}$ sec. 36, T. 63-13 W., west end of Long lake. From a ridge between the quartz vein and the railroad.

Ref. Annual Report, xxiv, page 43.

Meg. A medium-grained rock of greenish-gray color, composed essentially of feldspar and hornblende, the latter being conspicuous by its size. All the grain and structure indicate a much pressed and perhaps sheared rock.

Mic. The *hornblende* is in ragged, and often chloritized, grains. It has no ophitic structure, or other relation to the feldspars that would show that it crystallized from a molten magma. Its forms and sizes are consistent with the supposition that the hornblende was a fragmental ingredient in the process of accumulation of a green debris from older greenstones, and this origin is still more strongly probable from the nature of the rest of the rock, which consists of fragments of hornblendes, tending to become rods by separations along the cleavages, of secondary *feldspars*, *epidote*, *calcite* (sometimes surrounding crystals of epidote), *sericite*, *zoisite*, and nearly opaque *leucoxene*. One section.

Age. Probably near the bottom of the Upper Keewatin.

Remark. Such a rock might be called dioryte, and its present condition ascribed to pressure and brecciation. Its evidently fragmental origin, however, is shown by the photograph reproduced in plate W, in volume iv. Compare, also, plate Z, volume iv, both of the final report. Compare, also, rock No. 1786. N. H. W.

NO. 2126. GRAYWACKE. (*Jaspilitic.*)

Northeast corner sec. 36, T. 63-13 W. From a jaspilyte belt near the west end of Long lake.
Ref. Annual Report, xxiv, page 43.

Meg. A fine-grained, purple rock composed apparently of quartz, feldspar, hornblende (or chlorite) and a micaceous mineral. The rock resembles some of the fine-grained graywackes that have been reddened by surface fires.

Mic. A great number of small magnetite cubes are scattered through a finer matrix of chloritic and hornblendic fibres and scales, fine feldspar fragments and quartz. Some of the coarser opaque ores are of pyrite. The fine sparkling appearance is caused by reflection from magnetite crystals. One section.

Age. Keewatin (probably Lower).

Remark. In places this rock varies to a distinct jaspilyte, and as such has attracted attention as an iron ore and been traced through the country for about a mile. The rock blends with the country greenstone by acquiring more and more of the hornblendic component. The structure of this belt resembles that seen at Moose lake (No. 2180), but it is less conspicuously conglomeratic. N. H. W.

NO. 2127. QUARTZ. (*Gold ore.*)

S. W. $\frac{1}{4}$ S. W. $\frac{1}{4}$ sec. 30, T. 63-12 W.
Ref. Annual Report, xxiv, page 44.

Meg. White, vitreous, vein quartz, containing several minerals, as follows: pyrite, chalcopyrite or other copper sulphides, galena, sphalerite (apparently), malachite and azurite; also some granitic masses.

An assay of this sample by Sharpless and Winchell gave the following results: .24 ounce gold per ton and 6.04 ounces silver per ton, or \$4.96 of gold and \$3.62 of silver per ton, gold being taken at \$20.67 per ounce and silver at 60 cents. This would make the ore worth \$8.58 per ton. The ore (No. 2027) is a fair sample from one of the test pits at this place, the pit which showed what appeared to be the best ore. Other assays, by the same chemists, of ore from this locality, are as follows:

	I	II	III
Gold, per ton, - - - - -	5.16	.76
Silver, per ton. - - - - -	2.93	.48	.04
Totals, - - - - -	\$8.09	\$1.24	\$.04

No section.

Age. Vein in Archean.

U. S. G.

Diabase and grit.]

No. 2129. GRIT. (*Volcanic.*)

Taylor's Falls, corner of Government and West streets, 200 feet above the river.
Ref. Annual Report, xxiv, page 44.

Meg. Granular, siliceous, greenish, in sedimentary structures.

