old crystal had suffered a partial mechanical as well as chemical disintegration. The surrounding plexus, so far as it is of new development, consists of interlocking small feldspars and *hornblende* in which the hornblendes are earlier, and of *quartz* and *epidote*. Throughout this fine mass are plainly smaller "old feldspar" grains or fragments not entirely replaced by the secondary growth. These contain the same inclusions and are supplied with the same surrounding fringe as the large crystals, and appear to be simply such original grains as have not been entirely lost in the general transformation, but the groundmass in general is wholly new and fresh. The older ingredients, not of feldspar, which are found in this interlocking matrix, are *sphene*, *apatite*, *magnetite* (perhaps of later date), *garnet*. These are in insignificant amounts. The hornblendes are small and are arranged in a gneissic structure. One section.

Age. Archean (earlier granite).

Remark. This rock resembles the so-called porphyry seen at various places, and it is evidently an older intrusive than the granite which cuts it. It has the structure and appearance of the porphyroidal granite of Kekequabic lake, but that does not prove equivalence of age. Given a certain (conglomeratic) formation, such as that about Moose lake or about Kekequabic lake, and it is evident that a metamorphism, and even a plasticity, could be produced at different epochs, and that the resultant rock, under similar or identical agents, would be about the same at different places.

This rock is considered to be essentially the same in original character and genesis as No. 2184, only differing in having more advanced metamorphism. Structurally it is essentially an igneous rock, having been forced, when plastic, amongst the adjoining strata, under great pressure. N. H. W.

No. 2190. Tuff.

S. E. ¼ N. E. ¼ sec. 24, T. 64–9, Snowbank lake, near the head of the little bay, but on the north side of it.
Ref. Annual Report, xxiv, page 58.

Meg. Schistose, hornblendic, having dim porphyritic feldspars. This is a part of the great conglomerate of the region, but of indefinite outward characters.

Mic. There has evidently been a shearing pressure applied to this rock, as indicated by the elongation. This elongation is expressed chiefly by the streaks and bands of *epidote* and of *hornblende*, and by a uniform direction of the major axes of the feldspars. The old *feldspars* are coarsely and much twinned, and are rather uniformly decayed, *after* the micro-granulitic crystallization. It is also plain in this rock that the hornblende is derived from an alteration from *augite*, for some old augite forms remain. One section.

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

No. 2191. Conglomerate.

Same place as No. 2190, but about 150 feet from the shore.
Ref. Annual Report, xxiv, page 59.

Meg. The matrix of the rock is hard, green and rather fine grained; it contains fragments and crystals of hornblende and of feldspar. There is one large pebble of a very fine-grained, gray, pink-weathering, granitic rock, and also one of a diabase-like rock holding small, little-elongated feldspars in a dark background. No section.

Age. Archean (Keewatin). U. S. G.

No. 2194. Granite *(with augite)*.

N. E. ¼ S. W. ¼ sec. 19, T. 64–8, Snowbank lake. Small island.
Ref. Annual Report, xxiv, page 60. (Compare No. 271E.)

Meg. Granite.

Mic. This beautiful rock is porphyritic with an *ægyrine* augite which has its idiomorphic forms. These crystals lie in a coarsely crystalline interlocking granite of *microcline, oligoclase(?)* and *orthoclase,* in which is much *sphene* and also a little *biotite.* The microcline appears to have intergrown *pari passu* in some instances, with another feldspar (oligoclase?), and in other cases to have served simply as a cement to regenerate a decrepit old crystal. Frequently also these two feldspars together form such cement, the only sign remaining of the original crystal being a central area now so crowded with alteration products, chiefly mica, that it cannot be studied. One section.

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

No. 2195. Dioryte.

Just east of the section line between secs. 19 and 20, T. 64–8, at the shore of Snowbank lake.
Ref. Annual Report, xxiv, page 61. Compare Nos. 271E and 591E, Annual Report, xxii, page 189.

Meg. Granitic.

Mic. The feldspars (triclinic) are very much decayed, and the ferromagnesian minerals are *hornblende* and *biotite,* largely altered to *clinochlore. Epidote* is abundant especially in the clinochlore and also associated closely with *magnetite.* One section.

Age. Archean (intrusive).

Remark. Mr. Elftman obtained rocks near the same place which he found were augite granite. If this rock were ever augite granite, which is possible, it has lost that nature probably by weathering. N. H. W.

No. 2196. Syenyte. *(Porphyritic.)*

North shore of Snowbank lake, at line between secs. 19 and 20, T. 64–8 W.
Ref. Annual Report, xxiv, page 62.

Meg. A very fine-grained reddish rock, composed largely of feldspar. There are some feldspars which are porphyritic, but the fact that these feldspars on fresh

fracture are so closely like the groundmass makes the porphyritic nature of the rock very indistinct.

Mic. The micro-granulitic groundmass is largely of quartz and feldspar. It embraces much-altered crystals of *feldspar*, some *biotite*, *apatite*, *muscovite* in large masses and rarely a roundish quartz. One section.

Age. Archean.

Remark. This rock is allied to the granites and porphyries of Kekequabic lake. Its relation to the granite of the region is not known. N. H. W.

No. 2197. Muscovadyte.

S. W. ¼ N. E. ¼ sec. 4, T. 63–8, Disappointment lake, at Cheadle's cabin, site of an old iron exploration.
Ref. Annual Report, xxiv, page 62. Compare Nos. 1347, 1781, 1784, 1785; also Annual Report, xxi, pages 149, 150; Final Report, vol. iv, page 303.

Meg. Fine-grained, gray, non-micaceous, mainly massive, but conglomeratic in bands; firm, resembling muscovadyte. Position and dip like that of the conglomerate and tuff of the region.

Mic. The most of this rock is made up of a fine-grained feldspar, which, judged by several determinations on a bisectrix, varies from *labradorite* to *andesine*. These fine feldspars are fresh and interlock in the manner of micro-granulyte. Small *hornblendes* share in this groundmass and embrace the feldspars poikilitically, but the largest poikilitic crystals are *hypersthene*. It is remarkable that a large hypersthene crystal will maintain its orientation over so many of the feldspars, when generally it makes less than one-half of the mass. *Magnetite* is distributed in fine crystals. One section.

Age. Archean (Keewatin modified).

Remark. This rock shows the effect of the gabbro which lies but a short distance further south on the basic Keewatin schist and conglomerate. There could be no more ample and convincing proof of the origin of the rock which has been called muscovadyte. It has been supposed to be a form of the gabbro, as it approximates gabbro in composition and is nearly always near the gabbro margin. In the field work it was very generally denominated muscovado, whether it had any close association with gabbro or not. In the Twenty-first Annual Report a distinction was made, as it was presumed that some muscovado was of irruptive and some of metamorphic origin, and the name was assigned to a supposed phase of the gabbro. It is, however, plain that here it is a product of metamorphism by the gabbro (or cotemporary with it) on the Keewatin. N. H. W.

No. 2198. Muscovadyte.

Same place as No. 2197. Same rock, but plainly conglomeratic.
Ref. Annual Report, xxiv, page 62.

Meg. Fine-grained, pebbly portion of the same rock as No. 2197.

Mic. There is a little *quartz* and many remnants of old *feldspars* that have not been entirely consumed by the micro-granulation which has permeated the rock and which is much finer than in No. 2187. *Hornblende* and *biotite* compose the dark elements with a very little *magnetite* and *sphene*. Two sections.

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

No. 2199. PERIDOTYTE.

Same place as the last, but further south, at the iron-ore pits.
Ref. Annual Report, xxiv, page 62.

Meg. The rock that embraces the ore, grading into the ore.

Mic. *Olivine*, *diallage* twinned with *enstatite*, *quartz*, *magnetite*, in the order named, compose this rock. The twinned enstatite embraces all the others poikilitically. There is a tendency to roundish outlines, especially for the olivine and the quartz. That this contains enstatite rather than hypersthene is shown by the low double refraction (about the same as quartz), and by a basal section showing with the prismatic cleavages another parallel with the optic plane, and also showing the bisectrix n_g in the acute angle, which latter is quite small.* Probably the more intense contact with the gabbro at this point, or perhaps the presence of a large supply of iron, had something to do with this difference in the ferro-magnesian minerals. The olivine has the small optic angle (containing n_p) characteristic of *fayalite*. One section. N. H. W.

No. 2201. MAGNETITE IRON ORE.

Same place, Disappointment lake.
Ref. Annual Report, xxiv, page 62.

Meg. Appearing siliceous.

Mic. About one-half this rock is *magnetite*. The larger part of the rest is *quartz*. But there is a noticeable amount of the ferro-magnesian elements seen in Nos. 2198 and 2199, particularly *diallage*. The *magnetite* forms a sort of sponge in which the other minerals are held in roundish kernels. One section.

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

No. 2202. MUSCOVADYTE. *(Noryte.)*

Thirty feet further south than No. 2201. Disappointment lake.
Ref. Annual Report, xxiv, page 62.

Meg. This cuts the conglomerate which contains the iron ore, and embraces pieces of the conglomerate.

Mic. The pyroxene is *hypersthene*, but it is interleaved parallel to 010 by a monoclinic pyroxene, which has a higher birefringence, probably *diallage*. This

* *Minéraux des Roches*, p. 260.

intergrowth is also parallel with the prismatic cleavage (110) and with the orthopinacoid 100. The *labradorite* is fresh, and twinned on the albite and pericline plans. *Magnetite* is not abundant. One section.

Age. Cabotian (modified Keewatin).

Remark. This rock, so evidently a phase of Nos. 2198 and 2199, and of the same rock mass, here plays the rôle of an igneous rock intrusive on less modified parts of itself. N. H. W.

No. 2203. Muscovadyte.

Same place as No. 2202, Disappointment lake. At the gabbro contact.
Ref. Annual Report, xxiv, page 62.

Meg. Inclusion of the greenstone conglomerate in the gabbro.

Mic. The structure is granulitic, the *feldspars* averaging larger than any of the other minerals, which they embrace poikilitically. They show the albite and pericline twinning and are fresh and clear. Rarely, however, a *hypersthene* surrounds a few globular feldspars. The hypersthene is fresh and is distinguished from enstatite by having n_p for acute bisectrix perpendicular to 100. Besides the foregoing the rock only embraces a very few grains of *magnetite* and one or two of *biotite*. One section.

Age. Archean (Keewatin).

Remark. It is to be noted that the rocks Nos. 2202 and 2203 mineralogically are very nearly allied, but petrographically and structurally they are contrasted. The The former is a characteristically crystalline gabbro with large plates of hypersthene (interleaved with diallage), showing a partial ophitic structure. The latter is granulitic, the hypersthenes being small and round, and not infrequently wholly surrounded by the feldspar. The species of the feldspar can be safely taken to be labradorite in both cases, but no reliable measurement of extinction is obtainable in No. 2203. Were it not that the rock No. 2203 can be followed continuously from the gabbro border northward to the iron ore pits (but few rods, No. 2201) and thence to the lake shore at Cheadle's cabin (Nos. 2197 and 2198), and that throughout it is uniformly the same rock, often pebbly, distinctly stratified, and is thence demonstrably the same formation as the pebbly greenstone, often called *conglomerate*, it would be hazardous to affirm, in the face of numerous published statements to the contrary, that these are the same rock genetically, structurally and historically. The similarity of the metamorphosed clastic to the contacting gabbro is to be explained by the great *a priori* similarity of the greenstone debris in chemical composition to a basic igneous rock, and leads to the reasonable assumption that the gabbro itself is the end product of such metamorphism. N. H. W.

No. 2207. Granite. *(Esterellyte.)*

Central part of sec. 32, T. 64–8, Disappointment lake.
Ref. Annual Report, xxiv, page 64.

Meg. Dike of red granite cutting the gray pebbly rock.

Mic. In a finely granulitic groundmass are zoned and twinned crystals of *feldspar*, and imperfectly formed crystals and shreds of *hornblende*, with some *biotite*. The appearance is like the esterellyte of Kekequabic lake, with the exception that the ferromagnesian element is less abundant, and does not approach augite. The central portion of the feldspars is frequently converted to an obscure, crowded mass of minute crystals of *mica*, *epidote* and secondary *feldspar*. That the groundmass was at first fragmental, and that the zoning of the feldspars was coincident with the micro-granulitic development by which most of the smaller fragments have lost their identity, is an obvious conclusion which is in keeping not only with the present condition of the feldspar crystals, but also with the heterogeneous aspect of the micro-granulitic groundmass itself. The principal zone of the feldspars has an extinction on n_g of about 3°, indicating *andesine-oligoclase*, but the exterior zone has an extinction angle, in the same crystal, of about 17°, which is near that of *albite*, while the kernel is so obscured by inclusions of mica, etc., that its exact extinction can hardly be determined. Several trials, however, on the kernel, which has not a uniform simultaneous extinction, but a fragmentary or wavy one, give angles varying from 13° to 18°. Not much reliance can be put on this indication, but, if it be supposed that the variation in acidity was in the same direction at the centre as at the periphery (as is usually the case), these figures point toward *labradorite* as the original feldspar. One section.

Age. Archean (dike).

Remark. It is reasonable to infer that this granite is analogous to that cutting the green schists at Kekequabic lake. N. H. W.

No. 2208. Muscovadyte. *(Micaceous.)*

S. W. ¼ N. E. ¼ sec. 5, T. 63–8, Disappointment lake, at the lake shore.
Ref. Annual Report, xxiv, page 64.

Meg. Apparently a mica schist, but an approach toward muscovadyte. This is also plainly a part of the green, pebbly formation which prevails, irrespective of the intrusives, from Moose lake to Disappointment lake.

Mic. The rock is micro-granulitic, with variations in size, some of it being plainly due to replacement of original clastic feldspars, some of which are still preserved. *Hornblende* in small round and obtuse grains is the most abundant of the dark minerals, but shares with *biotite* and *magnetite*. The old feldspars, so far as they remain, are zoned, and the fringe is interlocked with the surrounding fine groundmass. One section.

Age. Archean (Keewatin).

Remark. This is in the line of strike from Cheadle's cabin, but further removed from the gabbro intrusion. N. H. W.

No. 2209. Muscovadyte.

Still in the line of strike from Cheadle's cabin, but a little further north, at the extremity of the point.
Ref. Annual Report, xxiv, page 64.

Meg. Gray, micaceous.

Mic. With the prevailingly new feldspathic groundmass in this slide are several *quartz* grains. The old feldspars are more numerous and hence more contrasted with the granulitic groundmass. The *hornblendes* are larger than in the last and sometimes surround grains of *quartz*, *biotite* and *feldspar*. One section.

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

No. 2211. Granite.

Head of the rapids at the outlet of Sucker lake, on the Canadian side; Prairie portage. Intrusive on fine schists.
Ref. Annual Report, xxiv, page 66.

Meg. A medium-grained granite.

Mic. The original granite, whatever its nature, shows evidence of having experienced one or more epochs of dynamic stress. The feldspars are much decayed, but rebuilt by small deposits of peripheral, cementing, fresher feldspar, which was perhaps the time of deposition of *microcline*, which occurs in larger crystals. *Quartz* is quite abundant, and was last to take the present posé, but also has a shadowy extinction, indicating a later mountain crushing. *Muscovite* is common. A little *hornblende* and some *chlorite* are the only dark minerals. One section.

Age. Archean. N. H. W.

No. 2215. Syenyte (?)

N. E. ¼ N. W. ¼ sec. 5, T. 62–10, on the south side of the large triangular island surrounded by the Kawishiwi river.
Ref. Annual Report, xxiv, page 67.

Meg. Rather coarse-grained mass of hornblende and feldspar, making a dark speckled rock.

Mic. The larger *hornblendes* spread rather irregularly so as to embrace poikilitically several other minerals, but they are broken and regenerated by new growths. The minerals thus embraced are usually globular, and consist of *feldspar* (often much altered), *epidote*, *sphene*, *apatite* and other hornblendes.

The feldspar is much crushed and kaolinized. It appears to be wholly of *orthoclase*; at least no striated twin-lines are visible. One section.

Age. Archean.

Remark. This rock seems to be of the age of the surrounding granite. It is fresher than the greenstones of the Keewatin, and is probably a variant of the granite of the region. N. H. W.

No. 2216. DIORYTE.

Near the same place as the last, but from the north side of the little bay.
Ref. Annual Report, xxiv, page 67.

Meg. A rock of finer grain than the last, of a dark gray color.

Mic. Seems to consist wholly of *hornblende* and a much altered *plagioclase*, the latter being embraced ophitically by the former, and hence was originally a diabase. The plagioclase is so much altered that it has almost entirely lost its striations. One section.

Age. Archean. N. H. W.

No. 2217. DIORYTE *(with quartz.)*

From the south side of the same little bay.
Ref. Annual Report, xxiv, page 67.

Meg. Resembles rock No. 2215, but finer grained.

Mic. Considerable areas of *quartz* are found amongst the other minerals so as to embrace them—even the altered *hornblendes*. The feldspar is only partly plagioclase; the rest is more decayed and is taken for *orthoclase*. Biotite and chlorite are quite common. One section.

Age. Archean.

Remark. This rock seems to be only a phase of the granite. N. H. W.

No. 2220. GRANITE *(with hornblende).*

A short distance further west.
Ref. Annual Report, xxiv, page 67.

Meg. Darker than Nos. 2218 and 2219, but lighter than Nos. 2215 to 2217. Some feldspars are red.

Mic. With much *hornblende* are both *plagioclase* and *orthoclase*, the latter considerably kaolinized; also a little *biotite* and *magnetite*. One section.

Age. Archean. N. H. W.

No. 2221. GRANITE. *(Hornblendic.)*

Narrows of the Kawishiwi river, N. E. ¼ S. E. ¼ sec. 5, T. 62-10, a little west of the so-called palisades. Forms a small knob on the north shore.
Ref. Annual Report, xxiv, page 68.

Meg. Compact, dark, hornblendic gneiss, with epidote in one of the open seams, cut by veins of red granite.

Mic. The section shows a fresh hornblendic granite, with considerable *quartz*. The more altered *feldspars* may be assumed to be orthoclase, and the rest, which are twinned polysynthetically, are some species of *plagioclase*. *Epidote* accompanies and surrounds small masses of *magnetite*. It is in multiple granules, and in that form is also scattered through the rock. One section.

Age. Archean.

Remark. The relation of this rock to the adjacent red rock forming the so-called "palisades," could not be exactly determined, but if the red dikes in this are from the red rock, as apophyses, as seems probable, this is the older rock. N. H. W.

No. 2222. GRANITE. *(Hornblendic.)*

Same place and same rock mass as the last.
Ref. Annual Report, xxiv, page 68.

Meg. Finer grained condition of No. 2221, having a schistose direction in the arrangement of the hornblendes.

Mic. This rock is more abundantly supplied with hornblende, but less with quartz. One section.

Age. Archean. N. H. W.

No. 2225. GNEISS.

N. E. ¼ S. W. ¼ sec. 24, T. 63–10, on the portage from Kawishiwi river to Triangle lake, near the Kawishiwi.
Ref. Annual Report, xxiv, page 68.

Meg. Schistose, fine interlamination of green, apparently chloritic, interrupted sheets with red, fine-grained, broader sheets which appear to be granitic, the whole having the aspect of fluidal structure, or of a transition from the granite to the greenstone, the former existing toward the south and the latter toward the north. As constituents of the red-weathering sheets are a few roundish masses visible on the weathered surface, resembling orthoclase phenocrysts. The fresh fracture of this rock is gray rather than green.

Mic. The rock is in general a granular mass of fine *quartz* and *hornblende*, with feldspar both *orthoclase* and *plagioclase*. There are numerous ragged feldspars of larger size, interlocking with the finer matrix about their margins. The hornblendes are small and ragged, and in places *magnetite* and *biotite* unite with it in composing the darker laminæ. Some fine *apatite* and also *rutile* are scattered irregularly through the slide. One section.

Age. Archean.

Remark. From the microscopical characters it appears that this megascopic laminated structure is probably due to the shearing of an igneous rock (granite).

N. H. W.

No. 2226. GREENSTONE.

From a large inclusion in granite, near the same place as No. 2225.
Ref. Annual Report, xxiv, page 68.

Meg. Fine grained, dense, hardly showing any structure, yet on the weathered surface the hornblendes and feldspars are seen to have one direction.

Mic. The larger *hornblendes* are ragged and irregularly interlock with and partially enclose some of the *feldspars*. It is apparent that they are secondarily

enlarged, and also that numerous hornblendic spicules have been developed, the latter piercing the fresh feldspars which are also secondary. *Quartz*, in fine isolated and sometimes spreading forms, is also secondary. A dark iron mineral which appears to be *magnetite* or *ilmenite*, is in close association with a highly refractive and transparent mineral, which in some of its elongated sections has parallel extinction and is probably *rutile*. This supposed rutile is not in needles, but usually in globular scattered individual grains resembling sphene which are occasionally grouped. Two sections.

Remark. This rock may have been originally a diabase. It is a firm rock and appears fresh, but it is plain that its present condition is wholly due to metasomatic alteration of earlier minerals. N. H. W.

No. 2227. Greenstone.

From the prominent ridge at the corners of secs. 8, 9, 16 and 17, T. 63-9 W., north of the Kawishiwi river. *Ref.* Annual Report, xxiv, page 69.

Meg. Fresh, green, diabase-looking rock. Sample represents the non-agglomeratic portion.

Mic. The trachytic feldspars have a radial manner of piercing the *hornblendes*, suggesting that the hornblende is an alteration product from ophitic augite. Two sections.

Age. Lower Keewatin. N. H. W.

No. 2229. Quartz-Porphyry.

Two hundred paces south of the quarter-post, east side of sec. 8, T. 63-9, southwest of Snowbank lake. *Ref.* Annual Report, xxiv, page 69.

Meg. Light-weathering, massive, porphyroidal rock, containing phenocrysts of *quartz* and *feldspar* in a fine siliceous matrix; also showing a little pyrite.

Mic. The *quartz* is bipyramidal and somewhat resorbed, having embayments filled with the fine matrix. It is not abundant. The *feldspar* is much twinned and somewhat resembles that of the porphyry of Kekequabic lake. They are much altered and in some places wholly disintegrated. The resulting secondary minerals are chiefly *calcite* and *muscovite*, the former sometimes constituting areas of considerable (microscopic) size, but the latter occurring in myriads of isolated minute scales. The same minute muscovite scales are also quite abundant throughout the matrix. *Biotite* in sizable groups is distributed through the rock, but sparsely. Its scales are from twenty-five to fifty times larger than those of the muscovite.