Mic. Named in order of abundance the ingredients of this rock are *epidote*, *quartz*, *leucoxene*(?), devitrified *glass*; these are in rounded forms, but the rounded forms are themselves composite, especially the quartz, and made up of a great many interlocking grains. The epidote is also of irregular shape in some instances, but it has the appearance, for the most part, of having been accumulated as a part of a beach sand. There are also variable amounts of *hornblende*, *actinolite* (secondary fibres growing from the hornblende and piercing the quartzes) and rounded pebbles of diabase. In the last are sometimes grains of epidote, which seems to show that the epidote was generated before it was made a constituent of this grit. Much of the quartz is pneumatolitic since the accumulation of the debris. Three sections.

Age. Keweenawan.

N. H. W.

No. 2129A. GRIT. (*Volcanic.*)

Same place as No. 2129.
Ref. Annual Report, xxiv, page 44.

Meg. Very fine and almost flinty condition of the same rock as No. 2129.

Mic. Consists of fine angular grains of *quartz* and *epidote*. One section.

Age. Keweenawan.

N. H. W.

No. 2131. GRIT. (*Epidotic.*)

Taylor's Falls, 250 to 300 feet above the river.
Ref. Annual Report, xxiv, page 44.

Meg. Irregularly cavernous and associated with fine-grained epidotic and quartzose rock, somewhat resembling No. 2129, but of a different composition, as it contains also much fine, fragmental feldspar. In the midst of this is a piece of volcanic glass, now changed (excepting its minute feldspars) to an isotropic chloritic substance. One section.

Age. Keweenawan.

N. H. W.

No. 2132. DIABASE AND GRIT.

Taylor's Falls, 1,030 to 1,040 feet above the river, near the summit.
Ref. Annual Report, xxiv, page 45.

Meg. Compact diabase, more or less porphyritic, seamed by a fine, greenish rock resembling No. 2129A or No. 2131, the widest seam being three-fourths of an inch.

Mic. The slide is composed of two different rocks, viz.: very much altered (weathered) porphyritic diabase and a granular mixture of fine *quartz* and *epidote*, evidently of clastic structure and origin, the latter forming thin greenish seams in the former. One section.

Age. Keweenawan.

Remark. These greenish seams are apparently of the nature of a clastic material which has entered fissures from above.* N. H. W.

No. 2134. GRIT. (*Breccia, volcanic.*)

Taylor's Falls, one block west of the public school building, about 175 feet above the river.
Ref. Annual Report, xxiv, page 45.

Meg. Breccia of rock similar to No. 2129.

Mic. Besides the *quartz* and *epidote* this slide contains what appears to have been a fragment of lava, now nearly opaque with *magnetite*, in which are small quartzes and epidote crystals (pseudomorphs after feldspar), with a background of quartz(?) embracing the whole poikilitically. This epidote has not so much a clastic aspect as that in No. 2129. One section.

Age. Keweenawan. N. H. W.

No. 2135. IRON ORE. (*Pisolitic.*)

Republic mine, sec. 4, T. 58-18, Mesabi Iron range.
Ref. Annual Report, xxiv, page 47.

Meg. The ore is massive, siliceous, but shows in part a pisolitic structure.

Mic. Under the microscope the taconitic structure is quite apparent, some of the round grains consisting wholly of microgranulitic quartz. One section.

Age. Animikie (iron-bearing member). Compare Nos. 1294 and 1530. N. H. W.

No. 2136. IRON ORE. (*Pisolitic.*)

Mountain Iron mine, Mesabi Iron range.
Ref. Annual Report, xxiv, page 47.

Meg. Not siliceous. Compare No. 1294.

Mic. The ore grains are frequently hollow, or are formed by two shells of ore which are connected in some places, with a vacant space, or two spaces at the centre. The general shape of the ore grains is that of the taconitic greensand. The ore is loose and soft, and crumbles readily into a finer powder or dust. The centres of the grains sometimes contain quartz. Three sections.

Age. Animikie (iron-bearing member). N. H. W.

No. 2138. TACONYTE. (*Siliceous.*)

Mountain Iron mine, Mesabi Iron range.
Ref. Annual Report, xxi, page 160, rock *b*; Annual Report, xxiv, page 47. Compare No. 1295.

Meg. The quartzite shows inclusions of darker ingredients.

Mic. The groundwork is exceedingly fine and apparently consists, as usual, of interlocking quartz. In the groundmass are the outlines of the usual taconitic granules which are frequently stained with a little *iron* as well as by *actinolite*(?), more or less dimmed by alteration. There are irregular areas, and particularly the

*M. E. WADSWORTH. *Report of the State Board of Geological Survey (Michigan), for the years 1891 and 1892 [1893], p. 130.*

Taconyte. Quartzite.]

triangular spaces embraced between the roundish taconite grains, which are filled with much coarser secondary quartz interlocked in apparently the same manner as in the grains. The difference of texture, while marking the outlines and size of the original grains, seems to indicate that the pebbles (taconyte grains) were deposited in their present places prior to the introduction of the intergranular silica. Lastly there are narrow strips or belts of fibrous silica, apparently arranged along cracks, to which they stand perpendicular, which, having a negative elongation can correctly be styled *chalcedony*, the rest of the silica, composing the interlocking mass in general, both coarse and fine, being simply ordinary quartz, so far as observed.

In this slide are also two grains of distinctly different kind, being of quartz of foreign origin, which must have accumulated when the taconitic "greensand" was brought together. One is angular and has a single orientation. It lies in the midst of fine interlocking quartz, with which it has no sympathy, but has a surrounding coating of iron ore. The other is a round pebble of coarse interlocking quartzite. It has distinct boundaries as a pebble, and also lies in the matrix of fine interlocking quartz. It is also coated with a film of iron, and iron enters somewhat within it. It is suddenly and boldly set off from the matrix in which it lies. So far as they go these foreign grains indicate a fragmental manner of accumulation for the original globular constituents of this rock. One section.

Age. Animikie.

Remark. The roundish taconitic grains in this rock, which is now almost wholly of quartz, are of two sorts: (1) Very fine or flinty, siliceous, resembling the quartz-feldspar mosaic of devitrified glass, and undistinguishable from flinty masses in the Animikie at Gunflint lake, as those embraced in No. 312, and like the flint of Nos. 1277 and 1295. (2) Irregularly shaped, but roundish, forms that are largely opaque with iron and still more resemble devitrified glass, or lava sand. The latter is represented in figure 3, plate V.

N. H. W.

No. 2139. QUARTZYTE.

Mountain Iron mine, Mesabi Iron range.

Ref. Annual Report, xxi, page 160, rock *c*; Annual Report, xxiv, page 48.

Meg. Greenish-gray, fine Pokegama quartzite, clearly striped parallel with the usual sedimentary strike of the region. Lies below the iron-bearing strata.

Mic. This quartzite appears quite different from the foregoing from this region. It is plainly of elastic origin and structure. The grains are angular, and, while they plainly have a secondary growth which forms an interlocking mass, they are not wholly of secondary date. Mingled with them are a few grains of striated *feldspar* and *microcline* and of *muscovite*. There is in this rock no visible taconitic structure. One section.

Age. Animikie.

N. H. W.

NO. 2140. QUARTZYTE.

Mountain Iron mine, Mesabi Iron range. Same place as No. 2139.

Ref. Annual Report, xxi, page 160, rock *d*; Annual Report, xxiv, page 48.

Meg. Coarser than No. 2139.

Mic. The boundaries of the original clastic grains are marked off from the secondary additions by the usual line of colored impurities. The original grains vary considerably in size and are accompanied, as in No. 2139, by a few triclinic feldspars. Between the quartzes, and sometimes staining them within, is a gray-greenish substance which appears to be chloritized hornblende. This substance, under favorable conditions, has a slight polychroism. This hornblendo-chloritic greenish substance sometimes takes the form of a spongy, gray mass in which lie many angular grains of quartz, and sometimes it forms small spaces without containing quartzes. It then suggests the possibility of its being of the nature of devitrified volcanic ash. One section.

Age. Animikie (Pokegama).

N. H. W.

NO. 2141. TACONYTE.

Mountain Iron mine, Mesabi Iron range.

Ref. Annual Report, xxi, page 160, rock *e*; Annual Report, xxiv, page 48.

Meg. Quartzyte, with large per cent of iron ore.