A secondary feldspar, in fine isolated grains, has been generated not only throughout the matrix, but not infrequently in the bodies of the old feldspar phenocrysts. These are glassy and cannot be specifically determined because they are destitute of visible cleavage and other criteria for measurements. While the old feld-

spars are mainly plagioclase there is occasionally one which has a pronounced *microcline* structure. In such microclines are numerous isolated fresh feldspar grains like the last mentioned, as well as dull areas filled apparently with kaolin, suggesting that the whole microcline grain is due to a regrowth on and in an older feldspar crystal.

Throughout the slide are also shreds of a highly refractive and doubly refractive mineral which resembles *epidote*, but the grains are so small and their color in common light is so white that it is not possible to affirm that these grains are not a light-colored augite. There is also a little *sphene* and a very small amount of green *hornblende*. One section.

Age. Lower Keewatin.

N. H. W.

No. 2231. GREENSTONE.

Phase or part of No. 2230; same place as No. 2229. No. 2230 contains rounded and angular pieces of No. 2229 and much finer debris, constituting a conglomerate.

Ref. Annual Report, xxiv, page 69.

Meg. Firm, fresh, uniform, massive aspect in the field, with much hornblende or pyroxene.

Mic. Hornblende constitutes the coarsest and most conspicuous part of the slide. It is nearly colorless and almost without pleochroism. Its angle n_g:c=16°. It has positive elongation in a section showing n_p perpendicular, and its acute bisectrix is n_p. If this be an aluminous hornblende it is *edenite**, but optically it is also much like tremolite.

Epidote, which is also almost colorless, is widely disseminated through the section, and frequently is embraced in minute grains in the foregoing amphibole. It constitutes in minute granules the major portion of some areas that were formerly either feldspar or some ferro-magnesian mineral, probably the former, because remnants of an old feldspar are sometimes seen in the midst of such an epidotic mass.

The *feldspar* is so altered that it cannot be specifically determined. It constitutes but a minor portion of the larger grains. It but rarely shows any albite or other twinning. One section.

Age. Upper(?) Keewatin.

Remark. Owing to the great variability in the amount of decay of the feldspars, the manner of connection of the grains into a rocky structure, and the great prevalence of finely granular epidote, it is perhaps reasonable to assign this rock to a clastic origin. Its close connection with rock No. 2230, which in the field was not detected to show an igneous contact, favors that view. N. H. W.

No. 2232. GRAYWACKE.

At a quarter of a mile north of the east quarter-post of sec. 8, T. 63–8.

Ref. Annual Report, xxiv, page 69.

* *Minéralogie de la France*, ii, pp. 634, 661.

Meg. Gray, siliceous, hardly porphyritic, a near approach to graywacke, but apparently, in the field, a variation of the quartz-porphyry No. 2229.

Mic. The rock is largely composed of very fine but irregular matrix of *epidote, feldspar, quartz, calcite, biotite, muscovite,* and a few cubes of *pyrite.* In the midst of this matrix are a few larger, broken plagioclase feldspars, much altered by biotite and epidote growths, and occasionally a large quartz. In the midst of the slide are areas crowded with a very fine, granulated structure consisting of epidote and apparently minute secondary feldspars. These are, in the main, a fine debris more or less regenerated, but some of them are also due to old feldspars that have been lost by micro-granulitization. One section.

Age. Lower Keewatin.

Remark. This rock is believed to have been originally composed of debris of the same elements as the quartz-porphyry. Ordinarily it might be classed as an altered quartz-porphyry, but its essential characters appear in the field to grade into those of the quartz-porphyry—a remark which is equally true of the microscopic characters. N. H. W.

No. 2234. Diabase. *(Uralitized.)*

Fifty-two paces south of the section corner of section 9. Apparently a dike cutting the graywackes and slates which strike northwest and southeast.

Ref. Annual Report, xxiv, page 69.

Meg. This is a dark, heavy rock, and on the weathered surface reveals an original ophitic structure.

Mic. This rock was originally an *olivine*-bearing diabase, but that mineral is altered to a dark, opaque, ferruginous substance which is unidentifiable, while the augite is now in the form of a green pleochroic *hornblende.* It contains also pyrite. One section.

Age. Dike cutting the Keewatin. N. H. W.

No. 2236. Diabase.

From a dike 650 paces west of the corner post, northwest corner of sec. 8, T. 63–9, running north and south, two feet wide, passing through quartz-porphyry No. 2229.

Ref. Annual Report, xxiv, page 70.

Meg. Very fine grained, with specks of pyrite.

Mic. The ferro-magnesian mineral is chiefly *hornblende* in small crystals that interlock with the fine microlitic feldspars. There is a suggestion of an original porphyritic structure, due to the appearance of areas that have become micro-granulitic, which once were apparently of feldspar phenocrysts. The minerals now occupying these areas are granular *epidote,* minute feldspar grains, or remnants of the old crystal, a little hornblende and less of *chlorite.* In the slide is one large porphyritic area occupied almost wholly by many hornblendes that have independent orientations. It has the shape of a feldspar phenocryst.

Throughout the rock is much fine, granular *epidote* and a few grains of *quartz*. One section.

Age. Dike cutting quartz-porphyry of the Lower Keewatin. N. H. W.

No. 2237. Quartz-Porphyry.

At 670 paces west from the same corner post (*i. e.*, northeast corner of sec. 8, T. 63–9), four rods west of the above dike.

Ref. Annual Report, xxiv, page 70.

Meg. The specimen from which the section was made is a gray quartz-porphyry, with the grain of the matrix graduating in size to that of the phenocrysts. The point at which it was collected is in the midst of the general quartz-porphyry mass, and its chief interest consists in its field relations. "At this place the porphyry, so called, presents fragmental characters. It is roughly schistose in a direction E. 25° ± N., and ridged with interrupted finer belts resembling siliceous argillyte. It holds pieces of greenstone and of slaty greenstone, varying in size from ten inches downward (rounded) to half an inch; also pieces of jaspilyte and rounded quartz. The slaty greenstone is like argillyte and runs usually with the structure, standing on edge. The rock contains much quartz in grains less than a pea in size, but also as large as an inch in diameter, the last being very rare, while other quartzes, as of phenocrysts in quartz-porphyry, are abundantly disseminated. Indeed, the bulk of the whole rock consists of more or less rounded fragments of orthoclase and quartz, lying in a pellucid matrix which appears to be quartz, essentially, sufficiently abundant to keep the quartz and orthoclase grains from interlocking, but apparently allowing them to come loosely into contact. * * * In other places near by are other variations in this porphyry. It may hold distinct crystals of orthoclase in abundance, or none at all. It also varies to a fine-grained gray rock with no apparent quartz nor feldspar as crystals, but yet on close examination it is seen that fine quartz grains are still present. In other cases it holds vitreous quartz grains surrounded by a mesh of quartz which is like that of the jaspilyte, *i. e.*, very finely granular and interlocking (rock No. 2238). This serves as a matrix for vitreous quartz grains. Such characters are seen in the porphyry ridge that extends northward along the west side of the dike represented by rock No. 2236.

Mic. The phenocrysts are *orthoclase* and *plagioclase*, with large bipyramidal *quartz*. The feldspars are much eaten into by decay, the resulting micro-granulitic substance being *calcite* (abundant), *muscovite*, secondary *feldspar*, *epidote*, the same feature mentioned already in several instances. Some of the feldspars are wholly obliterated, only their forms remaining, and all of them are more or less changed.

The matrix consists of *calcite*, *muscovite*, *epidote*, little feldspars and quartzes, generally coarser than the structure seen in the micro-granulitized feldspars. Still,

these structures grade into each other, and while it is certain that some portions of the slide consist of a fine reconstructed original clastic debris, other portions are simply granulitized feldspars.

A few spicules of bluish-gray *tourmaline* are in the granular matrix. One section.

Age. Quartz-porphyry of the Lower Keewatin.

Remark. It was the examination of this rock, and generally of this belt of quartz-porphyry, with its great alteration and its occasional clastic characters, that suggested the idea that this belt of quartz-porphyry is the result of Archean sedimentation combined and cotemporary with oceanic precipitation of silica and potassa. There must, if such be true, have been a thick akaline mud in the bottom of the ocean, and these crystals must have formed in it as in a saturated solution, many becoming broken by transportation, and all of them much decayed prior to the consolidation of the rock. The reader is referred to Part III. N. H. W.

No. 2238. Quartz-Porphyry.

Near the same place as No. 2237.
Ref. Annual Report, xxiv, page 70.

Meg. A form of the porphyry having a dense, fine, siliceous matrix which surrounds distinct quartzes and indistinct feldspars. The matrix appears like the fine silica of the great jaspilyte lenses.

Mic. Microscopically the matrix of the section examined does not appear so much like the jaspilyte, but is characteristically like that of quartz-porphyry. It is manifestly composed of very fine *quartz* and feldspar, with some *muscovite*, some *epidote* and a little *pyrite*. The phenocrysts, whether of quartz or feldspar, are much broken and disturbed, the latter having given rise to *calcite*, *chlorite* and *muscovite*. Two sections.

Age. Quartz-porphyry of the Lower Keewatin. N. H. W.

No. 2239. Granite. *(Porphyritic.)*

Twenty rods west of the last; in the descent to a swamp.
Ref. Annual Report, xxiv, page 71.

Meg. Reddish gray, rather fine grained, but holding feldspar phenocrysts about a quarter of an inch in diameter.

Mic. The matrix is siliceous with fresh secondary *quartz* and enlargements of *feldspars*. It also contains *calcite*, *hornblende*, *muscovite*, *biotite*, *chlorite*, *sphene* and *epidote*. The feldspar phenocrysts, although for the most part entirely lost as to their optic characters by a kaolinization (accompanied by much epidote) that has permeated them, yet about their borders are fresh and glassy by reason of a recrystallization which has strengthened the whole rock. Throughout the phenocrysts,

moreover, there are evidences that this new growth has penetrated and occasionally fresh areas are seen within them, which are like the fresh borders. Two sections.

Age. Archean.

Remark. This rock has the characters of several other granites, and especially that at Kekequabic lake, which indicate a recrystallization of an old debris. N. H. W.

No. 2240. Conglomerate.

Same place as No. 2235, north line of sec. 8, T. 63–9, a quarter of a mile east of the northeast corner of the section, and at the same stratigraphic horizon as No. 2230.
Ref. Annual Report, xxiv, page 72.

Meg. Has a speckled aspect, due to the abundant dissemination of pebbles of quartz-porphyry and of jaspilyte (mostly the former) through a finer matrix of green. Some of the pebbles are also green. Illustrated by figure 1, plate Z, vol. iv. No section.

Age. Perhaps the base of the Upper Keewatin. N. H. W.

No. 2243. Granite. *(Microporphyritic.)*

On the section line between secs. 4 and 5, T. 63–9, northward from the corner of section 8.
Ref. Annual Report, xxiv, page 75.

Meg. Fine grained, gray, subgranitic; except in the absence of porphyritic phenocrysts of feldspar this rock resembles rock No. 2239. A narrow dike running with the structure in slate and graywacke.

Mic. In thin section there appear a few scattered porphyritic phenocrysts, one of which, happening to be cut perpendicular to n_g and showing the basal cleavage (001), affords an angle of extinction of about 13° which, according to the method of Fouqué,* indicates a feldspar between *albite* and *oligoclase-albite*, n_g also being in the acute angle of the optic plane. This particular section shows no albite twinning, but other sections in the same slide show an occasional coarse albite twinning. The rock is considerably altered from its condition at original consolidation. This is evinced not only by the prevalence of various secondary minerals, notably *epidote* and *mica*, but by the microperthitic growth of fresh feldspars in the fissures of the old feldspars. One section.

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

No. 2244. Porphyry. *(Hornblendic.)*

Near the quarter-section post between secs. 4 and 5, T. 63–9, before crossing the creek at "Nelson's cabins."
Ref. Annual Report, xxiv, page 76.

Meg. Grain and color similar to No. 2243, except that this rock shows a contrast between the fine matrix and the porphyritic crystals. Spreads irregularly as an intrusive in hardened graywackes and slates.

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*Contribution à l' étude des feldspaths des roches volcanic. *Bulletin Société Française de Minéralogie*, vol. 17, p. 283, 1894.

Mic. The feldspar, which appears to have been in part a soda-lime species, is much altered by the development of *mica*, *calcite* and *epidote*, but has also been, in some cases, recrystallized by new growths about the margins, and more or less throughout its entire mass. Rarely a feldspar is embraced wholly within a hornblende, but as a rule these minerals are in independent idiomorphic relations.

The *hornblende* is green, distinctly pleochroic, having the maximum extinction angle, on elongation, about 16°. It is sometimes zoned with different shades of green. It has a negative acute bisectrix (n_p), and n_g nearest the vertical axis, and is hence apparently common hornblende.

The matrix is composed largely of very fine feldspars, micas and *epidote*, with some *calcite* and shreds of hornblende. One section.

Age. Intrusive in the Upper Keewatin.

Remark. This rock, in thin section, has the appearance of having originated from a hardening of a debris of feldspathic character. The alteration of the feldspars took place while they constituted a part of such debris. N. H. W.

No. 2245. Conglomerate. *(Granitized.)*

Part of the same rock as No. 2244.
Ref. Annual Report, xxiv, page 76.

Meg. Shows variations of grain due to a pebbly structure. The pebbles, while mainly of a porphyry, are sometimes of a dark, hornblendic rock, and the face of the rock, where weathered, occasionally shows also a sedimentary structure. The porphyry pebbles differ in the coarseness and in the frequency of their phenocrysts, in a manner like the differences seen in the pebbles of the Stuntz conglomerate. In this case, however, the crystals are of feldspar.

Mic. This rock also presents the appearance of a hardened clastic debris identical in history and origin with No. 2244. The grains of hornblende and feldspar are smaller, and more like fragments and shreds than phenocrysts. This debris contained also a little quartz. They also grade more regularly into the size of the grains of the matrix. One section.

Remark. "On looking about over these knobs it appears that this rock is generally finely porphyritic with feldspar, and had originally pebbles of porphyry and fragments of a dark rock, constituting a conglomerate, showing in spots traces of a sedimentary structure, and really is but a condition of some parts of the fragmental formation. Yet it appears like rock No. 2243, and is massive as granite, having angular cross-jointage. The appearance and action of this intrusion are quite similar to the same in some of the Kekequabic Lake granite. Nos. 2243, 2244 and 2245 constitute a series showing what outwardly indicates intrusive and igneous action of a rock that originally was fragmental, and which still retains (in No. 2245)

unquestionable pebbly forms of different kinds of rock. This, however, all appears to belong to the Upper Keewatin, and may be said to repeat the phenomena of Kekequabic lake on a small scale." This structure may be compared with the jointed graywacke seen in figure 2, plate Y in vol. iv, and as a rock it is like the porphyritic conglomerate, or porphyrel, of Zeta lake (vol. iv, page 281), except that the recrystallization has proceeded farther than in the Zeta Lake porphyrel, and the rock has been forced to occupy fissures in the clastics in the manner of an intrusive. N. H. W.

No. 2247. Greenstone. *(Igneous.)*

On the town line, north side of sec. 5, T. 63-9, not far from the lake.
Ref. Annual Report, xxiv, page 77.

Meg. A gabbroid rock in which apparently pyroxene and magnetite exist, the latter being reddish, and perhaps rutile or some other titanium mineral. Has a sharp contact on a schistose and conglomeratic greenstone containing jaspilyte in indigenous masses. It differs from the greenstone containing the jaspilyte in that the hornblendes (or pyroxenes) produce the prominent roughness, the feldspathic ingredient occupying the depressions on the weathered surface, while in the prevalent greenstone, which here embraces the jaspilyte, the surface roughness is produced by a white siliceous net work which permeates the rock and stands out on weathered surfaces.

Mic. The *feldspars*, now much altered, still retain their ophitic relation to the surrounding dark mineral, which, now *uralite*, was originally augite. With considerable *epidote* in small isolated grains is also isotropic *chlorite* and semi-transparent, highly refractive *leucoxene*, which in reflected light coming from the upper surface of the slide appears dull white. Three sections.

Age. Igneous greenstone of the Lower Keewatin. N. H. W.

No. 2248. Granite. *(Sub-porphyritic.)*

On the town line, north side of sec. 5, T. 63-9, not far from the west end of the lake (which is near the section line running north into the next town).
Ref. Annual Report, xxiv, page 77.

Meg. Sub-porphyritic granite. This acts at first like an intrusive, but rapidly widens out in the schistose greenstone. This specimen came from ten feet from either side, weathers nearly white; has pyrite cubes.

Mic. *Quartz* is quite common. It surrounds *muscovite* scales and interlocks with itself and all the other minerals. It was hence the latest of the constituents to take its place. It bears the same relation toward *calcite*, which is abundant. The rock contains a little *sphene*, *pyrite*, chlorite, and two feldspars, one of which appears to be *orthoclase*. The feldspars which give the rock a sub-porphyritic aspect are occasionally of the soda-lime series and embrace the muscovite scales in the same manner as the quartz. One section.

Age. Intrusive in the Lower Keewatin.

Remark. This rock has the appearance of several others which have been supposed to be derived from the re-crystallization of a fine acid, feldspathic debris. It is allied to the quartz-porphyry of the Lower Keewatin, from which it is perhaps an apophysis. N. H. W.

No. 2250. Granite. *(Fine.)*

Same rock as Nos. 2248 and 2249, at its northern contact on the greenstone. Finer grained. No section.

Remark. This rock has much pyrite in scattered cubes, and is scatteringly "porphyritic" with a feldspar. Its southern line of contact on the greenstone is curious, for it is mixed with the greenstone very confusedly. There are many angular pieces of the porphyry in the schistose greenstone through an interval of six or eight feet, and in many places these two rocks both appear to share in that confusion, there being many pieces of greenstone mingled with the porphyry. It is difficult or impossible to decide whether the porphyry, as an intrusive, has spread itself amongst the greenstone, involving and surrounding many pieces, and itself losing many, or the greenstone as a fragmental has formed a basal sedimentary contact on the porphyry—or whether, again, this confusion is due to friction along a plane of contact between the two rocks. Whatever the cause, it is apparently at the same horizon as seen near the section line between sections 5 and 8, three-fourths of a mile further south. This is probably the rock which forms fine-grained, red-weathering dikes in the upper greenstone that holds the jaspilyte along the south side of this lake, and which appears amongst the graywackes near Nelson's cabins, as described under Nos. 2244, 2245 and 2246. These are, hence, probably all later than the great quartz-porphyry, but belong above the agglomeratic greenstone. As granites or porphyries they may appear as apophyses in later formations if by metamorphism that great quartz-porphyry should become plastic. N. H. W.

No. 2251. Felsyte.

Near the same place as No. 2250, but a little to the west.
Ref. Annual Report, xxiv, page 78.

Meg. Nearly as fine and siliceous as flint, the only mineral visible, besides the fine-grained quartz, or mesh of quartz, which can be identified, being pyrite, which is sprinkled sparsely through the rock. From a narrow red dike, three inches wide, cutting the greenstone No. 2252 in a winding zigzag course along the side of a vertical cliff which looks northeast. No section.

Remark. It is reasonable to infer that this little dike is an offshoot from the mass represented by Nos. 2248–2250. Its densely fine grain is somewhat like that at the contact on the greenstone (No. 2250) and proves that it entered the greenstone when the latter was much cooler than it was. N. H. W.

No. 2252. Dioryte. *(Uralitic.)*

Near the lake mentioned, and on the knob presenting a northeastward vertical cliff mentioned under No. 2251. S. W. ¼ sec. 33, T. 64–9.
Ref. Annual Report, xxiv, page 78.

Meg. Has the aspect of an igneous greenstone of medium grain; occurs as an irregular intrusive in the midst of the general greenstone.

Mic. The relation subsisting between the hornblende and the altered feldspars is imperfectly that of an ophitic rock, showing that this rock was one that congealed from fusion, and is of later date than the greenstone which it cuts irregularly. One section.

Age. An ancient greenstone cutting Lower Keewatin greenstone. N. H. W.

No. 2253. Gabbro *(with quartz)*.

Same place as No. 2252.
Ref. Annual Report, xxiv, page 78.

Meg. Sprawling, dike-like areas, nearly white, in rock No. 2252.

Mic. *Quartz* is quite abundant in this rock, but it plainly was last to take its place amongst the other minerals. The feldspar is *labradorite*, as shown by its acute bisectrix n_g, and its extinction angle at about 20° on a section cut perpendicular to n_g. The *augite* is scarce and is broken and uralitized, but not wholly lost. One grain shows an angle n_g:c of 54°, which indicates an *ægyrine-augite*. These augites are idiomorphic toward the labradorite, as well as toward the quartz. One section.

Age. Gabbro cutting Lower Keewatin greenstone.

Remark. Owing to its light color, and the evident quartz, this rock was taken in the field to be granitic. The augite is inconspicuous and on alteration has lost its usual dark color, becoming light yellowish green, and the resultant uralitic mineral is scarcely pleochroic. A little original magnetite was apparently titaniferous, as it appears now as a dark *leucoxene* with a white reflecting surface. N. H. W.

No. 2254. Diabase. *(Uralitized.)*

At the west end of another small lake, a little further north, yet in S. W. ¼ sec. 33, T. 64–9.
Ref. Annual Report, xxiv, page 78.

Meg. A greenstone, cutting a coarse Keewatin conglomerate; fine grained at the conglomerate contact.

Mic. This rock was originally ophitic. It now has no augite, but *uralite*; also *leucoxene*, *calcite* and *epidote*. Two sections.

Age. Dike in Upper Keewatin. N. H. W.

No. 2255. Diabase. *(Uralitized.)*

North side of the west end of the same lake; top of the southward facing cliff.
Ref. Annual Report, xxiv, page 79.

Meg. Same rock as No. 2254, but showing roundish, light-colored mineral aggregations that give it the appearance of being amygdaloidal.

Mic. The ophitic structure is preserved although the augite is wholly altered to *uralite*. Considerable masses of coarsely cleaved *calcite* are conspicuous in this rock. The feldspar is so altered that its space is occupied by granular secondary minerals, and these are so abundant that it is wholly impossible to determine even the direction of extinction of the original feldspar. Amongst these secondary minerals, probably *epidote*, *chlorite*, *calcite* and *leucoxene* are the most abundant. Spicules of hornblende also sometimes pass through these areas. In the slide there is no evidence of amygdaloidal structure. One section.

Age. Igneous, cutting Upper Keewatin conglomerate. N. H. W.

No. 2256. DIABASE. (*Uralitized.*)

Same rock, same place.
Ref. Annual Report, xxiv, page 79.

Meg. Same rock, showing the white fillings.