Mic. This rock is wholly of secondary origin in its present condition, the quartz forming about one-half, and interlocking in the characteristic mosaic manner of taconyte. Some of the taconitic globules are nearly wholly opaque with iron, and some are composed of an exceedingly fine mosaic of quartz undistinguishable from the flint or devitrified silicified glass of Gunflint lake, and the same as seen in No. 2138. One section.

Age. Animikie (iron-bearing member).

N. H. W.

NO. 2145. GREENSTONE SCHIST. (*Pebbly.*)

S. W. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 36, T. 64-11, Saturday lake, south from the east end of the portage from Fall lake; a low bluff.

Ref. Annual Report, xxiv, page 49. Compare rock No. 175W.

Meg. Appearing greenish, pebbly and occasionally sericitic. Pebbles mostly less than three inches in diameter, but reaching eight to ten inches.

Mic. Abundant fine grains of *epidote* lie in a chloritic, hornblendic and calcareous matrix, associated with some cubes of *pyrite*. The structure is decidedly schistose. The small glassy feldspars are of secondary generation, but the larger feldspars, plainly clastic in origin, are dim and decayed. One section.

Age. Archean (Keewatin).

N. H. W.

NO. 2146. GREENWACKE.

Stragglng (dike?) cutting No. 2145.

Ref. Annual Report, xxiv, page 49.

Meg. Fine-grained, weathering lighter, with schistosity parallel with that of the enclosing rock.

Mic. This appears now like a schist. Old *feldspars*, secondary *feldspars*, *calcite*, *leucoxene*, and some *mica* compose this rock. One section.

Age. Archean (Keewatin).

Remark. Neither the field relations nor the petrographic characters are sufficient, nor both together, to determine whether this rock exists as a dike or a part of the clastics. The occasional crowding which it manifests upon the other beds, indicating an intrusive nature, may be due to crumpling and overthrust, while the microscopic characters rather favor a clastic origin.

N. H. W.

NO. 2148. GREEN SCHIST.

A little further south but still on the S. W. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 36, T. 64-11. Saturday lake; a second low bluff.

Ref. Annual Report, xxiv, page 49.

Meg. Rock is more uniform, but having scattered siliceous and calcareous spots, somewhat resembling amygdaloid, the silica areas sometimes being from two inches to two or three feet in diameter. The weathering of the calcite gives a decided aspect of porosity.

Mic. It is evident that these areas are of secondary origin, due to the replacement of some of the minerals by *calcite* and *quartz*, the latter being micro-granulitic and probably secondary after feldspar, while the calcite is the result of the same replacement, but accumulated as pseudamygdules. Calcite, moreover, is distributed widely through the rock in general. One section.

Age. Archean (Keewatin).

N. H. W.

NO. 2148A. SILICEOUS PART OF NO. 2148.

Same place as No. 2148.

Ref. Annual Report, xxiv, page 50.

Meg. Of irregular shape, evidently not wholly of quartz.

Mic. The *quartz* is of pneumatolitic origin and micro-granulitic structure, but the grains vary considerably in size. Nine-tenths or more are of such quartz, the rest being *calcite* and *epidote*. One section.

Age. Keewatin.

N. H. W.

2158. SERPENTINE. (*Imperfect.*)

Southwest corner of sec. 16, T. 64-10, Bassimenan lake.

Ref. Annual Report, xxiv, page 51.

Meg. Apparently originally peridotite.

Mic. This rock is largely serpentinized, but there are remnants of all the original minerals. The structure is wholly destroyed, apparently by decay and by crushing. One section.

Age. Archean (Keewatin).

Remark. This rock has been used by the aborigines for making pipes.

N. H. W.

NO. 2159. AMPHIBOLYTE. (*Epidotic.*)

Sec. 16, T. 64-10, Bassimenan lake. At the dull, high point just west of the mouth of the river which here enters the lake.

Ref. Annual Report, xxiv, page 52.

Meg. Schistose, hornblendic, with patches that weather lighter.

Mic. The rock is largely of *hornblende* and *epidote*, with a little *sphene*. What little feldspar there was in this rock formerly has been replaced by an irregular interlocking group of secondary *feldspars*. One section.

Age. Archean (Keewatin).

N. H. W.

NO. 2161. QUARTZ-FELDSPAR SCHIST.

Midway on the portage between Oak Point lake and Little Sucker lake, T. 64-10, lying next south of the area of granite.

Ref. Annual Report, xxiv, page 52.

Meg. Gray, fine-grained, siliceous, pyritiferous, schistose.

Mic. Evidently a sheared fragmental rock, consisting of fine angular quartz grains, some *old feldspars*, *mica*, *pyrite*, *epidote*. It is evident that a great many old feldspars have been altered into the micro-granulitic mosaic (quartz and feldspar) which is also the product sometimes of recrystallization from a schist of elastic origin to a new rock, approaching granite in proportion as this replacement is coarser and more and more prevalent. One section.

Age. Archean (Lower Keewatin).

N. H. W.

NO. 2162. QUARTZ SCHIST. (*Jaspilitic.*)

Little Sucker lake, south shore, near the portage going to Pine lake; sec. 27, T. 64-10.

Ref. Annual Report, xxiv, page 52.

Meg. Very siliceous, weathering nearly as white as a granite, fine grained, gray-green within, fibro-schistose, but not visibly laminated, rising in bold glaciated bosses on the weathered surface pitted from decay of some of the elements of the rock.

Mic. The rock consists essentially of fine interlocking quartz, but with a liberal cement of *calcite*, muscovite and of *chlorite* or chloritized *hornblende*. There are a few *tourmaline* crystals and frequent spicules of *rutile*, and apparently of *actinolite*. The pitted aspect of the weathered surface is due to the weathering out of the chloritic or calcitic areas. One section.

Age. Archean (Keewatin).

Greenstone. Porphyrel.]

Remark. This rock is allied to the greenstones of clastic origin, of which it furnishes a novel phase. It occurs within the general greenstone belt, and it probably fades out into that rock. Compare No. 869.

N. H. W.

No. 2164. GREENSTONE.

Northwest corner S. W. $\frac{1}{4}$ sec. 26, T. 64-10, Pine lake.*Ref.* Annual Report, xxiv, page 53.

Meg. Speckled with light and dark, a kind of "pepper-and-salt" rock, apparently a phase of a massive greenstone.

Mic. This rock perhaps had originally an ophitic structure, and some of the feldspars still show a "radial" arrangement, but the pyroxene is altered to *hornblende*, which is probably the "pepper" of the megascopic aspect, while the "salt" is represented by feldspar and *epidote*, and by *calcite*. *Feldspar* is present in ragged remnants, and in altered crystals. The finer epidotes are sometimes idiomorphic within an isotropic *chlorite*. The rock also contains a liberal amount of coarse *leucoxene*. One section.

Age. Archean (Keewatin).

N. H. W.

No. 2170. PORPHYREL. ("Porphyritic" conglomerate.)

N. E. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 32, T. 64-9, near Moose lake.*Ref.* Annual Report, xxiv, page 55.*Meg.* Apparently a porphyry.

Mic. This rock is peculiar in having large feldspars, which speck the surface as in a porphyry, some of them with sharp idiomorphic outlines, and yet in being clastic in all its other characters. There are occasionally quite well rounded feldspars which have the shapes of water-worn pebbles. There are fragments also of all sizes, but in general there is a sharp and remarkable contrast between the *feldspars* and the matrix in which they are embraced. They are completely permeated, uniformly, by the products of alteration, principally by *sericite*, and their twinning characters are very much obscured, although it is plain that they are twinned quite conspicuously and coarsely. In this character they are like those of Kekequabic lake. *Quartz* in large grains also is seen in this slide, again resembling the conglomerate of Kekequabic lake. The matrix is fine and has much scattered *calcite*. It also contains much fine feldspar. These are interlocked in a characteristic mosaic or micro-granulitic structure with *quartz*. It is also evident that this groundmass consists in part of a finer micro-granulitic structure which comes and goes in a manner indicating that some of the smaller original feldspar grains have given place entirely to the groundmass structure, as in the Ogishke conglomerate, or that there were originally in the rock pebbles of different structure.