Mic. The section cuts one of the white fillings. The structure of the mineral composing this substance is nearly parallel, fibrous or lamellar, but divergent and blending and confused, having a predominant positive elongation, but with some fibres of a negative elongation. It has a very low double refraction, and an extinction angle of about 10° on the elongation of the fibres. About the periphery of this mass is much granular *epidote*. From the single section at hand it is not possible to name this species with certainty by the foregoing optical characters alone; but, except for the small angle of extinction, it agrees well with *apophyllite*. If the interferences and anomalies which are known to appear in that mineral be allowed for in this section perhaps there is no obstacle to that identification. While some of the fibres have a small angle of extinction others have parallel extinction, and in others it is shifting and imperfect, which can be attributed to overlapping twins, or combinations which are somewhat oblique or distorted. Compare No. 2258. One section.

Age. Greenstone (igneous) cutting the Upper Keewatin.

Remark. Later this zeolitic mineral was repeatedly subjected to the Boricky test with hydrofluosilicic acid. No distinct crystalline forms were produced, but the field was covered with minute irregular rods and globules, the former branching and crooked. Through these forms feeble double refraction could be perceived by reason of extinction recurring at certain points on rotation, but for the most part the crystals were confused and imperfect. These forms were evidently fluosilicate of lime. There was no appearance of cubic forms, and hence the mineral may be free from potassium. N. H. W.

No. 2257. Diabase. *(Uralitized.)*

Same place as No. 2256.
Ref. Annual Report, xxiv, page 79.

Meg. Same rock, but having small masses more hornblendic and green in which are small aggregations of hornblende arranged radiatingly and ophitically. No section.

Age. Igneous greenstone cutting the Upper Keewatin. N. H. W.

No. 2258. Diabase. *(Uralitized.)*

Thirty paces north of the quarter-post, west side of sec. 33, T. 64–9.
Ref. Annual Report, xxiv, page 79.

Meg. Coarser condition of the rock last mentioned, forming a rough country, the ridges running a little north of east. The coarse hornblendes stand above the weathered surface.

Mic. The secondary *hornblendes* embrace the altered feldspars in the ophitic manner, and are sometimes interpenetrated and embraced in the same manner by *leucoxene*. The products of alteration of the feldspars are *epidote*, an isotropic, chloritic substance, and *apophyllite*. The epidote is abundant in granular aggregates so fine and so highly refractive that they show no polarization colors, but, between the nicols, present a nearly isotropic field. It also rises into grains of considerable size. The mineral here identified as apophyllite is scattered quite commonly throughout the slide, having low single and double refraction, appearing much like a secondary feldspar. It is sometimes in large plages which embrace much epidote. It has a parallel extinction, some of the crystals being much elongated and usually negative, having n_1 parallel with their length, but not invariably. In numerous instances these elongated crystals are nearly isotropic except along a narrow margin, and sometimes different orientations appear in the same mass. The accompanying diagram represents an oblique basal section. The central area is biaxial and has n_2 as acute bisectrix, extinguishing at about 45° from the point at which the peripheral portion extinguishes. This mineral was later in origin than the hornblende and epidote, enclosing both, epidote also being enclosed by the hornblende. It serves, apparently, as a background in much of the rock. One section.

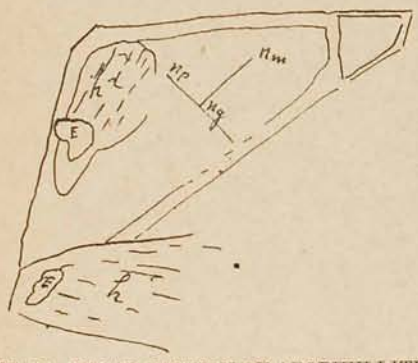

FIG. 50. BASAL SECTION OF APOPHYLLITE IN No. 2258.

Age. Igneous greenstone cutting Upper Keewatin. N. H. W.

No. 2259. Graywacke.

From a conglomeratic ridge running northeastwardly, lying some distance north of the west quarter-post of sec. 33, T. 64–9.
Ref. Annual Report, xxiv, page 79.

Meg. Gray or greenish-gray, granular, clastic; the matrix of a coarse conglomerate.

Mic. For such a rock this contains comparatively little *quartz*, many of the few translucent grains being biaxial and hence probably *feldspar*. None of the grains are friction-rounded. Other feldspars, which are now micro-granulitized, must have been much longer subjected to disintegration, and are rounded, but these are few. Some are plainly striated in the manner of the soda-lime feldspars. The most of the rock is of the darker minerals, *hornblende* and *leucoxene* predominating, while chloritic substance gives darkness to the slide between crossed nicols. One section.

Age. Upper Keewatin (Ogishke conglomerate).

Remark. The fragmental fresh feldspars are apparently only a finer dissemination of the clastic ("porphyritic") feldspars seen in No. 2260. N. H. W.

No. 2260. Porphyrel.

From the same rock as No. 2259, but from the northern part of the ridge.
Ref. Annual Report, xxiv, page 79. Compare the porphyrel of Zeta lake.

Meg. The specimen collected has a porphyritic aspect, due to the dissemination of white feldspars, the matrix being grayish green.

Mic. This rock, in its general composition and structure, is quite similar to No. 2259, but it contains larger feldspars. These are conspicuously banded on the pericline and albite plans of twinning, resembling those of the porphyry of Kekequabic lake, and of the porphyrel of Zeta lake. This rock also embraces notable amounts of calcite. One section.

Age. Upper Keewatin (Ogishke conglomerate). N. H. W.

No. 2261. Kersantyte. *(Dyke.)*

Intrusive in No. 2260.
Ref. Annual Report, xxiv, page 80. (Compare No. 2178.)

Meg. Greenstone, porphyritic with mica, the groundmass having a flesh-color tint.

Mic. The porphyritic scales are *biotite*. About one-half of the area of the section is occupied by a very low refractive mineral which is probably *apophyllite*, but that determination is not certain. It but rarely transmits sufficient light, between crossed nicols, to become visible. The rock contains much *calcite*, as well as innumerable small flakes of mica. One section.

Age. Dike cutting No. 2260.

Remark. This rock is unquestionably identical with rock No. 2178, which shows evident apophyllite. Compare, also, No. 2258. N. H. W.

No. 2262. Chlorite Schist.

A part of rock No. 2260, on its more northern extension.
Ref. Annual Report, xxiv, page 80.

Meg. A rather fine-grained, greenish-gray schist, with a few larger feldspars disseminated.

Mic. The section shows a much decayed clastic debris, which originally was constituted of the same materials as No. 2260, but now is darkened by the prevalence of *chlorite, leucoxene* and some iron oxide. But it is also lightened by *calcite* and a little *quartz.* The "porphyritic" feldspars were chiefly, if not wholly, of plagioclase, but are altered beyond specific determination. The quartz is in fine grains, sharply angular. In places it can be seen that the coarser feldspars have undergone an incipient loose micro-granulitization, with a scant development of fine epidote, but for the most part the feldspars and the finer parts seem to be darkened and disintegrated with development of a fine, highly refractive substance which is granular or irregularly spreading. This is in part chlorite, which embraces calcite. *Apatite* as clastic grains also exists in the rock in small amount, also an isotropic but perfectly transparent mineral, not determined. One section.

Age. Upper Keewatin. N. H. W.

No. 2263. Granite.

Near Moose lake, north from the last, on the section line.
Ref. Annual Report, xxiv, page 80.

Meg. Rather fine-grained for granite, gray.

Mic. The scant coloring elements are *chlorite,* mingled with some *hornblende.* There is, besides, a nearly colorless *amphibole* disseminated in minute fibres throughout the rock. There is a feldspathic and quartzitic background which is closely interlocked, embracing the few dark minerals and a notable quantity of *calcite* and numerous fine scales of *muscovite.* A considerable number of the feldspars are microlitic plagioclase, with nearly parallel extinction and negative elongation as cut, consisting of two to four albite macles; but both these and the larger feldspars, which may be orthoclase, are so related to the muscovite and the calcite that they surround them and appear to be of later date. One section.

Age. Intrusive in the Upper Keewatin.

Remark. This fine-grained, holocrystalline rock, with its curious petrology, is believed to be due to a recrystallization of a fine and clastic debris, a transformation which must have taken place simultaneously with the dynamic action which thrust it in the manner of an intrusive amongst its neighboring fragmentals where they were broken or bent so as to give it entrance. N. H. W.

No. 2264. GRANITE. *(Incipient.)*

Near the same place as the last, but a little further south.
Ref. Annual Report, xxiv, page 80.

Meg. A gray, felsitic-looking rock, without apparent phenocrysts, except pyrite, which is plainly visible in cubic forms; has a similar dike-like action, cutting a greenstone conglomerate.

Mic. The size of the grains in the composition of this rock is about the same as that of No. 2263, and the materials are about the same. The *hornblendes*, however, are more conspicuous, and in some cases they show their derivation from augite by the peripheral growths beyond the augitic nucleus, the whole being now converted to hornblende, but having a central area of greater absorptive power. For the most part, however, the hornblendes seem to be independent of any augitic nuclei, and especially the smaller ones. These degenerate in size to mere club-shaped spicules in which form they are very abundant in some places, and these spicules still further degenerate in size, becoming only minute globules, illustrating the infantile growths which have been noted in the case of quartz, feldspar, siderite and pyroxene and other minerals.

The principal ingredient of the rock is *feldspar*, but it is so far obscured by decay that it cannot be specifically identified, except that, in some cases, it can be seen to be of a striated species. The grains are, it is true, held together by a background of similar materials, through which has run a secondary feldspathic crystallization, and this has also permeated the old feldspars, but the secondary growths are very inconspicuous, and do not generally appear about the margins of the old feldspars. Occasionally, however, an old feldspar can be seen to be wholly rewrought by a more or less distinct granulitization, and the hornblende spicules run into such grains. Amongst the original clastic debris was an occasional distinct *quartz* grain. Such grains are somewhat enlarged by secondary growths, and finer secondary quartz appears also where there is no evidence of any original quartz. Scattered throughout the slide, and especially in the old feldspars, is a finely granular and highly refractive mineral which cannot be certainly determined, but may be *epidote*. With a little *leucoxene* and some *muscovite* this list completes the mineral composition.

Age. Intrusive in the Upper Keewatin.

Remark. This rock is intermediate, in crystalline state, between the last (No. 2263) and a compacted graywacke. The decay of the feldspars is exactly like that of the graywackes, and is here supposed to have taken place prior to consolidation into a rock, at least before the metamorphism. The mass, when still in its clastic condition, was under such pressure that it was forced as an intrusive amongst the adjoining rocks, and this generated an incipient recrystallization which was arrested before it completely permeated and altered the clastic grains, hornblende and muscovite being the first and most obtrusive forms in this regeneration. N. H. W.

No. 2265. Granite.

On the portage from Moose lake to Flask lake, sec. 28, T. 64–9 W. At several places a rock of this kind appears in lenticular bosses and dike-like intrusions in the coarse fragmentals.

Ref. Annual Report, xxiv, page 81.

Meg. Except for a tendency to a reddish color this rock is quite similar to the last two mentioned, but approaches nearer to No. 2263.

Mic. The old *feldspars* are crowded with *muscovite* flakes, and these are sometimes interleaved with *chlorite*. Calcite is not so abundant as in No. 2263, nor pyrite so abundant as in No. 2264. One section.

Age. Intrusive in the Upper Keewatin.

Remark. This rock is holocrystalline. The present feldspars, a regeneration from the old clastic feldspars, like those of Nos. 2263 and 2264, while generally fine, and for that reason hardly susceptible of specific determination, are occasionally larger, presenting a vanishing, irregular and interlocking periphery, set in close order with the finer feldspar grains that surround them. The present feldspar is probably more basic than the original, some of the potassa having gone into the production of the muscovite scales. The rock contains very little quartz. N. H. W.

No. 2266. Granite. (*Porphyritic.*)

On the same portage trail as the last, near the same place.

Ref. Annual Report, xxiv, page 81.

Meg. A reddish rock, porphyritic with feldspar, sprinkled with pyrite, and with an abundant finely disseminated, ferruginous oxide that appears to be the result of alteration of a carbonate. Considerably coarser grained than Nos. 2263–2265, containing pebbly forms, especially of greenstone.

Mic. The ferruginous oxide surrounds more or less completely cores of a gray or reddish-gray, highly doubly refracting, negative, uniaxial mineral, evidently that from which the oxide is derived, and it is necessary to infer that the rock originally contained a notable amount of *siderite*. It also contains now a large amount of *pyrite*, which sometimes is also peripherally oxidized in the same way. The feldspars are like those of the last described rocks (Nos. 2263–2265), except that some are larger and present a distinctly porphyritic appearance. They are also accompanied by original *quartzes* which are in part evidently bipyramidal. Some of the angular fragmental quartzes are enlarged by secondary rims which extend into and embrace the surrounding matrix, causing a narrow simultaneous darkening with the regular extinctions of the quartz. The feldspars are conspicuously twinned like those of the porphyrel of Zeta lake, and like those of the porphyry and granite of Kekequabic lake.

The matrix is non-homogeneous, but varies in spots in a manner suggestive of the assimilation and reconstruction of pebbles under the action of profound metamorphism. For instance: (1) Siderite is very abundant or is wanting; (2) There

are patches where chlorite and secondary quartz prevail almost to the exclusion of everything else, and others that consist almost exclusively of chlorite and muscovite; (3) There are isolated, sometimes roundish, spots in which there is a coarser granulitic recrystallization consisting apparently of new feldspar. These fine, new feldspars embrace no siderite nor muscovite, but the old feldspars are sprinkled with muscovite and sometimes with siderite. Muscovite and siderite seem to have been about cotemporary with the new feldspars. One section.

Age. Intrusive in Upper Keewatin.

Remark. It is probable that the mineral identified as calcite in No. 2263 and others may be in part siderite, but no oxidation is apparent in those rocks. This rock is comparable with the porphyrel of Zeta lake and with the porphyry of Kekequabic lake, standing between them in degree of regeneration. N. H. W.

No. 2267. Dioryte.

On the portage from Moose lake to Flask lake, sec. 28, T. 64–9 W., a little further east than the last.
Ref. Annual Report, xxiv, page 81.

Meg. A rather fine-grained, hornblendic rock, "which also has the jointage and aspect of an igneous rock. It is firm, fine grained, weathers coarsely very schistose, and is full of pebbles, rounded and angular, mostly and most evidently those of greenstone. These seem to be of the nature of inclusions in a basic intrusive, owing to the nature of this rock."

Mic. The rock consists essentially of *plagioclase* and *hornblende*, the latter, in its crystal faces, being independent of the former, but never having its faces 110 filled out. On the other hand those faces, as shown in section, are seen to be terminated by vanishing and irregular, ragged ends composed of sharp-pointed fibres that penetrate unequally into the surrounding rock, a feature quite common in regenerated rocks. Most of these hornblendes have borders surrounding darker cores, indicating an original augite, or some earlier condition of the hornblende itself. Besides the larger hornblendes there are a great many isolated spicules of the same mineral *(actinolite?)*. These in the same manner pierce the plagioclases in all directions.

The plagioclases are small, and of interlocking, irregular outlines. Some, which appear to be older than others, are pierced by mica scales.

Accessories are *epidote* and *iron ore*. One section.

Age. Upper Keewatin.

Remark. This is a reconstructed rock, whatever its original condition. It is very difficult to form an opinion as to its origin. Its outward megascopic characters, as above enumerated, appear to indicate a fragmental source, and there is nothing in its microscopic composition, so far as seen in the section examined, that precludes that origin. It would be ordinarily classed, however, as a basic intrusive of the diabase type, uralitized. N. H. W.

No. 2268. Porphyry *(or porphyrel)*.

On the same portage, near the same place as the last.
Ref. Annual Report, xxiv, page 81.

Meg. A gray rock with coarse, porphyritic white feldspars.

Mic. This is a compacted debris, partially regenerated by new minerals, but showing still plainly the decayed original stuff. There is a little fine quartz, but the rock is almost wholly feldspathic. *Epidote* and a little *hornblende* (often chloritized) give it a darker color. The twinned and striated porphyritic feldspars contain *epidote*, *muscovite*, *calcite* as products of alteration, also occasionally a hornblende spicule. These secondary minerals are distributed evenly throughout the feldspar "phenocrysts," *i. e.*, they do not affect the central areas. In that respect they differ from the secondary products of old feldspars that have been regenerated, as in granites. The only rule that can be observed is that epidote is apt to be more abundant in the peripheral parts. Most of the feldspar grains are so fine that they have been destroyed and blended in the general matrix by a micro-granulitization, and they can then be detected only by the contrast of their fineness with the coarser grain of the surrounding parts. The abundant calcite visible in some parts of the slide does not probably arise wholly from alteration of the phenocrysts, since sometimes such phenocrysts cut off the calcites sharply, with a distinct margin which encloses none of them. They seem to be due to some calcareous clastic ingredient which has been lost by alteration.

In the slide is one small crystal of *sphene*, also several irregular *pyrites*. One section.

Age. Intrusive in Upper Keewatin.

Remark. This rock stands intermediate, in point of recrystallization, between the porphyry of Kekequabic lake and the porphyrel of Zeta lake. N. H. W.

No. 2269. Graywacke. *(Hardened, feldspathic.)*

On the same portage, near the same place as the last.
Ref. Annual Report, xxiv, page 81.

Meg. A fine-grained, light-green-gray rock, having the appearance of an igneous intrusion, sharply much jointed.

Mic. In the field it was suggested that this rock might be due to the hardening of a siliceous mud, but it was, instead, a fine feldspathic mud with very little *quartz*. The section presents distinctly a field that is made up largely of small, angular fragments of *plagioclase*, very much altered with development of *muscovite*, *epidote* and *calcite*, being a rock essentially the same as the last, and differing in the absence of phenocrysts. One section.

Age. Upper Keewatin. N. H. W.

No. 2270. Green Schist. *(Ferruginous.)*

At the summit of the large island in Moose lake crossed by the section line between secs. 28 and 29, T. 64–9.
Ref. Annual Report, xxiv, page 81.

Meg. Has a bright-green, weathered surface, rough with siliceous projections from between which some softer mineral has been weathered out. It is charged, within, with carbonate of iron which on oxidizing does not stay so as to stain the weathered surface. The superficial green color fades out in other places, and the surface is more or less rusty, the interior being gray. It is cut by a rather fresh diabase dike four feet wide and by a narrow, vein-like quartzose dike of fine red granite. No section.

Age. Lower Keewatin(?) N. H. W.

No. 2271. Graywacke. *(Siliceous, ferruginous.)*

Part of the same mass as No. 2270.
Ref. Annual Report, xxiv, page 81.

Meg. This compact, fine-grained graywacke is quite siliceous, almost deserving the name quartzyte. It has *pyrite*, and is apparently cemented throughout by carbonate of iron, which, on oxidizing, gives the surface of the rock a rusty color. No section.

Age. Lower Keewatin(?) N. H. W.

No. 2272. Graywacke. *(Schistose, with chalcopyrite.)*

Part of the same rock mass as No. 2271, further east.
Ref. Annual Report, xxiv, page 81.

Meg. The rock is more schistose, sericitic, and, while rusty by oxidized pyrite, is also specked with a malachite green color, indicating that the pyrite was copper-bearing. No section.

Age. Lower Keewatin(?)

Remark. The copper in this rock may be compared with the metallic copper found in the Lower Keewatin at Tower, No. 2278. N. H. W.

No. 2273. Argillyte. *(Breccia.)*

On the trail from Moose lake to Wood lake, about the centre of sec. 20, T. 64–9 W., westward from the exposure of conglomeratic jaspilyte. The last and highest ridge before reaching Wood lake.
Ref. Annual Report, xxiv, page 82; Final Report, vol. iv, pages 557–562.

Meg. The ridge is composed of a fine, compressed reibungs breccia of fine graywacke and argillyte, the two rocks being closely folded and broken uniformly into a series of alternating short parts. "On the upper weathered surface where glaciation has evenly planed the rock off, the two parts recur with an irregular regularity, causing the rock to present an aspect of a squeezed conglomerate. But on

Jaspilyte and argillyte.]
Quartz-porphyry.

the face of the vertical surface the different pieces can be seen to extend downward for a foot or more in the general mass. The rock must have been at first a banded argillyte." No section.

Age. Lower Keewatin(?)

Remark. This structure is illustrated and discussed in volume iv, of the Final Report, pages 558–562. N. H. W.

No. 2274. Jaspilyte and Argillyte. *(Interbanded.)*

At the southerly slope of the hill containing conglomeratic argillyte near Moose lake, on the trail to Wood lake.

Ref. Annual Report, xxiv, page 82.

Meg. The weather-banding is very evident. The jaspilitic bands are about a third of an inch in thickness and of a light-grayish color, appearing like flint and nearly black within. The argillitic laminæ are about one-sixteenth of an inch in thickness and they weather out more rapidly, producing little grooves that run parallel. No section.

Age. Upper Keewatin(?) N. H. W.

No. 2275. Quartz-Porphyry.

"Burnt forties," near Soudan, at the corner of secs. 13, 14, 23 and 24, T. 62–15.

Ref. Annual Report, xxiv, page 84; vol. iv, pages 528–538.

Meg. Gray, with some feldspar, the probable source of the pebbles of the Stuntz conglomerate.

Mic. This rock is like numerous others that have been described as quartz-porphyry, or porphyrel. There are numerous old *feldspar* pieces and crystals nearly perfect, which are uniformly permeated by decay, with development of *muscovite* and *calcite*, and occasionally a distinct bipyramidal quartz. Some of the feldspars are so far decayed that they can with difficulty be distinguished from the matrix. This decay has been interrupted by an opposite process, which has thoroughly permeated the matrix, where it was originally fine grained, and has partly regenerated the feldspars. This regeneration is marked by fresh feldspathic substance which is clear and glassy, seen throughout the matrix and sparsely in the peripheries of the old feldspars. (Figure 4, plate V.) The quartz, where originally fine, has also been recrystallized and is clear and glassy; such quartz also forms a narrow rim about the old original quartzes, which penetrates the matrix and darkens in unison with the crystal to which it is an appendage. It is most marked about the distinctly bipyramidal grains. One section.

Age. Lower Keewatin(?)

Remark. This rock differs petrographically in no way from those porphyries and porphyrels which have been described between Moose and Flask lakes, which cut the Upper Keewatin conglomerate of that region. N. H. W.

No. 2276. Quartz-Porphyry. *(Granitic.)*

Part of the same rock as No. 2275, but further west.
Ref. Annual Report, xxiv, page 84.

Meg. Weathering pinkish, approximately a granitic structure, with a few coarse, roundish quartz grains or pebbles.

Mic. In the main this is a coarser rock than the last, and is more recrystallized. It also contains a larger percentage of free silica. This is in the form of original rounded grains and of minute, interlocking and micro-granulitic secondary *quartz*, fresh and glassy, some of it being arranged in a vein-like band in which the individual grains are coarser than throughout the rock generally. There are in the slide none of the original bipyramidal quartzes. The *feldspars* are in the form of fragments of uniform size. They never interlock, and rarely come into contact. Many of them are plainly triclinic, but quite a number appear to be of *orthoclase*—perhaps one-half of them. The arrangement of a few linear shreds of *hornblende* and of *biotite* is so generally roughly parallel with itself that there seems to be a trace of an old structure, which, if the hornblende were more abundant, would perhaps develop into a coarse schistosity. The secondary quartz surrounds the fine biotites. While most of the old feldspars are still perfectly evident, there are some that are nearly lost in a fine granulation, caused by decay and subsequent regeneration. Such feldspathic grains can be distinguished from the recrystallized matrix by the greater fineness of the structure in the areas occupied by their sections, their greater obscurity or their greater brightness and sometimes by the greater abundance of fine mica scales, or by an identifiable remnant of the original feldspar itself. In the last case there are apt to be a few peripheral secondary fine feldspar grains attached to the old feldspar.

The isolation of the old feldspar fragments in the regenerated fine matrix is illustrated by figure 5, plate V. That these are fragments and not phenocrysts developed in a magma is evident from the following considerations:

1. They never show crystal outlines, although they are perfectly unimpeded by the surrounding rock substance.

2. In size they graduate from the coarsest to the finest, passing into the general matrix.

3. Their forms are usually subrounded.

4. This rounding cannot be due to resorption, for the surrounding matrix never enters into them in embayments such as often seen in the quartzes of a magmatic quartz-porphyry.

5. The only manner in which they are linked with the matrix is by a later regeneration of the rock, by which the matrix has been reformed and the peripheral portion of the old feldspars has been simultaneously developed by secondary growths that interlock in the regenerated matrix.

6. The finer the grains the more they were decayed, and the less evident they have become after the regeneration.

7. They are both orthoclastic and plagioclastic, a fact which can be explained by reference to an original clastic accumulation, but hardly by simultaneous crystallization from a homogeneous molten magma. One section.

Age. Lower Keewatin(?)

Remark. It should not escape notice that this rock, here supposed to belong in the Lower Keewatin and to have contributed to the formation of the Stuntz conglomerate of the Upper Keewatin, is petrographically identical with much of the quartz-porphyry and granitic intrusive rocks, already described, occurring between Moose and Flask lakes, supposed to be intrusive in the Upper Keewatin, viz.: Nos. 2263, 2264, 2265, 2266, and is also structurally and genetically the same apparently as the quartz-porphyry of Kekequabic lake, which is also supposed to be intrusive in the Upper Keewatin. Therefore, the assignment of this to the Lower Keewatin must be with some uncertainty. N. H. W.

No. 2277. Chlorite. *(Massive, ripidolite.)*

In vug-like angular spaces of No. 2276, as exposed on the weathered surface.
Ref. Annual Report, xxiv, page 84.

Meg. Very fine grained, green; hardness about that of chlorite; massive.

Mic. The mass of this substance, when viewed with high power objective, is resolved into little groups of very low doubly refracting scales or fibres, which are placed divergently and irregularly together. They extinguish parallel and have a negative elongation. Their effect is to make the field of the microscope rather dark.

A micro-chemical preparation with hydro-fluosilicic acid affords numerous microscopic rhombohedrons of more or less irregular development, but with perfect edges and faces. These may be, and probably are, silicic fluorides of magnesium and of iron.* The species is probably *ripidolite*, owing to the position of the axis (n_g) with relation to the lamellæ, and the tendency of the clusters to assume vermicular forms. One section.

Age. In vugs in No. 2276.

Remark. In this chloritic mass are a very few *muscovite* scales, which are as fine as those of the ripidolite, and are arranged parallel with them. N. H. W.

No. 2278. Copper. *(Metallic.)*

Montana shaft of the Minnesota Iron company, Soudan.
Ref. Annual Report, xxiv, page 84: Proceedings of the Lake Superior Mining Institute, iv, 70, 1896. Compare No. 2272.

Meg. Occurs in a vein-like sheet, which crosses the ore deposit diagonally, and dips eleven or twelve degrees toward the south, encountered in mining iron at the

*The elements of a new method of chemico-microscopic analysis of rocks and minerals. Emanuel Boricky. Translated in *Nineteenth Minnesota Report* (for 1890).

depth of 265 feet below the surface of the ground, from one-fourth to one-half inch thick. The principal vein of copper was accompanied by several thinner ones which extended in crevices in the ore and also in the enclosing rock. Malachite, azurite and cuprite also existed in small quantities, thought to be secondary results by alteration of the pure copper, indicated by the discovery of an octahedron, which consisted at the centre of copper, surrounded first by cuprite and outwardly by malachite. According to Mr. Eby some copper specimens were as large as six by ten inches, and some were remarkably well crystallized and free from alteration products. Alteration products from the metallic copper extend downward into the ore for several feet, but above it the ore is free from such products. Dr. C. P. Berkey has discussed these minerals and their paragenetic relations in the paper above referred to.

Remark. This occurrence of metallic copper is in the upper part of the Lower Keewatin and is hence in the oldest rocks known to contain that substance. Its full extent is unknown. It may develop into a much larger body as the iron mining proceeds. The position of the metallic mass transverse to the ore body and to the main structures of the country rock indicates that its origin is not coeval with the ore nor with the country rock. In that respect it differs remarkably from the iron ore. Its manner of occurrence is very similar to that of the copper sheets in a heavy diabase layer of the Keweenawan at Fall river near Grand Marais already described (No. 200). Whether its date of origin is as late as that of the Keweenawan copper deposits is an interesting question which there is at present no means of answering satisfactorily. It can only be said that so far as its alliances and structures can be interpreted, they favor the idea of its dating from the same great convulsive epoch. If that be admitted there result some interesting corollaries.

1. The metallic copper of the Keweenawan was not the result of fusion or reduction of previously existing post-Archean ores.

2. It did not come to the surface of the earth by reason of igneous eruption.

3. The causes that gave it origin and location were not primarily seated in the Keweenawan, unless, as suggested by Dr. Berkey, the Keweenawan formerly existed in the region of Tower. There are some extensive diabase dikes in the region of Vermilion lake supposed to have the Keweenawan age, and these may ultimately be thought to prove the former existence of the Keweenawan overlying the Archean in an extensive deposit in that region. Aside from that consideration this metallic copper is far isolated geographically and structurally from the Keweenawan as now known.

4. If dating from the Keweenawan, but not of the Keweenawan, this occurrence still points to some relation or alliance of the rock (greenstone) in which the copper occurs, with the diabase of the Keweenawan.

Jasper. Quartz and red jasper.]

If on the other hand this copper existed in the Archean prior to the Keweenawan other important corollaries are evident.

1. The conditions precedent for the development of metallic copper in connection with basic eruption existed in the Archean before they existed in the Taconic.

2. Metallic copper in the Archean may be the direct source of that of the Taconic, through the fusion and complicated chemical reactions attending the transformation of the basal (Keewatin) greenstones into gabbro and diabase of the Keweenawan. Archean metallic copper or copper ores, and the Keewatin iron ore may have locally gone together into the composition of the gabbro and diabase of the Keweenawan.

3. If that be the source of the metallic copper of the Keweenawan, it implies the probable present existence of large bodies of copper in the Keewatin, but probably at great depths within the Lower Keewatin. N. H. W.

No. 2279. Jasper. *(Red.)*

From the dump of the Lee mine, near Tower.
Ref. Annual Report, xxiv, page 84. Compare No. 140.

Meg. Brick red, dense, but on a freshly fractured surface presenting an internal structure that shows numerous small and irregular conchoidal vitreous surfaces which resemble irregular cleavages. There are in the mass a few small, scattered, massive hematite grains of considerable size, also smaller ones of quartz, which latter also forms a few thin veins, and still fewer specks of a yellow sulphide, which resembles chalcopyrite. The entire mass seems not only to be finely crystalline, but to belong to the hexagonal system, resembling quartz. On the fresh surfaces mentioned are seen numerous dull faces which were produced by the separation of a crystal from its neighbors. These are sometimes grouped so as to suggest the hexagonal system with terminal pyramidal or other faces.

Mic. The coloring material is *hematite.* This is mainly as a pigment, but occasionally takes the form of minute, cherry-red, sub-translucent scales and crystals. The whole section breaks up, between crossed nicols, into angular, "patchy" areas of poikilitic quartz which have varying orientation. The rock might be called a vitreous quartzyte except for its fiery red color.

Age. Lower Keewatin(?)

Remark. It is unfortunate that the structural relations of this rock with the greenstone and the ore are unknown. N. H. W.

No. 2280. Quartz and Red Jasper. *(Spongy.)*

Same place as No. 2279; a portion of the same rock.
Ref. Annual Report, xxiv, page 84.

Meg. A harsh, siliceous, spongy mass, the cavities evidently due to the oxidation and removal of pyrite. The siliceous remnant consists in part of red jasper, the

same as rock No. 2279, and in part of white quartz. The latter is plainly of the same date as the quartz described as permeating the red jasper of No. 2279. The whole rock is evidently a secondary result of chemical infiltration in cavities within the iron ore or its surroundings. These elements, especially the sulphur of the pyrite, may be referred to the clastic (largely volcanic) greenstone in which the ore bodies are embraced. No section.

Age. It is unknown whether this jasper and pyrite are in the original rock containing the ore of the Lee mine, or in the conglomeratic base of the Upper Keewatin. Petrographically Nos. 2279 and 2280 much resemble the silicified "patchy" aporhyolytes of the Keweenawan, suggesting the same petrology; while they have an alliance with the jaspilyte of the Vermilion Iron range, in that they consist solely of quartz and hematite, the former embracing the latter in a poikilitic manner. N. H. W.

SPECIMENS COLLECTED BY U. S. GRANT.

No. 61G. Camptonyte (?)

From a dike in the granite at the falls of Gunflint river in N. E. ¼ N. E. ¼ sec. 13, T. 65–4 W. The dike is on the Canadian side of the falls.

Ref. Annual Report, xvii, pages 160, 161, 199, 204.

Meg. This rock is the same as No. 1318.

Age. Archean. U. S. G.

No. 86G. Esterellyte.

From the point on which is the northwest corner of sec. 32, T. 65–6 W.; north shore of Kekequabic lake.

Ref. Annual Report, xvii, pages 197, 205; Annual Report, xxi, pages 39–50. (This rock is the type of the porphyritic facies of the granite here described.)

Meg. This rock is the same as No. 1094, of which a complete description is given elsewhere. Three sections.

Age. Archean (Keewatin). U. S. G.

No. 344G. Syenyte (*in contact with amphibolyte*).

Shore of Clearwater lake, E. ½ N. E. ¼ sec. 32, T. 63–10 W. Here is an amphibolyte cut by stringers of syenyte.

Ref. Annual Report, xx, pages 41, 97.

Meg. The specimen shows both rocks. The syenyte is of medium grain and reddish in color, and the amphibolyte is of about the same grain and contains a little feldspar. In the syenyte near the contact of the two rocks the hornblende is quite abundant.

Mic. The section shows both rocks. The syenyte is composed essentially of (1) An almost opaque feldspar, which, nothwithstanding its alteration, shows traces of polysynthetic twinning; (2) A fresh feldspar with abundant twinning lamellæ; and (3) A few pieces of green hornblende. The small part of the amphibolyte in the section is seen to be made up almost entirely of green, highly pleochroic hornblende; a small amount of altered feldspar is also present. One section.

Age. Archean. U. S. G.

No. 368G. Granite.

Kawishiwi river (west shore) in S. W. ¼ sec. 34, T. 63–10 W.
Ref. Annual Report, xx, pages 43, 98.

Meg. A medium-grained, brownish granite forming the shore of the river.

Mic. The entire section shows essentially a granitic aggregate of orthoclase, hornblende and quartz. The orthoclase is gray and usually shows a cloudiness due to alteration; a few of the grains show a polysynthetic twinning lamellæ. The hornblende is the ordinary green, highly pleochroic variety, and is completely allotriomorphic; it has altered in some places to chlorite, but elsewhere appears to be quite fresh. Quartz is scattered through the whole section, but is not noticeable macroscopically; it presents the characters of ordinary granitic quartz. It occurs oftentimes in polysomatic areas, and a large number of the grains show decided undulatory extinction. The quartz makes up less than ten per cent of the whole rock. Apatite, sphene and magnetite are the accessory minerals; they all occur in only small amount. The apatite is in both short, stout and long, slender prisms. The sphene and magnetite show no characteristic crystal outlines. One section.

Age. Archean. U. S. G.

No. 383G. Graywacke. *(Fine.)*

North branch of the Kawishiwi river, N. E. ¼ N. E. ¼ sec. 28, T. 63–10.
Ref. Annual Report, xx, pages 46, 99.

Meg. Fine graywacke, evidently somewhat hardened by metamorphism. In the field shows distinct stratification.

Mic. The rock shows a slight schistosity, the graining being elongated prevailingly in one direction, and the darker elements arranged in broken lines or shreds in the same direction.

The most noticeable feature is the decayed condition of the feldspathic grains. They are permeated with *muscovite, chlorite* and *epidote,* which, in finer grains, render the original feldspar so vague and invisible that generally no part of it is sufficiently intact to afford any characteristic tests for species. Some of them can be seen to have been twinned formerly on the albite plan. These decayed grains do not show any conspicuous, and but rarely a narrow, indistinct, broken, reconstructed margin.

Yet it is evident that they are not now in a process of decay, but have been reconstructed and hardened by metamorphism. The matrix in which these old feldspars lie seems to consist of newly crystalline materials, viz., a new feldspar and quartz, with scattered scales of muscovite, a little hematite, chlorite. The little fresh quartzes interlock as in a granitic rock, being interlobed in and around each other.

In a second slide the whole grain is coarser. A well-preserved feldspar, showing n_g perpendicular, has extinction on cleavage at 12°, but a refractive index greater than the quartz adjacent, indicating a species lying between *andesine* and *labradorite*. All the quartz is so completely remodeled in both slides that there is nothing remaining to show its original clastic nature. Indeed, the only remaining clastic feature, so far as can be determined by the slides, is the decayed and then regenerated condition of the feldspars. Two sections.

Age. Keewatin.

Remark. In the field appearance this rock, which alternates with some that are coarser, is in places distinctly micaceous, being near a granitic area. N. H. W.

No. 384G. Graywacke.

Same locality as No. 383G.
Ref. Annual Report, xx, pages 46, 99.

Meg. Similar to the last, but coarser.

Mic. This rock is not distinctly schistose. It contains a conspicuous amount of *calcite*, *chlorite* and *muscovite*. The feldspars, some of which are large, while showing the same kind of alteration, are occasionally bordered by fresh interlocking growths, and this new growth penetrates and permeates, apparently, the whole feldspar grain and is not observable or is less distinguishable in the body of the grain because of the many muscovite scales and other inclusions which have been developed. The acid feldspars seem to be but little more prone to this alteration than the basic. One section.

Age. Keewatin. N. H. W.

No. 385G. Graywacke. *(Subcrystalline.)*

North shore of the Kawishiwi river, N. E. ¼ N. E. ¼ sec. 28, T. 63–10, near the same place as the last.
Ref. Annual Report, xx, pages 46, 99.

Meg. Gray, firm, when fractured, glistening with scattered cleavage surfaces.

Mic. This rock is quite similar in all respects to the last two. It is noticeable, however, that it contains much *epidote*. It is also observable that some of the larger *feldspars*, which were plainly triclinic at first and must have extinguished alternatingly in the albite twinning bands, in the regular manner of such twinning, now do not extinguish alternatingly. They are instead, simply banded, coincident with the albite macles, with lighter and darker lines and bands, but these bands extinguish

simultaneously. At the extinction point certain bands are faintly darker than the others, and at full illumination certain ones are somewhat brighter than the others. Others preserve the albite twinning distinctly. It is observable also that throughout the finer matrix the secondary feldspar is more freely developed, interlocking with the secondary quartz, some of the fine older grains being surrounded by a new rim, while the large feldspars exhibit usually no rim of new growth, although they are probably largely regenerated throughout, and it appears reasonable to attribute to such regeneration the impairment of the albite alternate maclation. The quartz is wholly remodeled, thus making a firm interlocked granitic structure. One section.

Age. Keewatin.

Remark. The modifications of this rock, due to metamorphism (Twentieth Annual Report, page 46), are in nature and structure like those seen in various crystalline rocks which, called granite or dioryte, are intrusive on the adjacent clastics. N. H. W.

No. 386G. Graywacke. *(Metamorphosed.)*

Same place as the last.
Ref. Annual Report, xx, pages 46, 99.

Meg. Weathers nearly white, apparently consisting of quartz and feldspar, fine grained.

Mic. The renewed mineral condition of the whole rock is the same as in the last four described rocks, but this rock contains almost nothing but quartz and the white silicates, with epidote which also is itself nearly white. In some instances (noted also in No. 385G), isolated small globular quartz granules are in the feldspars. This seems to imply that the feldspar has undergone a general molecular rearrangement. One section.

Age. Keewatin. N. H. W.

No. 403G. Quartz-Porphyry.

From a dike in the greenstone north of the Kawishiwi river; N. ½ N. W. ¼ sec. 28, T. 63–10 W.
Ref. Annual Report, xx, pages 48, 99.

Meg. This rock has a grayish groundmass in which are embedded a few quartz grains and numerous flesh-colored and blood-red feldspars. The quartz is more plentiful near the edge of the dike (No. 402G). In places the rock contains minute cavities, apparently formed by the weathering out of certain constituents of the rock.

Mic. Under the microscope the rock is seen to have a microgranitic groundmass of rather variable grain. In this are feldspars of all sizes up to pieces over a quarter of an inch in length. The crystal outlines of the feldspars are not usually distinct and most of them show no planes at all, being pieces with irregular outlines. Many of the feldspars show polysynthetic twinning lamellæ, and a large number do

not. Alteration to sericite is quite common, and in some cracks and areas of considerable size in the groundmass sericite has been developed in large amount. Secondary calcite is also present. No distinction between the flesh-colored and the blood-red feldspars can be made in ordinary section,—they both appear colorless; and as yet no oriented sections of the two kinds have been studied; they appear very distinct in the hand specimen. Scattered through the rock are colorless to greenish secondary needles of chlorite or hornblende. A few areas of green hornblende, more or less altered, also occur, but it is not possible to say whether this hornblende was the form of the original ferro-magnesian constituent of the rock. Sphene and apatite are present in small amount. Large quartz grains are not present in the sections examined, although macroscopic grains are often seen in the hand specimens collected. One section.

Age. Archean. U. S. G.

No. 407G. Gneiss. *(Biotitic.)*

S. E. ¼ N. W. ¼ sec. 28, T. 63–10 W. South of the Kawishiwi river.
Ref. Annual Report, xx, pages 49, 99.

Meg. Medium grained, gray, showing biotite.

Mic. This is like a regenerated graywacke. It contains many old, centrally-clouded *feldspars*, most of which have not been much extended, or not at all, beyond their original limits, by new growths, but some of which have been thus enlarged, and they have probably all been more or less reformed by the metamorphosing action which the rock has suffered. This metamorphosing action has wholly reformed the *quartz*, some small granules of which are embraced within the regenerated feldspars, but the most of which forms the interlocking plexus in which the feldspars lie. Besides *biotite*, the rock contains *epidote*, *brown hornblende(?)* and *chlorite*, these forming part of the groundmass; also muscovite (generally within the feldspars) and a little *apatite* and *sphene*. One section.

Age. Archean (modified Keewatin).

Remark. Neither by its mineral composition nor by its internal structure can this rock be distinguished from many granites, nor from the modified graywackes, such as Nos. 385G and 386G. N. H. W.

No. 408G. Gneiss.

Same place as No. 407G.
Ref. Annual Report, xx, pages 49, 98.

Meg. Gray, medium-grained, typical gneiss.

Mic. The same barred structure of some of the large feldspars mentioned in the description of No. 385G, is conspicuous in this rock, and the bars sometimes have two directions, in the same crystal, crossing each other at an

angle of about 30°. Other feldspars are distinctly twinned on the albite plan. Otherwise this rock is much like No. 407G. One section.

Age. Archean.

N. H. W.

No. 416G. Quartz-Porphyry.

South shore of small lake, W. ½ N. E. ¼ sec. 21, T. 63–10 W. From a dike, within two inches of its edge, in greenstone.

Ref. Annual Report, xx, pages 56, 57, 100.

Meg. A very fine-grained, pinkish rock, with porphyritic quartzes and abundant pinkish porphyritic feldspars.

Mic. Similar to No. 417G, except that the groundmass is some finer grained and the feldspars are not usually in well defined crystals. One section.

Age. Archean.

U. S. G.

No. 417G. Quartz-Porphyry.

From the centre of the same dike (see under No. 416G).

Ref. Annual Report, xx, pages 56, 57, 100; Annual Report, xxi, page 43.

Meg. Similar to No. 416G, but more granite-like in appearance.

Mic. Microscopically the rock shows a decided microgranitic groundmass of rather small but irregular grain. Embedded in this are numerous feldspar phenocrysts of all sizes up to those nearly half an inch in length. Most of these feldspars show their crystallographic outlines on all sides, but some few appear as fragments partially bounded by crystal planes. Zonal structure is quite common, and about half of the individuals show polysynthetic twinning lamellæ. Quartz individuals of good size are also present, but are not nearly as abundant as the feldspars. The quartzes are all corroded and show no crystal faces, and they frequently have large embayments filled in with the groundmass. Some of the quartz shows undulatory extinction, but otherwise the rock gives no evidence of having been subject to pressure. Scattered through the groundmass are irregularly outlined green areas composed of chlorite and epidote. What the original ferromagnesian constituent of the rock was is now impossible to determine. A few small acute rhombs of sphene are also present. Two sections.

Chemical analysis. An analysis of this rock, made by Mr. A. D. Meeds, is as follows:

SiO_2	69.70
Al_2O_3	18.72
Fe_2O_3	.65
FeO	.79
CaO	2.25
MgO	.45
K_2O	1.68
Na_2O	5.01
H_2O	.71
Total	99.96

Age. Archean.

U. S. G.

No. 490G. PORPHYRY. *(Syenitic.)*

West shore of a narrow bay of Snowbank lake, S. E. ¼ S. E. ¼ sec. 27, T. 64–9 W. From a dike cutting diabase.