Throughout the slide is more or less obscure isotropic chloritic substance, the result of alteration of *hornblende*. This is frequently collected in shreds and patches of larger size, characteristic of fragmental debris. One section.

Age. Archean (probably Upper Keewatin).

Remark. Were it not for the positive field relations it would be difficult to affirm that this is not an eruptive of two dates of consolidation, though much altered.

N. H. W.

NO. 2171. PORPHYREL. (*Tuff.*)

Same place as the last, in another little ridge a little further south.
Ref. Annual Report, xxiv, page 55.

Meg. This is "porphyritic" with similar feldspars as No. 2170, also with hornblendes, but at the same time is a pebbly conglomerate.

Mic. The slide consists of fragments of *feldspar* and of *hornblende*, of all sizes, but very few perfect crystals of the former, with much *calcite*. One section.

Age. Archean (Keewatin).

Remark. This is quite similar to several slides already described from the vicinity of Kekequabic lake. The materials show very little effect of abrasion by wave-action, and as there is no other known source for such material, this rock is necessarily classed as of volcanic (tuff) origin.

N. H. W.

NO. 2175. GREENWACKE. (*Tuffaceous.*)

N. W. $\frac{1}{4}$ N. W. $\frac{1}{4}$ sec. 33, T. 64-9, a little north of Flask creek, near Moose lake; near the same place as No. 2171.

Ref. Annual Report, xxiv, page 75.

Meg. Green, massive-looking, apparently a bed in the prevailing conglomerate, but outwardly having the petrographic aspect of a greenstone. Bed is twenty to twenty-five feet thick.

Mic. With less *calcite* than in No. 2171, and with a considerable angular *quartz*, this rock still is of the same category as No. 2171, etc. It shows little or no beach-action, such as rounding of the grains, but it has a large amount of supposed devitrified volcanic *glass*, such glass being now mostly chloritic and isotropic, but showing a few small points in which polarized light passes, as if minute *feldspars* or *quartzes* were embraced. In the main, it is composed of fragmental *hornblendes*, *feldspars* and *quartz*, with pebbles which now are composed of micro-granulitic mosaic of feldspar and quartz, but which at first were probably feldspars. Some of the original pebbles were microlitic with feldspar, showing still a fluidal structure in the parallel arrangement of the little feldspars, or a "diabase structure." One section.

Age. Archean (Keewatin).

Andesyte. Greenstone.]

Remark. The hornblendes were derived from augite in the same manner as those of the Kekequabic Lake region, and they show also the same zoned and part-coloration between the nicols, the darker, and generally central, areas indicating the forms of the original augite grains—the latest of the hornblende to be formed. Compare Nos. 1051, 1060, 1409–1413.

N. H. W.

NO. 2176. ANDESYTE(?)

From a dike cutting the conglomerate; near the same place as No. 2175.
Ref. Annual Report, xxiv, page 56.

Meg. A light-brown rock, fine-grained and compact. One of the specimens is roughly schistose, the other is not. The rock seems to be composed of feldspar, possibly quartz, and dark minerals, probably hornblende and chlorite, in fine grains.

Mic. The section was made from the non-schistose specimen. The rock is porphyritic with small feldspars which, in part at least, appear to be near *andesine-oligoclase*. These phenocrysts are set in a fine-grained groundmass in which feldspar seems to be the only original mineral remaining. It is in part *plagioclase*. Throughout the section and in the porphyritic feldspars much *muscovite* and *calcite* have been developed; also some *chlorite*. *Magnetite* and a little *pyrite* are seen also. There are some grains of *quartz* which are larger than the grains composing the groundmass, but these quartzes do not appear to be phenocrysts. They sometimes occur in connection with collections of chlorite scales, this mineral and the chlorite apparently occupying the place of an original ferromagnesian mineral. The quartz, in large part at least, thus seems to be secondary. One section.

Age. Dike in Archean (Keewatin).

U. S. G.

NO. 2177. GREENSTONE.

Near the "contact" between the foregoing tuff and graywacke and a greenstone, but on the greenstone side. The conglomerate all along dips south about 85°, *i. e.*, toward this greenstone, which is a wide belt extending, in general terms, to the Kawishiwi river.