Ref. Annual Report, xx, pages 61, 102.

Meg. This porphyry has a reddish to purplish aphanitic groundmass, in which are porphyritic crystals of red feldspar and small areas of chlorite.

Mic. Under the microscope the groundmass is seen to be microgranitic in structure and apparently composed of *quartz* and *feldspar*. The feldspar phenocrysts are more or less altered and the majority of them show polysynthetic twinning. Irregular areas of chlorite occur in the groundmass, but nothing is left to show what was the mineral that originally occupied these areas. A few small apatite prisms are present, and scattered through the whole rock are minute green flakes of chlorite. Two sections.

Age. Archean. U. S. G.

No. 491G. GRANITE.

West shore of Snowbank lake, at the line between secs. 26 and 35, T. 64–9 W.

Ref. Annual Report, xx, pages 62, 102.

Meg. It is a granite of medium grain, reddish color and compact texture; the feldspar varies from reddish to white, and the hornblende is in small grains and does not make up more than one-fifth of the whole rock. Quartz is present in small amount.

Mic. Under the microscope this rock is seen to be a distinct hornblende granite. *Quartz* is present in larger quantity than is noticed in the hand specimen. The *feldspar* is more or less cloudy and many of the grains show a microcline structure and have a wavy extinction, as have also some of the quartz grains. The *hornblende* is quite fresh and of the ordinary green variety. A few scales of brown *biotite* are present, and also some green *chlorite*, which appears as an alteration product from the biotite. Bright brownish *sphene* is seen in considerable amount. *Ilmenite*, or *magnetite*, and *apatite* prisms are also present. One section.

Age. Archean. U. S. G.

No. 499G. GNEISS.

South shore of small bay on the west side of Snowbank lake, S. E. ¼ S. W. ¼ sec. 26, T. 64–9 W.

Ref. Annual Report, xx, pages 63, 64, 102.

Meg. A fine-grained, granular, biotitic gneiss.

Mic. In section this gneiss is seen to be a holocrystalline aggregate of interlocking grains of *quartz*, *feldspar*, *biotite* and *hornblende*. Many of the grains are elongated somewhat in one direction; this is especially true of the biotite, and there seems to be a tendency for grains of the same size and of the same minerals to be collected somewhat in irregular parallel lines. This causes a decidedly schistose

structure to pervade the rock. None of the mineral grains show any evidence of a clastic origin. The quartz is clear and limpid and is in larger grains than the other minerals; it makes up about half of the rock. The feldspar, while cloudy in small areas, is usually clear; most of it is orthoclase, but some good-sized plagioclases are present. The biotite is brown and fresh; it, more than any of the other minerals, is chiefly confined to certain irregular lines. The biotite is in small scales, most all of which are arranged with their long axes in the direction of the schistosity of the rock. Hornblende of the ordinary green variety is present in a few irregular areas; it appears very fresh. All the minerals of the rock present a decidedly fresh and unaltered appearance. One section.

Age. Archean (Keewatin). U. S. G.

No. 521G. Granite.

North shore of Snowbank lake where the east line of sec. 24, T. 64–9 W., cuts the shore.
Ref. Annual Report, xx, pages 66, 103: Annual Report, xxii, page 156.

Meg. A very fine-grained, dark-gray granite.

Mic. Dr. A. H. Elftman's description of this section is as follows (Twenty-second Annual Report, page 156): "Specimen No. 521G, from the S. E. ¼ of N. E. ¼ sec. 24, T. 64–9, is a fine dark hornblende granite. Under the microscope this shows the *feldspars*, *hornblende*, *sphene* and *magnetite*. The hornblende has altered to chlorite and shows no traces of augite." One section.

Age. Archean. U. S. G.

No. 522G. Granite. *(Augitic.)*

Small island in Snowbank lake, N. E. ¼ S. W. ¼ sec. 19, T. 64–8 W.
Ref. Annual Report, xx, pages 66, 103; Annual Report, xxii, page 156.

Meg. A medium-grained, pinkish-gray granite.

Mic. Dr. A. H. Elftman's description of this rock is as follows (Twenty-second Annual Report, page 156): "No. 522G, from the island in the N. E. ¼ S. W. ¼ sec. 19, T. 64–8, is an augite granite. The mineral constituents are the same as in No. 271E.* *Augite* and *hornblende* are present in separate plates. There is no direct alteration of the former into the latter, but the hornblende possesses the fibrous cleavage of uralite and is a paramorph after the augite. *Biotite* is secondary from the hornblende. In this section we have a change of augite to hornblende, which in turn is altering to biotite and chlorite." Two sections.

Age. Archean. U. S. G.

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*The description of No. 271E is as follows (*Twenty-second Annual Report*, p. 155): "On the west side of the narrow bay in the W. ¼ of sec. 20, T. 64–8, is a large outcrop of a light-gray granite (No. 271E). The rock is medium grained, and the ferromagnesian minerals constitute about one-half of the rock mass. Under the microscope this rock is shown to be an augite granite. *Orthoclase*, *microcline* and *oligoclase* occur in equal proportions. All of the feldspars have a well-defined, clear zone around a kaolinized centre and are in some cases porphyritically developed. Quartz is not very abundant and occurs in small grains. The augite and hornblende are closely associated. The *augite* is of a light-green color, has no pleochroism and extinguishes from 45° to 50°. It forms the cores of the hornblende, which has a darker color, is pleochroic in brown and dark green, and extinguishes at less than 22°. The cleavage of the hornblende is a continuation of that in the augite core. The line of division between the two minerals is distinct, and the extinction angle of both minerals is readily measured along the same cleavage. One pyroxene plate is unaltered, and its extinction and striations bring it near to diallage. Hornblende occurs in several places in bent bundles of slender rods. *Sphene* occurs in double wedges and rounded grains. *Magnetite* and *biotite* are secondary and are not abundant."

No. 523G. Granite.

North shore of Snowbank lake, N. W. ¼ S. W. ¼ sec. 29, T. 64–8 W.
Ref. Annual Report, xx, pages 66, 103; Annual Report, xxii, page 156.

Meg. A medium-grained gray granite, with small yellow stains.

Mic. Dr. A. H. Elftman's description of this rock is as follows (Twenty-second Annual Report, page 156): "No. 523G from the N. W. ¼ of S. W. ¼ sec. 29, T. 64–8, is a medium-grained hornblende granite of a light-gray color. Examined in thin section, this rock shows the usual composition of the hornblende granite in this locality. The *feldspars* are considerably altered, *quartz* occurs only in small grains, and the *hornblende* is highly pleochroic in green and brown. *Sphene* is the oldest mineral. *Magnetite* is largely secondary. *Limonite*, an alteration product, stains the rock yellow. Combined with the kaolin of the feldspar this produces a yellow powder which is easily removed from the rock and leaves cavities. In the hand specimen this peculiar yellow stain is very noticeable." Two sections.

Age. Archean. U. S. G.

No. 524G. Granite. *(Augitic.)*

East shore of Boot island, Snowbank lake. This island is the one crossed by the line between ranges 8 and 9 west.
Ref. Annual Report, xx, pages 67, 103; Annual Report, xxii, page 157.

Meg. A medium-grained, dark-gray granite, in which the ferromagnesian minerals are abundant.

Mic. Dr. A. H. Elftman's description of this rock is as follows (Twenty-second Annual Report, page 157): "No. 524G, from the east shore of the large island (Boot island) on the range line between T. 64–8 and T. 64–9, is a coarse augite granite. In general the rock is the same as No. 271E,* differing only in the character of the augite, which in this section is fresh, shows no signs of alteration, is not pleochroic, extinguishes at 45° and has a deep green color." Biotite is common. Three sections.

Age. Archean. U. S. G.

No. 551G. Granite. *(Augitic.)*

From a little promontory on the south shore of Kekequabic lake, S. W. ¼ S. W. ¼ sec. 3, T. 64–7 W.
Ref. Annual Report, xx, pages 71, 104; Annual Report, xxi, pages 39–50. (This rock is a good representative of the normal phase of the granite here described.)

Meg. A fine-grained, pinkish-gray granite composed of pinkish feldspar, quartz and small grains of augite. Sub-porphyritic feldspars are common.

Mic. Under the microscope the sub-porphyritic feldspars are not so noticeable, except for their size, as in the hand specimen. All the feldspar has a tendency to an idiomorphic form, and all is somewhat clouded by alteration. It is frequently polysynthetically twinned and sometimes, especially in the larger crystals, is zoned. On separating the powder of this rock by means of Thoulet's solution, the larger

*For the description of No. 271E see foot-note under No. 522G.

proportion of the feldspar fell between a specific gravity of 2.58 and 2.62, which would indicate that the mineral was a mixture of the orthoclase and albite molecules; and the analysis, as here given, shows that it belongs to the *anorthoclase* series. It is

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	H_2O	Total
67.99	19.27	.82	.75	.02	3.05	6.23	.90	99.03

to be noticed that the silica percentage is larger than is required by the amount of soda, potash and lime present. This is probably due to the fact that a small amount of quartz was so intimately intergrown with the feldspar that certain grains of the feldspar powder contained some quartz. From the analysis it is calculated that this feldspar is an *anorthoclase* with approximately the composition $Or_5\ Ab_{14}\ An_1$.

Quartz is present only in small amount. Green augite is common. A description and analysis of this green augite is given under No. 1094. One section.

Chemical analysis. An analysis of this rock gave the following result:

SiO_2	P_2O_5	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O	H_2O	Total
66.84	trace	18.22	2.27	.20	3.31	.81	2.80	5.14	.46	100.05

Age. Archean.

Remark. This rock is a typical specimen of the augite soda granite of Kekequabic lake.

U. S. G.

No. 593G. Conglomerate. *(Granitized.)*

S. W. ¼ N. W. ¼ sec. 31, T. 65-6, south shore of the east end of Kekequabic lake.

Ref. Annual Report, xx, page 76. "On the northeast corner of this point is a low outcrop of a fine-grained, gray, apparently holocrystalline rock. The groundmass is grayish, and in it are small, black needles, probably of hornblende, and a few scattered, rather irregularly outlined feldspar individuals. There are also a few rounded pebbles up to those two inches in diameter, scattered through the rock. The specimens collected (No. 593G) show some of the pebble forms. Some of these pebbles are seen to be subangular, but most of them are rounded. They seem to be scattered irregularly through the rock, and lie in no definite planes or layers. There is nothing in the rock to show any sedimentary lamination or bedding; it appears perfectly massive. This rock is seen in several outcrops in the N. E. ¼ S. W. ¼ sec. 31, T. 65-6, and the shore is here usually lined with fragments of it. In the eastern part of this one-sixteenth section is quite an extensive exposure a short distance back from the shore. Here the pebbles, which have been steadily increasing in abundance eastward from the first-mentioned outcrop, are very numerous. It would be almost impossible to find any surface a foot square in the rock at this place which would not contain one or more pebbles, and many areas of this size would include as many as twenty. The rock is here represented by No. 594G, and pebbles from it by No. 594aG. This rock extends along the shore in a few outcrops nearly to the east line of section 31. The pebbles grow less abundant in going east from No. 594G. No. 595G shows a more highly crystalline condition of this rock from the S. E. ¼ N. E. ¼ sec. 31. The noticeable features of this rock are its sharply outlined, rounded and subangular pebbles, and a few scattering, apparently porphyritic, feldspar crystals, sometimes a quarter of an inch in length. No bedding, lamination or definite arrangement of the pebbles could be seen in the rock. It seems that this rock is a metamorphosed conglomerate, and it strongly reminds one of certain facies of the Ogishke conglomerate." *U. S. Grant.*

Meg. The rock is gray, of medium but not uniform grain, and specked with white feldspars that are usually mere fragments of crystals and with pebbles. Its feel is sharp and rough. While evidently a fragmental rock originally it is now compact, sub-crystalline and massive.

Mic. The bulk of the rock is composed of feldspar, the most of which appears to be of *orthoclase*, some of it originally zoned, but there is occasionally an instance of albite twinning. The grains are fresh and even glassy in their translucency

about their margins, and by these fresh margins they interlock with each other. Their central portions are invariably clouded by decay.

Quartz unites with feldspar to form the interlocking bond which gives firmness to the rock. There is nothing that can be identified as original clastic quartz. If it ever existed in this rock—and it probably did—it has been reformed so that now it is in sharply interlocking grains. This alteration of the quartz appears to have been simultaneous with the new growths of the feldspars. The feldspars did not lose their original forms and identity, but the quartz is wholly transformed. Occasionally the quartz is so shaped in contact with a border of a feldspar that it shows it was either later or was not able to resist the recrystallizing force in the feldspar.

A few rather fresh, long *hornblendes* are conspicuous for their independent manner of thrusting themselves among the other minerals. There are also many small and irregular ones. The whole of the hornblende is probably of secondary growth, especially the straight and independent crystals; but there is besides a a considerable hornblende which seems to occupy the places of some other original mineral, and some of this is chloritic. They are irregular and imperfect both in form and in cleavages. Indeed, sometimes two dark minerals are curiously and quite irregularly intergrown, having different extinction points. This is caused by partial uralitization of *augites* which in part retain still their crystalline integrity. Such augite, however, is quite light colored.

With some *chlorite* and accessory amounts of *biotite*, *pyrite* and *sphene*, the foregoing constitutes the mineral contents of this rock. Two sections.

Age. Upper Keewatin.

Remark. This rock perfectly exemplifies the manner of conversion of an evidently clastic rock into a crystalline one, and is comparable to several others described from the same region. Its granitization is not so nearly perfect as in some that belong to this belt taken at points further west, but it is more nearly perfect than some which came from the same mass a few miles further east, *i. e.*, from the porphyrel at Zeta lake.

It is evident that it is difficult to decide, in some such cases, whether the rock should be called granite or graywacke, for it has characters of both.

N. H. W.

No. 594G. Conglomerate. *(Granitized.)*

N. E. ¼ S. W. ¼ sec. 31, T. 65–6, south shore of Kekequabic lake.
Ref. Annual Report, xx, page 66.

Meg. Like the last, but more completely conglomeratic, and in general perhaps a little coarser in the general matrix.

Mic. This rock is like the last in all respects, but contains more *sphene*. These grains are usually nearly perfect crystals, though very small, and occasionally one is wholly within a hornblende. One section.

Age. Upper Keewatin.

N. H. W.

No. 594aG. DIORYTE.

Pebbles from No. 594G; same locality.
Ref. Annual Report, xx, page 76.

Meg. Fine-grained, dark, greenish-gray rock appearing like a fine diabase, of granular texture.

Mic. The slide varies, having on one side apparently a portion of the matrix of the conglomerate. This portion is composed of small *feldspars* compactly crowded together, more or less decayed, but subsequently regenerated, with occasionally a small *hornblende* and a small *sphene*. The rest of the slide consists of the same minerals, but hornblende greatly preponderates. It is also here apparent that the hornblendes are poikilitically embraced in the secondary feldspars. One section.

Age. Pebble in Upper Keewatin conglomerate.

N. H. W.

No. 601G. SLATE. *(Metamorphosed.)*

S. W. ¼ N. W. ¼ sec. 3, T. 64–7, west shore of Kekequabic lake.
Ref. Annual Report, xx, page 72; Annual Report, xxi, pages 37, 51.

Meg. Aphanitic, almost flinty, greenish gray.

Mic. A fine, pulpy mass of feldspathic debris, with a few quartzes. There were a few grains of *feldspar* that were larger than the average, but they were decayed and macerated before consolidation. Their disintegrated remnants are dislodged and slightly out of place with each other, the interstices having been filled with the finer matrix; yet these remnants have been recrystallized and appear now quite fresh. Their borders throw angular and hooking projections into the surrounding matrix. The whole matrix is also in a completely recrystalline condition, and is composed of finer feldspars and *quartz*, with a sparse network or sprinkling of a light-green, non-pleochroic, highly refractive mineral or minerals, which, in high power, seems to be resolved into granular *epidote*, spicules of *hornblende* and grains of *calcite*.

The rock shows indistinct variations in size of grain as well as in composition, the same that are more conspicuous in the coarser clastic rocks of the region, viz.: Small, angular and roundish areas occur in the midst of coarser grains which are either (1) More abundantly supplied with the darker elements, and between the nicols are so much darker constantly as to suggest the existence of chlorite, or (2) Are almost wholly occupied by finely interlocking granular quartz. These seem to have been originally small clastic masses which differed from the prevailingly feldspathic material, and which, on recrystallization, have been reformed but have

not been so completely transformed, molecularly, as to have lost their original shapes. Another variation consists in the occurrence of occasional irregular bands of much finer materials. One is quite marked. It transmits but little light between the nicols owing to the overlapping refraction, but is no less transparent than the adjacent rock. It evidently consists of the same minerals in finer comminution, quartz being evident. One section.

Age. Upper Keewatin.

Remark. This rock was collected as a possible gray slate, with a view to representing the clastic end of a gradation to the granite of the region. It is very evident that it is now in the form of a regenerated fine debris such as could be produced at first in rather quiet water. It seems to have been affected by the same process as that which has passed over the coarser debris, giving it a secondary crystalline bond.

Dr. Grant's note is as follows: "Here there is a gradual change from a gray aphanitic rock much resembling some of the gray slate of the vicinity to the pyroxene granite as represented by Nos. 556G and 557G. The gray rock, however, shows no evidence of lamination or any definite slaty cleavage; it may be a very fine-grained facies of the granite in which the porphyritic feldspars are lacking. As yet these specimens have not been studied microscopically. Nos. 601G to 615G represent this gradation. No. 601G is the gray rock. The specimens up to No. 612G were taken within distances of one to four feet, going eastward from No. 601G. Nos. 613G, 614G and 615G occurred thirty or forty feet further east, and there pass into the facies of the granite represented by Nos. 556G and 557G." N. H. W.

No. 602G. Slate. *(Metamorphosed.)*

Same place as No. 601G, but further east.
Ref. Annual Report, xx, page 72; Annual Report, xxi, pages 37, 51.

Meg. Quite similar to the last, but with greenish shadings in which evidently epidote is more abundant.

Mic. Same as the last, but with fewer of the coarser feldspars. There is also occasionally a fine alternation of *epidote* with the rest of the rock, producing a microscopic, banding-like schistosity. One section.

Age. Upper Keewatin. N. H. W.

No. 603G. Graywacke. *(Fine, metamorphosed.)*

Same place as the last; a little further to the east.
Ref. Annual Report, xx, page 72; Annual Report, xxi, pages, 37, 51.

Meg. Appearing much like the last two, but evidently of coarser grain, showing an occasional cleavage reflection of feldspar.

Mic. *Hornblende* appears more evident as a constituent of the dark (and greenish) element of the rock. The coarser feldspars are fragmentary, and some of

them are striated. The coarser grains are rather evenly distributed in the midst of the fine, but in size they grade downward to the fineness of the matrix. Indeed, there is no way of separating the grains distinctly into coarse and fine, except arbitrarily, as the coarse grade into the fine. Still the coarser are sometimes prevailingly in one part of the slide and wanting in another, the texture varying in its average coarseness. *Quartz* is more common than in the last. One section.

Age. Upper Keewatin. N. H. W.

No. 604G. Graywacke. *(Granitized.)*

Same place as the last.
Ref. Annual Report, xx, page 72; Annual Report, xxi, pages 37, 51.

Meg. Undistinguishable from the last. Some close, irregular joints, opened by the fracture, show epidotic lining.

Mic. This averages somewhat coarser, but is still a fine-grained rock. Some of the feldspars, in the regrowth, show a clear peripheral portion which surrounds the more clouded central area. *Hornblende* is more plentiful. It is granular and ragged, and but faintly pleochroic. Some of the feldspars are distinctly plagioclastic, with extinction angle between the optic plane and the basal cleavage in a section perpendicular to n_g 18°, indicating *oligoclase-albite*, near albite. The latest to take its present place was *quartz*.

This rock has a finely-granitic, interlocking structure, and being wholly crystalline, might be classed amongst the crystalline rocks approaching granite. One section.

Age. Upper Keewatin. N. H. W.

No. 605G. Graywacke. *(Granitized.)*

Same place as No. 601G to 604G.
Ref. Annual Report, xx, page 72; Annual Report, xxi, pages 27, 51.

Meg. Fine grained, gray, similar to the last, but rather coarser.

Mic. In this it is apparent that the *hornblendic* masses are finely granular, the short individual hornblendes lying at sixes and sevens with each other. This probably accounts for the absence of evident pleochroism in the hornblendic masses, since the general effect would be monochromatic and greenish in such a composite.

In this slide are larger examples of a mineral that exists also in the foregoing (from No. 601G), but in so fine a state that its name could not be ascertained. It is apparently *garnet*. It is highly refractive, but usually dark or faintly light at four points on rotation between crossed nicols. It is water-clear, but has a wide refractive margin on lowering the lower nicol. It is most frequent in the vicinity of the composite hornblendic masses, and is even included within them. It is in irregular, and sometimes sprawling, shapes, without cleavage.

This rock might be called a fine-grained granite. One section.

Age. Upper Keewatin. N. H. W.

No. 630G. Conglomerate. *(Metamorphosed.)*

N. W. ¼ S. E. ¼ sec. 31, T. 65–6, south of Kekequabic lake.
Ref. Annual Report, xx, pages 79, 107.

Meg. Rather fine, conglomeratic, with much feldspar, making a speckled-gray rock, with no evidence of sedimentary bedding in the field.

Mic. The original *quartz* is entirely reformed, and no trace of the clastic shapes remains. The forms of the *feldspars* are preserved, especially of the larger ones, but frequently the finer feldspars are much changed by regeneration, having a narrow rim of new growth. The larger feldspars are zoned, but not by new increments. The impurities are, for the greater part, arranged in belts that run parallel with the margin. The marginal or first belt is most conspicuous, and gives outline to the grain. Occasionally a second belt is formed parallel with the first, but usually the whole of the interior is irregularly crowded, though less thickly than in the margin, with the same fine inclusions as seen in the marginal belts. These consist of *muscovite*, *epidote*, *chlorite* and apparently of *zoisite*. There are in the matrix of these feldspars abundant epidote, some *calcite*, *hornblende*, *sphene*, *chlorite* as well as quartz. One section.

Age. Upper Keewatin. N. H. W.

No. 638G. Conglomerate. *(Crystalline.)*

S. E. ¼ S. W. ¼ sec. 7, T. 64–6, south of Kekequabic lake.
Ref. Annual Report, xx, pages 80, 107.

Meg. A gray, plainly fragmental rock, holding pebbles. Some red granitic pebbles seem to have been fused or plastic, and are distorted and diffused more or less amongst the surrounding matrix; but the dark pebbles, whether coarse or fine grained, maintain their round outlines.