Ref. Annual Report, xxiv, page 56.

Meg. Apparently massive, at least not showing distinctly any stratification, and thus in marked contrast with the tuff and conglomerate. Weathered surfaces show a protruding siliceous mesh, a character that sometimes distinguishes a clastic greenstone from an igneous one.

Mic. This consists of *hornblende*, *feldspar*, *quartz*, *epidote*, *sphene*, *calcite*. The feldspars have been much eaten into by a secondary micro-granulitic generation, which also serves to form a part of the finer matrix or groundmass for the rock in general, constituting the siliceous roughness of the weathered surfaces, but in nearly all cases there is still quite evident a remnant of the original feldspathic constituent. One section.

Age. Archean (Keewatin).

Remark. This rock differs from the foregoing in not showing in the section evident clastic characters, and in possessing some that are of the nature of eruptive rock, viz.: there are no pebbles, nor any variation in the texture or composition comparable with that mentioned in the adjoining strata. The composition includes epidote and sphene, which, while not exclusively characteristic of eruptive rocks, are still wanting in the clastics immediately adjoining. It is, however, to be noted that the original feldspars (as well as the pyroxene) have suffered the same change as seen in the tuffs, etc., viz.: the feldspars are largely micro-granulitized, and the pyroxene is turned to hornblende. In the rock at large are more or less rounded greenstone fragments, indicating a detrital source for the rock. N. H. W.

NO. 2178. KERSANTYTE. (*Dike.*)

Same place as the last.

Ref. Annual Report, xxiv, page 56.

Meg. Acts as an intrusive in No. 2177, forming dikes and bosses, micaceous, the mica appearing in porphyritic crystals. Compare No. 2261. This is a very rare rock petrographically, having been seen in Minnesota only in this region.

Mic. The pyroxene is *augite*, but is almost entirely altered to *hornblende*. The mica is *biotite*, but is also largely changed to chlorite (*clinocllore*), which has n_c perpendicular to the cleavage. *Epidote*, *sphene*, *calcite* are also present in notable amounts, while evident feldspar, much corroded and in small interlocking grains (not micro-granulitic) is in subordinate amount, a considerable amount having been lost in alteration to *apophyllite*, which, by its very low double refraction gives a general darkness to the field between cross nicols. One section.

Age. Archean (Keewatin).

N. H. W.

NO. 2179. CONGLOMERATE. (*Tuff.*)

Same place as No. 2177, but from the conglomerate.

Ref. Annual Report, xxiv, page 56.

Meg. Some of the finer parts of the conglomerate of the region.

Mic. The slide varies from amphibolyte in micro-amphibolyte, and to a porphyritic lava, whose groundmass is finely micro-granulitic and whose crystals are *feldspar* and *hornblende*. The amphibolytes are pebbles of a once diabase rock. One section.

Age. Archean (Keewatin).

N. H. W.

NO. 2180. PORPHYRYTE. (*Esterellyte.*)

Near the section line between secs. 20 and 21, T. 64-9, near Moose lake.

Ref. Annual Report, xxiv, page 56.

Meg. Pebble in a conglomeratic jaspilyte; weathers red.

Conglomerate. Jaspilyte. Graywacke.]

Mic. In a finely micro-granulitic groundmass are altered crystals of *feldspar* and of *hornblende*. Much *calcite* is scattered throughout.

This pebble appears to be of the same nature as the granitic and porphyritic intrusive rocks at Kekequabic lake, the feldspars being much twinned, somewhat irregularly. See remark under No. 1065. One section.

Age. Archean (Keewatin).

N. H. W.

NO. 2181. CONGLOMERATE. (*Greenstone.*)

Near the same place as No. 2180, but further west.

Ref. Annual Report, xxiv, page 57.

Meg. Finely conglomeratic portion of the greenstone lying west from the jaspilyte belt.

Mic. Largely composed of fragmental feldspars with a copious matrix of debris of the same, also of micro-granulitized pebbles in which are visibly embraced small feldspars porphyritically, in the same manner as in No. 2179, with *epidote*, *calcite* and *chlorite* as usual. One section.