Mic. This rock has very noticeably the muscovadyte structure, *i. e.*, the minerals have globular shapes, and when large they act poikilitically toward each other. *Hornblende* and *hypersthene* are the coarsest and most conspicuous of these poikilitic minerals, but there is a feldspar (or cordierite?) which also plays the same rôle toward the finer grains. *Quartz* in small quantity mingles in the interlocking mosaic. One section.

Age. Keewatin.

Remark. Gabbro exists on the south half of the southeast quarter of the same section (No. 639G) on the east shore of a small lake, but is rather fine grained.

N. H. W.

No. 686G. Granite. *(Hornblendic.)*

Saganaga lake, S. W. ¼ N. E. ¼ sec. 22, T. 66–5 W.
Ref. Annual Report, xx, pages 88, 109; Annual Report, xxi, page 43.

Meg. A rather coarse-grained, pinkish-gray granite composed essentially of quartz, feldspar and hornblende. Epidote is present, and sometimes small crystals of sphene. This rock is a typical specimen of the Saganaga granite.

Mic. The section shows a granite composed mainly of quartz and feldspar. The latter is commonly clouded and in part altered to fine flakes of a micaceous mineral. The feldspars appear to be in part orthoclase and in part plagioclase near oligoclase. Hornblende is present and has largely altered to a mixture of chlorite and epidote. Sphene is present in small amount, as are also calcite, magnetite and apatite. Two sections.

Chemical analysis. An analysis of this rock by Mr. A. D. Meeds gave the following result:

SiO_2	Al_2O_3	Fe_2O_3 and FeO	CaO	MgO	K_2O	Na_2O	H_2O	Total
69.34	17.25	2.46	3.43	1.18	.71	4.33	1.17	99.87

Age. Archean.

U. S. G.

No. 739G. Graywacke. *(Matrix of altered conglomerate.)*

S. W. ¼ S. E. ¼ sec. 1, T. 64–7, south of Kekequabic lake.
Ref. Annual Report, xxi, page 59; Annual Report, xxiv, page 88.

Meg. Gray, fine, firm.

Mic. The rock contains quite a number of angular clastic *quartzes*, also areas, sub-rounded or angular, of a mosaic of quartz grains that closely interlock in the manner of the quartzes of jaspilyte; in these the size of the quartz grains, while about uniform in any individual area, varies from fine to coarse. Other areas seem to have been occupied by different rock pebbles, amongst which some were apparently fine diabase or basaltic (glassy) rock which now is thickly sprinkled with *actinolite*, or with fine scales of yellowish-green *biotite*, but these can with difficulty be distinguished from the general matrix. *Magnetite* and *sphene* (the latter scantily) are scattered through the slide. *Feldspars* in conspicuous grains are as abundant as the quartzes. They are much altered and are sometimes pierced by actinolite and biotite. They show no marginal enlargements. Their edges are ragged and the fine matrix fills in the angles between the ragged projections, and also enters fissures.

The rock is simply a densely compacted, fine debris, the alteration of whose individual grains was accomplished mainly prior to their incorporation in this rock. It is probable that the actinolite is of secondary origin. It is impossible to say whether quartz has been transformed. The only indication of such change that is apparent is the fact that sometimes the actinolites penetrate it for short distances, and that different quartzes are sometimes interlocked in a secondary manner. One section.

Age. Archean (Upper Keewatin).

N. H. W.

No. 740G. Muscovadyte. *(Matrix of altered conglomerate.)*

N. W. ¼ N. E. ¼ sec. 12, T. 64–7, south of Kekequabic lake, in the vicinity of the gabbro border, No. 741G.
Ref. Annual Report, xxi, page 59; Annual Report, xxiv, page 88.

Meg. Gray, firm, showing in the field a few pebbly forms.

Mic. This is a rather uniform muscovadyte. The minerals tend to have a roundish form, and embrace, poikilitically, many small, round grains, each of the others. *Feldspar*, occasionally albite-twinned, is the most abundant. *Augite* and *biotite* come next in amount, the former sometimes surrounding small globular feldspars and sometimes piercing them, and frequently containing small granules of augite, and most frequently having the form of isolated roundish grains scattered promiscuously and apparently of about the same date of generation as the feldspars. Biotite acts poikilitically toward the other minerals. A little pleochroic *hornblende* serves the same purpose, but is usually in larger crystals. *Quartz* is not abundant, but some large secondary grains are distinctly composed of quartz. A little fine magnetite is scattered in the feldspars, in the hornblende, the augite and the biotite. One section.

Age. Upper Keewatin. N. H. W.

No. 766G. Porphyry.

Kekequabic lake, E. ½ S. W. ¼ sec. 34, T. 65–7, point on the north side of the lake.
Ref. Annual Report, xxi, page 60.

Meg. Conspicuously porphyritic with a white feldspar in a fine matrix; contains considerable pyrite. The specimen shows the intrusive contact of the porphyry on a black slate, the former not showing, however, a finer grain at the exact contact, some of the large feldspars being in absolute contact on the slate.

Mic. The feldspars, which are twinned, both by pericline and by albite, the former sometimes coarsely, are much altered by the usual microscopic growths, such as *sericite*, *calcite* and perhaps *epidote*, and sometimes appear to be distorted or crushed, evinced by the interruption of the albite twins. There are several conspicuous original *quartzes* and much quartz that is finer and evidently of later origin. The later quartz forms a coarsely micro-granulitic interlocking matrix, and is mingled with some feldspar grains of about the same size, and also with much *calcite*. The earlier quartzes are somewhat fissured or granulated, and occasionally give an undulatory extinction. The *hornblendes*, which are not common nor conspicuous, are fragmentary and feebly pleochroic, usually much chloritized—indeed, it cannot be affirmed safely that a trace of hornblende remains in the slide examined. One section.

Age. Intrusive in the Upper Keewatin.

Remark. It is evident that since the formation of this rock it has undergone a rough and precarious history. It is also evident that the phenocrysts did not form

from a molten magma in the places in which they now lie in proximity to the slate with which the intrusive is now in contact. In other words the porphyry was not a molten mass when intruded into the slate, but simply a plastic mass, moved by pressure, suffering internal fracture and subsequent recrystallization. It might be called a secondary intrusion, but hardly an igneous rock. What may have been the age and origin of this rock at first, it is impossible to state from any evidence in the rock itself, but from general considerations and from alliances which it shows with other Keewatin "porphyries," it is reasonable to assume that it dates from some earlier portion of the Archean. It may have been at first a *porphyrel* like that of Zeta lake. N. H. W.

No. 798G. Diabase. *(Coarse grained.)*

From the centre of a dike at least 150 yards wide and running nearly north and south, near the south line of sec. 20, T. 65–6 W., between Knife and Epsilon lakes.
Ref. Annual Report, xxi, page 62.

Meg. A coarse-grained, somewhat uralitized, greenish diabase. The feldspars are also somewhat greenish in color.

Mic. The section shows a coarse-grained diabase, the essential minerals of which are plagioclase, augite and iron ore. The plagioclase (species not carefully determined, but apparently near labradorite) is much clouded by kaolinic alteration. The augite is reddish in color and very slightly pleochroic. It occurs in large ophitic grains and there is more fresh augite than would be supposed when one considers the altered nature of the feldspar. The augite has, however, altered in many places to a more or less confused, fibrous, greenish and yellowish aggregate, in which can be recognized some green hornblende, some chlorite and a little biotite. The iron ore is accompanied by opaque gray alteration products (leucoxene) and is thus shown to be ilmenite. A little secondary quartz is present. One section.

Age. Cabotian(?)

Remark. This rock (also No. 799G) is somewhat similar to and comes from the same general locality (Knife lake) as Nos. 1742 to 1751. U. S. G.

No. 799G. Diabase. *(Olivinitic.)*

Near the centre of the east side of N. W. ¼ sec. 7, T. 65–6 W., Amœba lake, at the portage to Knife lake.
Ref. Annual Report, xxi, page 62.

Meg. A coarse-grained diabase, with gray to greenish feldspar.

Mic. The section is quite similar to that of No. 798G. No. 799G, however, has a little olivine. One section.

Age. Cabotian(?) U. S. G.

No. 847G. Muscovadyte. *(Fragment in gabbro.)*

S. W. ¼ N. W. ¼ sec. 6, T. 64–5. Island in Gabemichigama lake.
Ref. Annual Report, xxi, page page 65; Annual Report, xxiv, page 127; Annual Report, xv, pages 171, 172; Final Report, vol. iv, figure 43.

Meg. A characteristic, gray muscovadyte.

Mic. While the general grain is fine, the structure is decidedly ophitic. The *augite* has a violet tint. Besides the feldspars the rock contains some *quartz* and *biotite*. One (thick) section.

Age. Cabotian. N. H. W.

Remark. Owing to the importance of the ophitic structure in this rock, another slide was prepared. In this the characteristic granular structure is well displayed, differing from the foregoing. The augite has the lamellation of diallage, and, while it occasionally surrounds roundish feldspars, the augite thus surrounding the feldspars is not of the same orientation, but is divided between two or four or more orientations. It is but rare that a single grain of augite, having a single orientation, wholly surrounds a single roundish feldspar, yet there are a few such instances. This slide does not show the normal ophitic structure of the foregoing, since the feldspars thus included do not possess their crystal forms. It is possible, therefore, that the former slide, by some mistake in handling, was not made from the rock No. 847G. One section. N. H. W.

No. 854G. Gabbro? *(with quartz).*

S. E. ¼ S. W. ¼ sec. 12, T. 64–6, southwest shore of a small lake west of Little Saganaga lake.
Ref. Annual Report, xxi, page 65.

Meg. A pinkish-gray syenitic rock.

Mic. The feldspars appear to be both *orthoclase* and *plagioclase*, but they are crowded with *muscovite, calcite,* iron ores, and perhaps other products of alteration, and are closely associated with *quartz.* Within the quartz, and elsewhere, is *pennine.* Quartz embraces the altered feldspars in an ophitic manner, yet in the slide it is also in isolated patches that extinguish in common. There is no olivine nor augite. If these ever existed in this rock, which is doubtful, they are now represented by the pennine and iron ores. One section.

Age. Cabotian.

Remark. It may be considered very questionable whether this rock ever was a gabbro. It is now more nearly a granite, and seems to have resulted from the transformation of an "intermediate" clastic rock. N. H. W.

No. 854aG. Gabbro *(with quartz).*

Same place as the last.
Ref. Annual Report, xxi, page 66.

Meg. A coarse gabbroid rock, with some pinkish feldspar and some quartz.

Mic. Essentially like No. 854G, but having more of the structure of gabbro while lacking its minerals. There are areas that are now occupied by *biotite* (or biotite and *chlorite*) which appear to have been once occupied by *augite*, inasmuch

as they sometimes embrace the much altered feldspars in an ophitic manner. This rock has less quartz than the last, but what it has is secondary to the other minerals as in that. It contains also much *calcite*. Biotite and chlorite are interleaved. Two sections.

Age. Cabotian.

Remark. This rock is in a secondary state. The most of its minerals are such as are known to be the products of alteration. The introduction of the quartz, biotite and calcite seems to have been simultaneous with the alteration of the plagioclase.

There may have been a primordial basic magma of the ordinary diabase type, which rose near the surface of the earth at the time of the Cabotian disturbance, but coming into contact with the clastic crust, which was necessarily more acid than itself, was modified by it during the process of cooling. This modification, so far as evinced by the composition of rocks Nos. 854G and 854aG, and the altered condition of the primordial minerals, consisted in the total loss of the ferromagnesian minerals (augite and olivine) and of any magnetite or apatite that may have been in the primordial magma, and the introduction of acid elements, viz., quartz, orthoclastic feldspar and muscovite. Calcite may have been derived from the simultaneous alteration of the original labradorite. These changes were a "secondary" process so far as concerns the original basic rock, but the minerals that resulted are as old as the rock itself, considered as a solid body, and in that sense they are original to the rock. These alterations therefore are believed to be not due to weathering nor to dynamic action, nor to contact metamorphism of any igneous rock of later date than that of the rock itself. These "secondary" minerals are more stable, as a group, than the minerals which they have replaced. They are quartz, biotite, calcite, muscovite; and such minerals as a group endure weathering and all dynamic action, as is well known, more successfully than olivine and augite. Throughout the body of the diabase and gabbro mass in Minnesota, wherever olivine and augite are found at all and have not been subjected to abnormal contacts or dynamic action, they are apparently as fresh and clear as when they were first formed. They have not suffered any deep-seated, metasomatic alteration. That fact not only shows that they have endured intact since Taconic time, but also that it is only in abnormal conditions resulting from igneous contact and its heated solutions under dynamic stress that they are lost to the rock. N. H. W.

No. 857G. · Gabbro. *(Olivinitic.)*

Northeast shore of bay at north side of Bashitanaqueb lake, near the north line of sec. 2, T. 64–5 W.
Ref. Annual Report, xxi, pages 66, 150, 151.

Meg. A fine-grained, dark-gray, granular rock composed of feldspar and dark minerals.

Mic. The section shows a granular aggregate of feldspar, pinkish diallage and olivine. The latter is altering to a fibrous green material, and throughout the section is much of a very fine-grained, secondary mineral, which appears to be calcite. The feldspar is frequently, though not always, polysynthetically twinned; equal extinction angles in sections cut normal to 010 run up to 20°, indicating a plagioclase as basic as andesine. A little biotite is present, as is also a small amount of magnetite. Three sections.

Chemical analysis. An analysis of this rock gave the following result:

SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	MnO	Na_2O	K_2O	CO_2	H_2O	Total
49.07	17.21	.46	12.18	9.66	3.60	trace	2.96	trace	2.70	1.55	99.39

Age. Cabotian.

Remark. This is one of the rocks to which the name "muscovadyte" has been applied. U. S. G.

No. 879G. TACONYTE(?)

E. ½ S. W. ¼ sec. 21, T. 65–4 W., north of the works of the Gunflint Lake Iron company.
Ref. Annual Report, xxi, page 67. (Compare No. 1896.)

Meg. A fine-grained, heavy, banded rock, the bands being composed of (1) Magnetite, and (2) Very fine-grained, gray, siliceous material.

Mic. With a scattered taconitic structure, evinced both by the prevalence of an interlocking quartz background and by globular aggregations of siliceous iron ore, this rock shows much *pyroxene*, which serves to include poikilitically many fine granules of *magnetite*, of *quartz* and of globular pyroxene. There are also a few needles of *actinolite* that radiate into the quartz from some of the small augite grains, and a small amount of *cummingtonite*. Two sections.

Age. Animikie(?)

Remark. The irony, taconitic globules of this rock are like those of the Mesabi iron ore; but here they are mingled with much pyroxene, some of which is in imperfect crystals as large as the taconitic globules. The usual quartz mosaic serves as background for both these substances. This pyroxene is an anomaly for taconyte. The taconitic nature of this rock is determined by the patchy and globular grouping of the magnetite grains, these grains being sometimes quite coarse, but also sometimes finer, and more scarce or wanting in some portions of the slide. N. H. W.

No. 989G. GABBRO *(with diallage)*.

S. W. ¼ N. W. ¼ sec. 11, T. 64–3. At the south end of the portage from Tucker lake to the long lake next south.
Ref. Annual Report, xxii, page 84; Final Report, vol. iv, page 489.

Meg. Granulitic gabbro, heavy with magnetite.

Mic. The minerals are fresh and all have rounded outlines, as if they were formed simultaneously. The *augite* is uniformly diallagic, and, while it spreads irreg-

ularly amongst the feldspars, it does not surround them ophitically. The slide contains very little *olivine*. There is a small amount that surrounds in a narrow rim some of the magnetites, but it is so small that it is only accessory, the rock being composed essentially of *diallage*, *feldspar* and *magnetite*, one-half being diallage. One section.

Age. Cabotian. N. H. W.

No. 989aG. Gabbro. *(Almost anorthosyte.)*

Same place as No. 989G, and interbanded with it.
Ref. Annual Report, xxii, page 84; Final Report, vol. iv, page 489.

Meg. Coarsely crystalline, and consisting largely of gray feldspar.

Mic. The minerals show a succession in the date of formation. The *magnetite* and coarse *feldspars* were the first to crystallize. Next came the *diallage* which is not abundant, or rather small in amount, occupying the open angular spaces left between the feldspars. If it had been in sufficient amount the diallage would have embraced the feldspars ophitically. The slide contains no olivine. The diallage is largely altered to *hornblende*. One section.

Age. Cabotian.

Remark. With some qualification this rock might be styled a diabase, since its structure is essentially ophitic. N. H. W.

ROCKS COLLECTED BY A. WINCHELL.

No. 24W. Quartz-Porphyry.

S. W. ¼ N. W. ¼ sec. 3, T. 62–14, eastern extremity of Little Mud lake.
Ref. Annual Report, xvi, page 27. (Compare No. 376.)

Meg. Light gray, massive or coarsely schistose.

Mic. In a very fine, interlocking and rather uniform groundmass of *feldspar*, *quartz*, *muscovite*, *chlorite* and *calcite* are large feldspars of idiomorphic form, which are themselves so crowded with the same minerals in fine granules that they can hardly be distinguished from the rest of the section. It is only by rotation of the stage between the nicols that it can be seen, at the points of greatest light, that feldspar forms are concealed in the section. There are also a few irregular patches, of considerable size, of *chlorite* which has doubtless resulted from an alteration of hornblende. *Apatite* in a few small crystals, and *sphene* smaller and fewer, can be

noted. Besides the large feldspars there is also one large bipyramidal *quartz* crystal. One section.

Age. Keewatin (Lower).

Remark. The appearance of this section indicates a clastic rock rather than an igneous one. There is no apparent schistosity in the slide. The rock is of a common kind. N. H. W.

No. 25W (bis). Quartz-Porphyry.

S. E. ¼ N. W. ¼ sec. 3, T. 62–14, south side of Mud lake.
Ref. Annual Report, xv, page 27.

Meg. Light gray, nearly massive.

Mic. Like No. 24W, except that the feldspars are not so far decayed. One feldspar shows a large embayment, as if produced in the magmatic state. This rock, like the preceding, is slightly reconstructed after long decay, by the formation of new feldspar and quartz which interlock throughout the fine matrix, while a new feldspar substance has generally not replaced the original species, at the same time that most of the fine inclusions have had birth. These inclusions are evenly distributed or are most abundant about the ragged edges of the feldspar sections. The old feldspars are best preserved at their centres, and they have no marginal new growths. One section.

Age. Lower Keewatin. N. H. W.

No. 26W. Schist. *(Flinty.)*

S. E. ¼ N. W. ¼ sec. 3, T. 62–14, south side of Mud lake.
Ref. Annual Report, xv, page 27.

Meg. Bluish, fine, compact, jointed like the quartz-porphyry.

Mic. Exceedingly fine, without large feldspar forms, yet this slide shows a few apparently fragmental pieces of feldspar. The rest of the rock is much darker between the nicols than the foregoing, and this darkness is seen to be due (on lowering the lower nicol) to the presence of much finely divided *chlorite* and highly refractive *epidote* with a little *sphene*. One section.

Age. Lower Keewatin.

Remark. This is not known to be separable either structurally or petrographically from No. 25W. N. H. W.

No. 27W. Schist. *(Flinty.)*

S. E. ¼ N. W. ¼ sec. 3, T. 62–14, south side of Mud lake.
Ref. Annual Report, xv, page 27.

Meg. Gray, fine, hard, but internally somewhat conchoidally brecciated.

Mic. Like No. 26W, but having somewhat larger and more numerous feldspar grains, but not approaching the porphyritic aspect of No. 24W. One section.

Age. Lower Keewatin. N. H. W.

No. 33W. Greenstone. *(Graywackenitic.)*

N. E. ¼ S. W. ¼ sec. 14, T. 62–14, northwest part of Sand lake.
Ref. Annual Report, xv, page 29.

Meg. Compact, but finely jointed, tough, weathering like a greenstone.

Mic. *Hornblende, chlorite, epidote*, with more or less indistinct *feldspar*, compose this rock, giving it a green color. The first is in more or less large crystals and parts of crystals, as well as in fragmentary and interlocking shreds which are spread throughout. One section.

Age. Lower Keewatin. N. H. W.

No. 82W. Amphibolyte.

S. W. ¼ N. W. ¼ sec. 29, T. 63–12, Long lake. Island north of point.
Ref. Annual Report, xv, page 53; Annual Report, xxiv, page 42.

Meg. Fine, compact, with weathered aspect of a schist. Compare No. 2104.

Mic. *Hornblende* and an altered *feldspar*, with a little *quartz*, compose essentially this rock. The feldspars are nearly dark between crossed nicols, due to a saussuritization (largely of granular and scaly chlorite) which they have suffered, except in an occasional very narrow thread-like border or zone about their peripheries, which is quite bright and evidently of some other but indeterminable mineral. One section.

Age. Keewatin. N. H. W.

No. 83W. Amphibolyte.

N. W. ¼ S. W. ¼ sec. 29, T. 63–12, Long lake. Island close to point.
Ref. Annual Report, xv, page 53.

Meg. Green, feebly schistose.

Mic. This slide is like No. 82W, but in addition shows considerable *leucoxene*. One section.

Age. Keewatin. N. H. W.

No. 84W. Tuff(?)

N. W. ¼ S. W. ¼ sec. 29, T. 63–12, Long lake. Little island near the shore.
Ref. Annual Report, xv, page 54. (Compare rock No. 2099.)

Meg. Fine sericitic schist, holding hornblendes porphyritically.

Mic. This rock has a strong schistosity. The porphyritic *hornblendes* are surrounded by a fine saussuritized feldspathic mass, which is nearly dark between the nicols, like the feldspars in No. 82W. These hornblendes are bordered and patched by a second development, *i. e.*, the forms of the original augites are shown by the different coloration of the central portions, these central portions being the latest to acquire the hornblendic composition and cleavage.

Age. Keewatin. N. H. W.

No. 89W. SCHIST. *(Sericitic.)*

S. E. ¼ S. E. ¼ sec. 29, T. 63–12, main land, shore of Long lake.
Ref. Annual Report, xv, page 55.

Meg. Coarse, gray, schistose.

Mic. The same fine interlocking groundmass of fresh quartz and feldspar embraces *feldspar* and *augite* forms, but in place of feldspar and augite are now other minerals, viz., in place of feldspar *muscovite and calcite*, with considerable *chlorite*, the two former in unusually large grains, and in place of augite is chlorite. There is also in general much *epidote*, sometimes in grains of size sufficient to give colored polarization. One section.