Age. Archean (Keewatin).

N. H. W.

NO. 2182. JASPILYTE.

Portage from Moose lake to Wood (Wind) lake, near Moose lake; S. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$ sec. 20, T. 64-9 W.

Ref. Annual Report, xxiv, page 57.

Meg. The specimens vary from dark-brown jaspilyte to a dark-gray argillyte. Intimately interbanded with the jaspilyte is fine-grained, greenish-yellow material, which is evidently largely *epidote*. Minute veinlets of quartz cross the specimens and are brought out sharply by weathering. No section.

Age. Archean (Keewatin).

U. S. G.

NO. 2184. GRAYWACKE. (*Tuff.*)

On the trail from Moose lake to Flask lake, sec. 28, T. 64-9 W. The land rises into a ridge or succession of ridges, consisting mainly of conglomerate and graywacke.

Ref. Annual Report, xxiv, page 57.

Meg. The rock is evidently fragmental and conspicuously stratified, spotted with crystals of *feldspar*.

Mic. The rock is much decayed. The *feldspars* are of clastic origin, as parts of a coarse graywacke. Since the matrix is largely, or wholly, not recrystallized by regeneration of the original elements, or by the formation of new elements, it was plainly at first a clastic one. The old feldspars are crowded with little crystals of other minerals, such as *mica*, *calcite* and chloritized *hornblende*. The matrix of these feldspars, which are sometimes perfectly idiomorphic and identical in appearance with those of the graywacke and conglomerate of Zeta lake (Nos. 1062 and 2187), is

made up largely of small feldspar fragments, of *hornblende* and *chlorite*, with some *quartz*, and of devitrified glass in small grains, and of *sphene*. One section.

Age. Archean (Upper Keewatin).

Remark. This rock terrane, which is a large and important one in the region, can safely be parallelized with the Ogishke conglomerate, and especially with the conglomerate at Zeta lake. It sometimes takes the character of the Stuntz conglomerate, as seen on the ridge between Moose and Flask lakes. (Compare remark under No. 2189).

N. H. W.

NO. 2187. CONGLOMERATE. (*Porphyrel.*)

Shore of Snowbank lake, near the centre of sec. 26, T. 64-9.

Ref. Annual Report, xxiv, page 57.

Meg. A condition of the conglomerate of the region, having conspicuous feldspars. Compare No. 1062.

Mic. The large *feldspars* are much twinned, like all those in this curious conglomerate, but are permeated by the same kind of alteration, viz., the production of innumerable scales of *mica*. In this case *epidote*, and occasionally a secondary feldspar with different orientation, are plainly shown. This secondary feldspar is also sparsely distributed in the matrix as an interlocking groundmass and as an interlocking fringe about the crystals. Epidote is quite abundant in the chloritized hornblende areas and *sphene* is in the matrix in sparse grains. One section.

Age. Archean (Keewatin).

N. H. W.

NO. 2189. GRANITE-PORPHYRY.

At the point, S. W. $\frac{1}{4}$ N. E. $\frac{1}{4}$ sec. 26, T. 64-9, Snowbank lake.

Ref. Annual Report, xxiv, page 57.

Meg. This rock acts as dikes cutting mica schist. It contains green pebbles, and is cut by later granite intrusions, *i. e.*, by the prevailing granite of Snowbank lake.

Mic. This is a wholly crystalline rock, but it has two dates of crystallization. The large *feldspars* are "old feldspars" in the sense that they became much altered and were then regenerated. The alteration products are largely *mica*, *calcite*, and *epidote*. Throughout they are renewed by the formation of new feldspars, often globular in form, and still more frequently in the form of an interlocking fringe or exterior zone which surrounds them and unites them with the fine feldspathic matrix in which they lie. They are plainly twinned (albite plan) and their nearly parallel extinction indicates for some of them a composition near *oligoclase*, but they are considerably broken up by the growth of a finer interlocking structure with different orientations. This finer structure is not always of freshly developed material, but is clouded with the same impurities as the unbroken crystal, showing that the