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

No. 91W. GREENWACKE.

Centre of N. E. ¼ sec. 28, T. 63–12, Long lake.
Ref. Annual Report, xv, page 55.

Meg. Chloritic graywacke.

Mic. A confused mingling of fine *feldspars* and *quartz*, with abundant *hornblende*, *calcite* and *leucoxene*, and with *epidote*. In the slide are inequalities of grain and in the distribution of the hornblendes, denoting the former existence of other minerals, probably of feldspars, which have been absorbed and replaced by a fine micro-granulitic growth, such as is common in old greenstones. In other places remnants of such old feldspars are still visible. The rock was probably at first a debris of basic composition, perhaps tuffaceous. One section.

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

No. 92W. GRAYWACKE.

S. W. ¼ S. W. ¼ sec. 23, T. 63–12.
Ref. Annual Report, xv, page 55.

Meg. Graywacke.

Mic. Similar to 91W, but much lighter colored, having no hornblende, little chlorite, and much better preserved feldspars, but the rest of the slide is largely composed of a fine quartz-feldspar secondary replacement, which is irregular in fineness, indicating that the rock was originally fragmental.

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

No. 94W. GREENSTONE. *(Altered diabase.)*

S. E. ¼ S. W. ¼ sec. 20, T. 63–11, Garden lake.
Ref. Annual Report, xv, page 68.

Mic. The *feldspar* is almost wholly destroyed, its place being occupied by saussuritic products, largely *epidote*. *Hornblende* is abundant, but is frequently replaced by a later isotropic chloritic substance. There are large angular masses of *leucoxene*

and others of *pyrite*, and groups and scattered grains of *epidote;* but the general aspect is that of a much altered diabase rock of originally massive nature, there being a structure which is like the ophitic structure of diabase. One section.

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

No. 139W. CAMPTONYTE(?)

N. W. ¼ S. W. ¼ sec. 18, T. 63–11, Fall lake.
Ref. Annual Report, xv, page 66.

Meg. Coarse, green, schistose, with distinct hornblende crystals.

Mic. In a fine groundmass of indistinct *feldspar* and fibres of *hornblende* are numerous idiomorphic crystals of *hornblende* usually twinned on 100, and frequently showing a narrow peripheral zone which extinguishes with the central area, but exhibits slightly different polarization tints, and in some instances the original augitic form is well preserved by this difference of polarization. The rock is not much decayed. One section.

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

No. 177W. DIABASE. *(Altered.)*

N. E. ¼ N. E. ¼ sec. 30, T. 64–10, Urn lake.
Ref. Annual Report, xv, page 95.

Meg. Doleritic.

Mic. With much *calcite* and *magnetite* and some *chlorite*, a little *hornblende* and *leucoxene* this rock still shows, in the position of the feldspars, that it was originally a diabase with ophitic structure. One section.

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

No. 770W. GABBRO.

T. 64–5 E. (unsurveyed), Pigeon river.
Ref. Annual Report, xvi, page 289.

Meg. Compact, hard, gabbroid.

Mic. This rock seems to have been an olivine gabbro, but nothing now remains to attest the former presence of olivine except a yellowish, serpentinous substance in which apparently *antigorite* takes part. The *augite* was nearly cotemporary with the feldspar and is in small grains. The feldspar is evidently *labradorite.*

Age. Cabotian. N. H. W.

ROCKS COLLECTED BY H. V. WINCHELL.

No. 2H. Graywacke. *(Sheared, or sericitic schist; fine.)*

Stuntz island, sec. 21, T. 62–15.
Ref. Annual Report, xv, pages 276, 280, 283, 304, 310, 312, 314, 413.

Meg. Schistose indistinctly, also presenting a basaltic appearance.

Mic. The rock is mostly a sericitic schist. The very fine micro-granulitic groundmass having *mica* and much *calcite*, contains numerous forms of old *feldspars* that are much altered by the generation of secondary minerals, such as mica and calcite. The points of darkening, on rotation between the nicols, are distinct, but the twinning bands are lost. In some places also no trace of the original feldspar is left, except its shape and size outlined in an area that has a general uniform fineness contrasted with the surrounding variations. A little *epidote* and *leucoxene* appear, the former in the areas of the altered feldspars. The feldspars show no new growths of feldspar. One section.

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

No. 2aH. Sericite Schist.

Pebbles contained in No. 2H.
Ref. Annual Report, xxv, page 276.

Meg. Soft and greenish, schistose.

Mic. The rock consists entirely of very fine sericitic scales, and debris of feldspathic character, having a marked schistose structure. N. H. W.

No. 4H. Graywacke.

From the island crossed by the line between secs. 15 and 16, T. 62–16, Vermilion lake.
Ref. Annual Report, xv, pages 281, 413.

Meg. Gray, sericitic, hard, tough, compact, with pyrite.

Mic. *Quartz* and old *feldspars* lie loosely in a micro-granulitic groundmass. The latter are plainly striated, but still are very much replaced by secondary *sericite* and *calcite*. They, as well as the quartz, are interlocked at their margins, with the fine groundmass. One section.

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

No. 6H. Granite. *(Hornblendic.)*

North side of the bay in S. E. ¼ sec. 7, T. 62–16, Vermilion lake.
Ref. Annual Report, xv, pages 282, 414.

Meg. Reddish gray, somewhat gneissic.

Mic. The *quartz* in this slide appears as a pneumatolitic product, and not as original grains; along with *feldspar* in form of old (even porphyritic) crystals, is also a considerable amount of *hornblende*, and, later, a large amount of *epidote*. The groundmass in general is coarser, and more varied, and the hornblendes are evidently the result of uralitization, the old form of the augite scarcely remaining in the dark central areas. One section.

Age. Archean (Keewatin).

Remark. This rock shows well the partial formation of granite from a clastic rock, affording some of the same phenomena as described at Kekequabic lake.

N. H. W.

No. 7H. Graywacke.

From the point, S. E. ¼ sec. 8, T. 62-16, Vermilion lake.
Ref. Annual Report, xv, pages 282, 414.

Meg. Gray, fine, slaty or coarsely schistose.

Mic. A fine debris of feldspar and quartz, with a little *hornblende; mica, epidote, calcite, chlorite*, as later products, having a schistose structure. One section.

Age. Archean (Keewatin).

N. H. W.

No. 8H. Graywacke (?) (*Sericitic.*)

Same locality as the last.
Ref. Annual Report, xv, page 414.

Meg. Finely conglomeratic; color varies from reddish to greenish; essentially an acid rock, now sericitic.

Mic. Coarse *feldspars*, large *quartz* grains and probably some augite composed this rock originally. It is now so changed that the finer grains and much of the feldspar have been recrystallized, forming an interlocking, fine groundmass; the feldspars are affected by the generation of multitudes of *sericite* scales and *calcite*, and furnished with a new interlocking border, and the rare hypothetical augite is now in the form of *hornblende* and *chlorite*. Cotemporary with this transformation has been produced a considerable amount of *epidote*. A small *sphene* is preserved in one of the old feldspars. One section.

Age. Archean (Keewatin).

N. H. W.

No. 9H. Greenstone

N. E. ¼ sec. 9, T. 62-16, Black Duck point, Vermilion lake.
Ref. Annual Report, xv, pages 282, 283, 299, 414.

Meg. Acts somewhat like a dike, but has an indistinct sedimentary structure; gray, schistose.

Mic. This rock is similar to the last, except that it contains more *chlorite* and *hornblende*, and the *feldspars* are almost entirely lost in the granulitization of the

rock. In this slide also is a larger amount of *calcite*. *Sphene* also exists in grains in the groundmass. One section.

Age. Archean (Keewatin).

Remark. According to the field description this was an igneous rock. N. H. W.

No. 10H. Quartz-Porphyry.

West side of point in sec. 5, T. 62–16, Vermilion lake.
Ref. Annual Report, xv, pages 283, 414.

Meg. Homogeneous dike-rock cutting graywacke.

Mic. Coarse, idiomorphic, but somewhat altered, *feldspars*, with some large *quartzes*, are in a uniform, fine mosaic of feldspar and quartz. In this fine matrix are many *sericites*, which frequently pierce the little quartzes. There are also areas of *calcite*. One section.

Age. Archean (Keewatin).

Remark. The date of the matrix of the large crystals is later than the sericites. The sericites have resulted from an alteration of feldspathic material. They are also distributed through the feldspar crystals, but not so abundantly. The rock shows traces of hornblendic material; therefore, notwithstanding the striking contrast between the crystals (phenocrysts they might be called in an igneous rock), and the fine, uniform grain of the interlocking matrix, it is possible, if not probable, that this rock has resulted from a debris of acid porphyritic rock. Further, the fact that the large feldspars are striated and much twinned, evidently like those of the *esterellyte* of Kekequabic lake, shows that, if from a granite as a debris, the granite was not of the normal type, and that it supplied large, perfect crystals at the same time with a very fine debris, with no grains (or fragments) of intermediate sizes. For these reasons it is quite reasonable to consider this rock as an intrusive, in the manner of the esterellyte of Kekequabic lake, and originating in the same way from some of the neighboring clastics of the Keewatin. N. H. W.

No. 11H. Greenstone. *(Altered.)*

S. E. ¼ sec. 5, T. 62–16, Vermilion lake.
Ref. Annual Report, xv, pages 283, 414.

Meg. From a dike running through graywacke; tough, grayish green, hornblendic.

Mic. Roundish, interlocking grains of *quartz* and of a glassy *feldspar* (oligoclase or oligoclase-albite) are visible throughout this slide, but they are liberally mingled with *hornblende*, *sericite*, *calcite* and *epidote*. The minerals are largely or wholly secondary, the hornblendes being the largest. There is no radial or other structure indicating an original igneous origin. The feldspars and quartzes are later in origin than the hornblendes and sericites. One section.

Age. Archean (Keewatin).

Remark. The field relations show that this rock was intrusive in the graywacke of the region. Its great alteration shows to what extent original diabases or dolerytes are transformed; *i. e.*, unless the rock be a regenerated basic debris compelled to act as an intrusive by dynamic folding and fracture. N. H. W.

No. 12H. Greenwacke.

South side of the island in S. W. ¼ sec. 32, T. 63–16, Vermilion lake.
Ref. Annual Report, xv, pages 299, 414.

Meg. Cut by dikes of greenstone; a green, coarse rock.

Mic. Uralitized and chloritized *augites*, lie in a debris of the same material. In the finest material is apparently a little *feldspar* and a noticeable amount of *epidote*. One section.

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

No. 15H. Dioryte.

Near the township line, in N. W. ¼ sec. 7, T. 62–16, Vermilion lake.
Ref. Annual Report, xv, pages 284, 285, 415.

Meg. Heavy, massive, greenish black, probably a dike.

Mic. Principally composed of coarse *hornblende* and of *feldspar* interlocked in a somewhat igneous fashion. The feldspar is considerably broken and reconstructed by new growths, but shows still, in the main, the sizes and forms of the original crystals. The hornblendes are secondary after pyroxene, and in numerous instances they show the usual differences of polarization which indicate approximately the forms of the original pyroxene grains. *Calcite*, *epidote*, *magnetite*, *biotite* and *muscovite* appear in accessory amounts. One section.

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

No. 17H. Greenwacke.

S. W. ¼ S. E. ¼ sec. 1, T. 62–17, from the point, Vermilion lake.
Ref. Annual Report, xv, pages 285, 415.

Meg. Greenish, siliceous schist.

Mic. Schistose. The rock is quite fine grained, but long-drawn bands of *hornblendic* debris give it a strong parallelism of schistosity, while *epidote* in fine, granular, mostly isolated individuals, is very numerously distributed, but somewhat in lines parallel with the schistosity. The finely granulitic matrix is of *quartz* and *feldspar* of later date than the hornblendes, but the epidote is earlier than the hornblende. There are but very few, if any, sericite scales. One section.

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

No. 19H. Dioryte (*with sphene*).

Sec. 3, T. 62–17, Vermilion lake.
Ref. Annual Report, xv, pages 286, 287, 415.

Meg. In hills and ridges that alternate with hills of mica schist along the shore.

Mic. Similar to No. 15H but less altered, the *pyroxene* being still somewhat preserved. Large *sphenes*, with crystal outlines, are frequent. These crystals, as well as all the smaller grains which do not show definite crystal form, are secondary to the hornblende. Not only is the sphene indented by hornblende about its margin, but it surrounds completely several globular grains of hornblende, as shown in the accompanying figure. It also encloses two other grains that are apparently calcite and feldspar. One section.

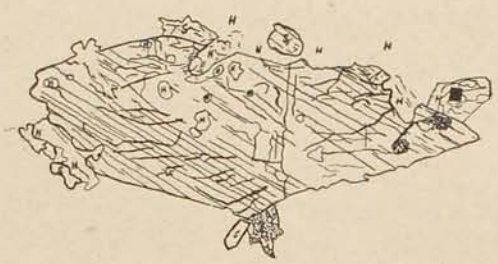

FIG. 51. SECONDARY SPHENE IN NO. 19H.
H-Hornblende; S-Sphene.

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

No. 22H. Chlorite Schist. *(Greenstone.)*

From the top of Sunset peak, north of the east end of Long lake, sec. 22, T. 63-12.
Ref. Annual Report, xv, pages 404, 416.

Meg. Greenish, schistose.

Mic. In the midst of the *chlorite*, which is in fine, radiating or fan-shaped forms, are a few spicules of hornblende, and a finer, granular feldspar fills some of the interspaces. The most of the rock consists of chlorite. A few minute *sphenes*, some *pyrite* and *leucoxene* are also visible. Two sections.

Age. Archean (Keewatin).

Remark. Another section bearing the same number is from what was probably originally an igneous rock, but which now has no feldspar, there having been substituted for it a very fine granular mass of secondary products which, owing to the thickness of the section, cannot be minutely studied, but in which *calcite* seems to enter largely, probably consisting of *feldspar* and *quartz*. In this fine substance lie numerous *hornblendes*, much chloritized, whose size is in strong contrast with the very fine matrix in which they lie. N. H. W.

No. 26H. Amphibolyte.

Sec. 15, T. 63-12, ridge north of Long lake.
Ref. Annual Report, xv, pages 404, 416.

Meg. The crystals of hornblende stand out on the weathered surface, giving a darker and rougher appearance.

Mic. The rock consists almost entirely of *hornblende*, but also contains *muscovite*, which is also intimately associated with *chlorite*, with a little *epidote*. Between the hornblendes, which in one section lie uniformly in one direction, is a fine granular matrix of muscovite and feldspar, the contrast with the nearly idiomorphic hornblendes being quite remarkable. Two (thick) sections.

Age. Archean. N. H. W.

No. 256H. QUARTZYTE.

Pokegama falls.
Ref. Annual Report, xvi, pages 438, 473.

Meg. Gray quartzyte, weathering red.

Mic. *Quartz* only composes this rock. The original clastic round grains are grown out to fill the angular interstices, making a dense quartz rock. Nearly all the original grains are unique, *i. e.*, simple, having one orientation, but two or three in the slide are compound, the parts being interlocked in the fashion of secondary quartz. They all have lines of inclusions. One section.

Age. Pokegama (at the base of the Animikie). N. H. W.

No. 257H. QUARTZYTE.

Pokegama falls.
Ref. Annual Report, xvi, pages 438, 473.

Meg. Rusty quartzyte.

Mic. Same kind of rock as No. 256H, but having some rustiness in the planes separating the individual grains. One section.

Age. Animikie, basal member. N. H. W.

No. 261H. QUARTZYTE.

Foot of the lower falls of Prairie river.
Ref. Annual Report, xvi, page 473.

Meg. Quartzyte.

Mic. Same as No. 257H, but shows also a few grains of triclinic *feldspar*, and one of *hornblende*. One section.

Age. Animikie, basal member. N. H. W.

No. 265H. QUARTZYTE.

Upper end of the lower falls of Prairie river.
Ref. Annual Report, xvi, pages 441, 473.

Meg. Quartzyte.

Mic. Quite like No. 257H, but finer, less cemented by secondary quartz, and more coated by an opaque oxide; also, apparently, has some garnet(?) One section.

Age. Animikie, the basal member. N. H. W.

No. 364H. CONGLOMERATE.

From a boulder seen east of Iron lake, N. W. ¼ sec. 24, T. 60–13.
Ref. Annual Report, xvii, pages 83, 136.

Meg. Rounded quartz pebbles, three to ten times as large as mustard seeds, are the most conspicuous element. They lie in a matrix of ferro-magnesian debris, and are associated with some feldspathic detritus.

Mic. *Quartz* and *labradorite(?)*, (extinction 58° on n_p in the obtuse angle), are

the most conspicuous and coarsest parts of this rock. Some of the quartz is in individual grains, but some was originally an interlocking multiple quartz with rounded outlines. *Actinolite* forms the chief coloring element, being in confused, fibrous, matted and fine mass which surrounds the quartz and which in form of rosettes penetrates the quartz about its borders, and which is in general much chloritized, or at least is associated with chlorite. Besides these are pebbles that appear to have been feldspars of detrital origin, but now consist wholly of micro-granulitic replacement, the grain (or pebble) maintaining its size and form in the midst of the green matrix. In other parts the matrix does not consist of this green substance, but of a mixture of all the other elements in fine granules, including also some *mica* and *epidote*, and in others it is of the same fine interlocking quartz-feldspar mosaic as has replaced the feldspars. *Sphene* is scattered in the section. One section.

Age. Pokegama.

Remark. It is remarkable that in this rock, while all the fine clastic feldspars of the matrix, and also several large ones which now are still evident in their outlines, have been replaced, as above stated, by a quartz-feldspar mosaic of fine grain, there remains one large labradorite which has not been affected in that way. Compare No. 366H, where it is shown that pebbles of originally micro-granulitic quartzyte(?) are embraced in a conglomerate similar to this. It is hence probable that this supposed replacement of old feldspars is not tenable, but that these were also original pebbles of micro-granulitic quartz, perhaps from jaspilyte of the Lower Keewatin.

No. 366H. Conglomerate.

S. W. ¼ sec. 13, T. 60–13, north end of Iron lake.
Ref. Annual Report, xvii, pages 84, 136. (Compare Nos. 364H, 370H.)

Meg. Conglomerate, rather coarse.

Mic. Six sections made from this rock are calculated to show its composition: 1. A piece of granite, consists largely of *quartz* and *microcline*, the latter being intergrown with another feldspar in manner of a *microperthite*, and also containing numerous isolated small crystals of some triclinic feldspar, the microcline having embraced them pokilitically, and being much more preserved than the inclusions. The same crystal of microcline also embraces a crystal of *sphene*. Besides microcline the slide contains several large but considerably decayed feldspars, which have a close albite twinning and are probably *oligoclase*. *Chlorite*, some of which is *pennine*, *muscovite*, *epidote* and more or less iron oxide *(limonite?)* also appear as alteration products. 2. At first this slide appears much like No. 1, but it differs in having a matrix matter of green, fine, granular *hornblende* (with some chlorite) which in some places is abundant and forms a large proportion of the slide, and in others is only a narrow band between the large grains, and yet in others is absent, allowing

the feldspars and quartzes to come exactly into contact. In that case these minerals also appear to be interlocked as if they had been connected originally in a common foreign source. In short, the fine green debris seems to embrace a quartzose coarser debris derived from granite. 3. With a few large grains of quartz and of a micro-perthited feldspar *(orthoclase?)* is much of the same green fine substance, which shows not only hornblende in its composition, but also much of an amorphous green chlorite. In this green hornblendic mass are also included as foreign grains a few crystals of *apatite*, one of which is abnormally slightly biaxial. 4. Same as No. 3, even to the occurrence of *apatites* in the green matrix. 5. With a diminution of detrital *quartz* and *feldspar* there is an appearance of granulitic and micro-granulitic quartz, which is distinctly separable from the detrital quartz, both in its boundaries and in its microscopic aspect. The detrital quartz extinguishes in a shadowy manner, and is in large grains, but the granulitic quartz is fresh and fine, and each grain is throughout simultaneous in its extinction, while sometimes the hornblendic fibrous development encroaches on it, sending sharp needles into it, yet there are *pebbles* of granulitic quartz, as of the shadowy quartz, some of them being much coarser and some much finer than the general matrix of granulitic quartz. One large round pebble of granulitic quartz is coarse, and lies in a matrix of very fine granulitic quartz, the separating boundary of the pebble being distinct through its whole circumference. Other similar pebbles are much finer than the granulitic quartz matrix in which they lie. Other pebbles are partly of granulitic quartz and partly of the green matrix, while in still other places the green matrix itself is gathered in spots resembling pebbles. The green substance is almost entirely of *hornblende*. 6. In the midst of a general groundmass of micro-granulitic quartz, varying in fineness, are roundish spots or pebbles of the green hornblendic "matrix," but here the hornblende is so stained by iron oxide that it appears red, and instead of acting as matrix, it is surrounded by the granulitic quartz in the manner of a matrix. Six sections.

Age. Animikie(?)

Remark. When collected, this conglomerate was supposed to be a part of the Animikie, but both the field and microscopic characters indicate that some parts are in the Keewatin. The entire series of interesting facts can apparently only be explained by supposing that here the Pokegama conglomerate, the base of the Animikie, lies non-conformably on the conglomeratic base of the Upper Keewatin, and that the latter exhibits, as it does at Saganaga lake, a gradual and almost imperceptible transition to the underlying Archean, the difference of dip of the two formations not being evident. N. H. W.

No. 370H. Mica Schist *(with cordierite)*.

Ref. Annual Report, xvii, pages 85, 136.

Meg. Tough, black, heavy, but not magnetic.

Mic. The rock is thickly set, as it were porphyritically, with idiomorphic small crystals of *cordierite*, which are uniformly twinned so as to show six individuals whenever they are cut perpendicular to the bisectrix, as shown by the sketch here given. These extinguish in pairs, composed of opposite sectors, when well exhibited, but there are numerous instances in which the grouping seems to be irregular or defective. Such sections have approximately a hexagonal outline, although the crystal is orthorhombic.* Most of the sections of this mineral are elongated parallel with n_p, and contain many fine inclusions, such as *biotite*, but the most of these inclusions are undeterminable. The rock at large containing these cordierites is crowded with biotite. One section.

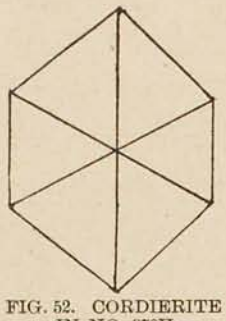

FIG. 52. CORDIERITE IN NO. 370H.

Age. Animikie. N. H. W.

No. 372H. Conglomerate.

S. W. ¼ N. W. ¼ sec. 32, T. 60–13, south of Birch lake.
Ref. Annual Report, xvii, pages 86, 136. (Compare No. 366H.)

Meg. Conglomerate.

Mic. The slide shows principally *quartz*, of interlocking structure, varying in fineness, some of it having the original detrital form of pebbles, and some of it having originated since the pebbles were deposited in this position. It is also evident that the rock contains pebbles of quartz of detrital origin, which were not of interlocking structure, but which since have been built into the general rock by the secondary deposition of interlocking quartz. Throughout the interlocking finer portion of the slide are *calcite* and *mica*, *hornblende*, *epidote* and small triclinic *feldspars*. One section.

Age. Upper Keewatin(?)

Remark. This occurrence of fragmental grains or pebbles of interlocked *quartzyte* in this conglomerate indicates a break of structure between the base of the conglomerate and that on which it lies. If the conglomerate be the bottom of the Animikie, then these curious composite pebbles of quartzyte were before the Animikie. Still, they resemble very closely the fine interlocking quartzyte associated with and forming a large constituent in the iron ore rocks of the Mesabi range. They are probably to be referred to an underlying older quartzyte, or jaspilyte, belonging in the Keewatin.

Since such pebbles are also common in the basal conglomerate of the Upper Keewatin, they do not here demonstrate whether this conglomerate is of the base of the Animikie or older. The features described by the field notes rather indicate the Keewatin age of the most of this conglomerate, at least at the point where the most of the specimens bearing this number were collected. N. H. W.

* *Minéralogie de France*, vol. i, p. 515.

Graywacke. Grünerite and magnetite. Granite.

No. 378H. Graywacke. *(Conglomerate.)*

Southeast "forty" of sec. 11, T. 59–14, Mesabi range.
Ref. Annual Report, xvii, pages 87, 137.

Meg. Gray, coarsely slaty graywacke.

Mic. Rather fine *quartz* and *feldspar*, with a finer intermixture of chlorite. The feldspars are old and altered. These elements vary in grain, especially the interlocking quartz, showing pebble forms, as in No. 372H. Two sections.

Age. Keewatin. N. H. W.

No. 379H. Grünerite(?) and Magnetite. *(Rock.)*

N. W. ¼ sec. 14, T. 59–14, from a shaft northeast of Mesabi station.
Ref. Annual Report, xvii, pages 88, 137. (Compare No. 437.)

Meg. Apparently a breccia of black slaty rock with an actinolitic cement.

Mic. The slide contains two quite different rocks. 1. *Calcite*, embracing crystals of grünerite(?), through which are also distributed some coarse magnetite groups. 2. Taconyte in which the rounded pebbles of interlocking quartz are very numerous and essentially compose the rock. The matrix of these pebbles is also a coarser interlocking quartz, the pebbles being outlined by the characteristic distribution of *magnetite* about their borders. There is also in this part a much coarser magnetite in spreading sponge-like mesh, and in some of the angles between the groups or within a circular band formed by the magnetite, is *calcite*, while small spangles or stellar rosettes of *actinolite* (or grünerite) pierce the quartz in places. With the exception that the taconitic structure is not visible in the calcite side of the slide, the two parts are quite alike in their essential characters, differing only in the relative proportions of the minerals. One section.

Age. Animikie. N. H. W.

No. 385H. Granite. *(Decayed.)*

Three miles north of the Giant's range, on the Duluth and Iron Range railroad.
Ref. Annual Report, xvii, pages 89, 137.

Meg. Coarse, hornblendic, with red orthoclase.

Mic. There is a noticeable contrast in the apparent freshness and integrity of the different minerals of this slide. There seems to have been a granitic rock or a granitic debris consisting of *feldspar*, *quartz*, *sphene*, *apatite*, more or less decayed, having *epidote*, *chlorite*, etc., already generated, which was microperthited and surrounded by fresh *microcline*, cementing the whole into a firm rock, so that now it has again the aspect of granite. One section.

Age. Archean. N. H. W.

No. 387H. Mica Schist *(with biotite)*.

Partridge river, N. E. ¼ S. W. ¼ sec. 9, T. 58–14.
Ref. Annual Report, xvii, pages 90, 137. (Compare No. 1708.)

Meg. Dark, silico-argillaceous and micaceous.

Mic. There is an interlocking fine *quartz* as a basis of this schist, which was later in its granular deposition than the *mica* which cuts the quartz and maintains its form in the granular structure. But there are larger, later micas, which give way to the quartz. These are colorless, and appear to be of *muscovite*. One section.

Age. Animikie. N. H. W.

No. 389H. Graywacke(?) *(Subcrystalline.)*

Near the centre of S. E. ¼ sec. 8, T. 59–14.
Ref. Annual Report, xvii, pages 91, 137.

Meg. Gray, gneissoid, having the aspect of an igneous rock.

Mic. A fine-grained rock, consisting largely of old *feldspars*, has been permeated by secondary fresh *quartz* and fresh *feldspar* (near oligoclase). Some shreds of hornblende are changed to chlorite, while fine *muscovite* scales permeate thickly the original feldspars. There are also several grains of *sphene* and of *biotite*. One section.

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

No. 390H. Graywacke. *(Fine.)*

S. E. ¼ sec. 11, T. 59–14, Mesabi range.
Ref. Annual Report, xvii, pages 91, 137.

Meg. Fine, gray, micaceous.

Mic. This rock is finer, but is essentially the same as No. 389H; it shows also *hornblende*; and *muscovite* and *biotite* are intimately associated. The feldspars have the form and size of clastic debris. Some of the larger muscovites enclose poikilitically several of the small old feldspars. One section.

Age. Keewatin. N. H. W.

No. 397(a)H. Amphibolyte.

S. E. ¼ N. E. ¼ sec. 26, T. 61–12, near Birch lake.
Ref. Annual Report, xvii, pages 93, 137.

Meg. Hornblendic quartzyte.

Mic. The slide consists almost entirely of *hypersthene*, in which are embraced, however, poikilitically, a number of round, small grains of *quartz*, and others of about the same size and shape of a highly refractive mineral resembling *olivine*, and a few of *magnetite*. This gives place to a fibrous divergent network of some amphibole, which in turn passes into a distinct *cummingtonite* (often known as grünerite), having multiple twinning. At the extreme other end of the slide is another crystal

of orthorhombic pyroxene showing the twinning of 104. It is here plain that the orthorhombic pyroxene was of later origin than the monoclinic. One section.

Age. Keewatin (condition of the jaspilyte). N. H. W.

No. 399H. QUARTZYTE *(with magnetite, hypersthene, etc.)*

E. ½ N. E. ¼ sec. 35, T. 61–12, near Birch lake.
Ref. Annual Report, xvii, pages 95, 138.

Meg. Nearly all quartz, but with varying amounts of magnetite and hypersthene.

Mic. Quartz, magnetite, hypersthene, cummingtonite, diallage(?) constitute this rock about in the order named. It is a phase of the ferriferous beds which are common near the gabbro, and as a rock is difficult to name. It is always accompanied by some form of the well-known muscovadyte.

Age. Pewabic quartzyte, a phase of the jaspilyte of the Keewatin, under the action of the gabbro revolution. N. H. W.

No. 402H. PYROXENYTE.

N. E. ¼ S. W. ¼ sec. 35, T. 61–12, near Birch lake.
Ref. Annual Report, xvii, pages 95, 138.

Meg. Hornblendic and magnetitic.

Mic. Hypersthene and *augite* are closely associated in the composition of this rock, the former being the later to be formed. With these, especially in the hypersthene, are also a little *quartz* and *magnetite.* One section.

Age. Same age and genesis as No. 399H. N. H. W.

No. 405H. PYROXENYTE. *(Ferriferous.)*

N. ½ S. E. ¼ sec. 24, T. 61-12, near Birch lake.
Ref. Annual Report, xvii, pages 95, 138.

Meg. Quartz and iron ore in bands, alternating with bands of pyroxene.

Mic. Magnetite, augite and a little *quartz.* This is so heavily magnetited that it might be taken for a lean iron ore. One section.

Age. Pewabic quartzyte, same as No. 399H. N. H. W.

No. 406H. PYROXENYTE. *(Ferriferous.)*

S. E. ¼ N. E. ¼ sec. 35, T. 61–12, near Birch lake.
Ref. Annual Report, xvii, pages 94, 138.

Meg. Hornblendic.

Mic. Augite, hornblende, biotite, magnetite, apatite, quartz. The apatite is sometimes within magnetite and sometimes within feldspars, of which a few are seen in the slide, though they are considerably altered. Two sections.

Age. Same age and genesis as 399H, but more allied to muscovadyte.

Remark. For some years these olivinitic and pyroxenic rocks were considered a part of the Animikie, especially when they were found to be iron bearing, under the name Pewabic quartzyte, while the muscovadyte, which always accompanies them, and which has strong affinities with the gabbro, was assigned to the gabbro, or post-Animikie. The various chapters descriptive of the geological plates were all written from this point of view (vol. iv).

It became evident, however, that this olivinitic iron ore belonged with the Keewatin, and that the muscovadyte is only a regenerated basic debris of the Keewatin. It remained to complete the genetic round of transformation by recognizing the bond which attaches the gabbro to the muscovadyte, and to reach the hypothesis that the gabbro itself is the last result of the metamorphism of the the Keewatin greenstones. This point has since been critically examined at Disappointment lake and everything seen there tends to show such a relationship. The term Pewabic quartzyte is retained for this modified jaspilyte, and the term Pokegama has been applied to the basal member of the Animikie. Consult the Lake county chapter in volume iv. N. H. W.

No. 505H. Noryte *(with olivine)*.

A short distance north of the quarter-post between secs. 14 and 15, T. 63-9 W., south of Snowbank lake.
Ref. Annual Report, xvii, pages 120, 142; Annual Report, xxi, pages 151, 152.

Meg. A rather fine-grained rock of a gray to brownish-gray color. Not gneissic. Composed of grains of a glassy mineral and smaller ones, which are yellowish to black in color.

Mic. A granular aggregate of *feldspar*, *pyroxene*, *olivine*, *magnetite* and a little *biotite*. The feldspar is largely, perhaps entirely, plagioclase. Some grains do not show twinning striæ, and in some the cleavage is not well marked. Such grains might be quartz; however, a dozen such grains which, if quartz, would be approximately basal sections, were examined for interference figures and every one showed a distinct biaxial figure. I think there is no quartz in the section. The pyroxene is distinctly pleochroic, and is hypersthene. The minerals of this rock, except the olivine, are unaltered and fresh. A little monoclinic pyroxene is also probably present.

Age. Cabotian.

Remark. This rock is one to which the name muscovado (or muscovadyte) has been applied. U. S. G.

ROCKS COLLECTED BY J. E. SPURR.

No. 37S. Flint.

S. E. ¼ sec. 4, T. 58-16, Chicago property, Mesabi range.
Ref. Annual Report, xxii, page 127; Bulletin x, page 53.

Meg. Gray, fine, with calcite.

Mic. Very fine mosaic of *quartz* (and feldspar?) interlocking, interspersed sparingly with *calcite*, which also crosses it in veins, accompanied by a little *hematite*. One section.

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

No. 39S. Taconyte.

Same place as No. 37S.
Ref. Annual Report, xxii, page 127; Bulletin x, page 53.

Meg. Light-green, spotted, granular taconyte.

Mic. In a framework of interlocking *quartz* of the typical character are many roundish, greenish-yellow areas, which are not in crystalline condition (at first), but simply amorphous, isotropic aggregates. These are crossed by numerous irregular cracks, and along these cracks, in other grains, it is seen that a kind of change is set up. This change progresses irregularly, frequently appearing in isolated points in the yellow mass (figure 53) and forming more transparent, finely crystalline nests. These nests multiply and also enlarge, such enlargements taking on a radial, or

FIG. 53. GREENSAND IN NO. 39S.

spherulitic structure, thus converting the whole original grain into a finely reticulated and radial network of fine, fibrous, crystalline matter. Many such spots are wholly changed to this network, others are in process of change, and others show

the change only about their margins. As to the nature of these radiating fibres, they are plainly *actinolite*, or an amphibole allied. At the present stage of change shown by this rock, about five-sixths of the whole area are of this fibrous network and the yellow substance that gives place to it, the rest being of the interlocking quartz, which forms the general matrix. One section.

Age. Animikie (iron-bearing member).

Remark. This slide shows that the green substance, supposed by Mr. Spurr to be glauconite, is of such a nature that it almost spontaneously gives place to an amphibole and that it thus has an alliance with the darker debris of the tuffaceous greenstones.

The figure above is designed to illustrate some of the changes that take place in this primordial greensand. Within the area of the field is one grain of that substance so magnified as to occupy nearly all the space, that is, about one hundred diameters. Some grains in the rock are larger, and their size also runs down to mere specks. There are to be noted various things of interest and importance in connection with this greensand:

1. In its earliest state, so far as can be affirmed by the evidence of the section illustrated, it is feebly translucent, greenish, or olive green, and is broken into many irregular areas by cracks that cross it in the manner of shrinkage cracks.

2. It becomes transparent when it begins to crystallize by the chemical separation of its ingredients into definite compounds. Several such more transparent roundish spots are seen in the figure. These are, for the most part, filled with quartz in imperfect or globular fine grains, but are also somewhat occupied by actinolite. The size of the quartz grains in these confined areas is smaller than that of the quartz which is outside of the glauconite, and which forms the groundmass of the rock.

3. Radiating, fibrous actinolite (or perhaps cummingtonite) pierces the quartz, being apparently cotemporary with or a little earlier than the quartz. This amphibole surrounds the greensand grain and its fibres run independently into the margin of the grain in such a manner as to show that it, as well as the quartz, originated wholly from the greensand. Such actinolite spicules are sometimes seen (in other greensand grains) wholly within the body of the greensand.

4. The greensand begins to crystallize and is wholly transformed about its margin and at points within the grain, giving rise to quartz and actinolite (or cummingtonite).

5. In the case of the grain illustrated there is no apparent segregation of iron ore, but in other slides cut from this rock sample iron ore is manifested as one of the secretions from the greensand. These are its appearance within certain grains, rendering them wholly opaque, and in the same way as with the quartz and cum-

Quartzyte. Granite and amphibolyte.] Taconyte.

mingtonite it begins at points in the main greensand grain, involving certain of the polygonal areas into which it is cut by the general cracking.

6. It is apparent that the greensand is the source of the quartz, the cummingtonite and the iron ore, and that the quartz, gathering in the interspaces about the greensand grains, is coarser than that in the areas of the grains themselves, because of greater freedom of chemical transference in those open spaces.

It seems to the writer that these features, and other facts mentioned in the description of other rocks derived from the Mesabi Iron range, whether at Gunflint lake or at Prairie River falls, indicate that the greensand was of the nature of a ferruginous volcanic sand. This result is further discussed in Part III. N. H. W.

No. 43S. Quartzyte.

S. E. ¼ S. W. ¼ sec. 4, T. 58–16, Mesabi Iron range, near Biwabik.
Ref. Annual Report, xxii, page 127.

Meg. Loose conglomeratic quartzyte with kaolin.

Mic. Round grains of uniform size of clastic *quartz* are surrounded by a debris which is probably of kaolinic nature which has been incorporated in the secondary rim of quartz by which the rock is cemented and made firm. One section.

Age. Pokegama quartzyte(?) (base of the Animikie). This rock may belong to the Cretaceous instead of the Animikie.

No. 47S. Granite and Amphibolyte.

S. W. ¼ N. W. ¼ sec. 35, T. 59–17, Mesabi Iron range.
Ref. Annual Report, xxii, page 127.

Meg. Contact of granite on the Keewatin.

Mic. The slide differs. One side consists almost wholly of green *hornblende* in large crystals, but having a general parallelism of direction. With these are mingled a little *quartz* (within the hornblendes), *epidote* and *pyrite*. The other part of the slide, while containing also hornblende in form of elongated schistic fibres, consists chiefly of much altered *feldspars* and interlocking *quartz*, with *biotite*. These feldspars (oligoclase, apparently), evidently of some anterior state, are now charged with *muscovite*, some *calcite*, and occasionally contain *quartz* as secondary products, while epidote also is in scattered grains. One section.

Age. Archean. N. H. W.

No. 53S. Taconyte. *(Greensand.)*

S. E. ¼ sec. 4, T. 58–16, Mesabi Iron range.
Ref. Annual Report, xxii, page 127; Bulletin x, page 68.

Meg. Dark green, spotted-granular.

Mic. The green primordial element is in one slide entirely broken up, and a crystalline network is formed, consisting of the same actinolitic(?) ingredient as

noted in No. 39S, but the stellate structure is wanting. Further, in the midst of this actinolitic product are areas of loose *magnetite* and occasionally of irregular *siderite* with a few small grains of *quartz*. Indeed, it appears that quartz and siderite alternate in areas, forming the supporting background for this yellowish actinolitic product. In a second slide the forms of the primordial pellets are distinctly preserved, but they are replaced by the products of alteration, sometimes by siderite, which frequently is of a single crystal orientation occupying nearly the whole area of the original pellet, sometimes by a biotitic and ferruginous substance, and sometimes by a globular or an interlocking quartz finer than the rest of the rock, but usually they are in some part still preserved as greensand, often with shrinkage cracks. These pellets are surrounded by an interlocking quartz. In still another section the same characters are seen as in the last. Three sections.

Age. Animikie. N. H. W.

No. 55S. Greenstone. (*"Mottled."*)

N. W. ¼ S. W. ¼ sec. 34, T. 59–16, Mesabi Iron range.
Ref. Annual Report, xxii, page 128.

Meg. Greenstone.

Mic. *Feldspar* of a triclinic species composes this rock essentially, but there was originally a ferro-magnesian mineral in small amount which is now turned to *chlorite*. Some opaque *leucoxene*, some *sphene*, *calcite* and *epidote* are subsidiary in amount. The structure seems to indicate that this rock has suffered pressure amounting almost to crushing, but the feldspars are not lost as to crystalline form, showing occasionally an interlocked growth. They have been subsequently recemented and regenerated by a microperthitic deposition of a fresh feldspar. The rock may have been a hornblende granite or a diabase with little augite. One section.

Age. Keewatin. N. H. W.

No. 58S. Hornblende Schist.

About 200 paces north of No. 57S.
Ref. Annual Report, xxii, page 128.

Meg. Hornblendic.

Mic. *Hornblende* and secondary interlocking glassy *feldspars* with a little *biotite* compose this rock. One section.

Age. Keewatin, recrystallized. N. H. W.

No. 59S. Hornblende Schist.

Same locality as No. 58S.
Ref. Annual Report, xxii, page 128.

Meg. Hornblendic.

Mic. Same kind of rock as No. 58S, but containing evidently also a considerable quartz in the interlocking groundmass. One section.

Age. Keewatin, recrystallized. N. H. W.

Mica schist. Taconyte. Graywacke.] Amphibolyte.

No. 60S. Mica Schist.

Interbanded in No. 59S.
Ref. Annual Report, xxii, page 128.

Meg. Micaceous.

Mic. *Quartz*, *muscovite*, interlocked in cotemporary development, compose this rock. One section.

Age. Keewatin, recrystallized. N. H. W.

No. 61S. Taconyte. *(Pebble from conglomerate.)*

S. E. ¼ N. E. ¼ sec. 6, T. 58–17, Mesabi range.
Ref. Annual Report, xxii, pages 122, 128.

Meg. Green conglomerate, with rusty specks; accompanied by green shale.

Mic. A green mass from the rock, consisting of chlorite, *stained* with *hematite*. Round the green mass are taconitic pellets of the characteristic form and size, some of which are replaced by *siderite* and *siderite* enters considerably, in places, into the green mass. This is preferably siderite, since it is numerously and regularly cleaved and is iron stained by oxidation. One section.

Age. Cretaceous.

Remark. Rock No. 62S is from the same conglomerate, but is wholly hematited. N. H. W.

No. 77S. Graywacke. *(Very fine.)*

N. W. ¼ N. E. ¼ sec. 7, T. 58–17, Mesabi range.
Ref. Annual Report, xxii, page 128.

Meg. Dark, slaty, banded with stratification.

Mic. This rock is made up of a fine debris of *quartz*, *feldspar*, *sphene*, and some dark mineral which is now altered to *chlorite*, and of *muscovite*. It is darkened also by *pyrite*, *hematite* and apparently by a dark *leucoxene*, with a scant cement of *calcite* One section.

Age. Animikie. N. H. W.

No. 94S. Amphibolyte.

S. W. ¼ N. E. ¼ sec. 17, T. 59–17, Mesabi range.
Ref. Annual Report, xxii, page 129.

Meg. Massive hornblende rock.

Mic. *Hornblende* in coarse (microscopic) crystals, and a little *feldspar* and *apatite* are the only minerals perceptible in this rock. One section.

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

No. 125S. Taconyte.

N. E. ¼ S. E. ¼ sec. 17, T. 58–19, Mesabi range.
Ref. Annual Report, xxii, page 130.

Meg. Glauconitic taconyte.

Mic. Green pellets are breaking up into interlocking *quartz*, *siderite* and *actinolite*, the last being sometimes stained by *hematite*. These pellets, still preserving their forms, lie in a groundwork of coarser interlocking quartz. One section.

Age. Animikie. N. H. W.

No. 127S. GRAYWACKE. *(Fine, sideritic.)*

S. E. ¼ N. E. ¼ sec. 17, T. 58–19, Mesabi range.
Ref. Annual Report, xxii, page 130; Bulletin x, page 129.

Meg. Banded taconyte slate.

Mic. A very fine grouping of *quartz* (and feldspar?) similar to No. 77S, but stained by oxidized *siderite*, which still retains its crystalline outlines, though converted to oxide. Much of it, however, is not oxidized. One section.

Age. Animikie. N. H. W.

No. 133S. TACONYTE.

S. E. ¼ S. E. ¼ sec. 18, T. 58–19.
Ref. Annual Report, xxii, page 130.

Meg. Taconyte grit rock, with seams of iron.

Mic. This rock represents various stages in the transition from greensand to iron ore as described by Mr. Spurr in Bulletin x, viz.: (1) "Glauconite" without alteration; (2) With the formation of *actinolite;* (3) Formation of *siderite;* (4) Formation of fine interlocking *quartz;* (5) Formation of crystalline iron ore, apparently *magnetite.* These products, with occasional exception of the last, are generated within the pellets, which, surrounded by a coarser interlocking quartz, retain their original round outlines distinctly until the process is completed in the production of a promiscuous mass of iron ore; and, even after the ore is complete, the pisolitic structure prevails in thousands of tons which are shipped from the state. One section.

Age. Animikie. N. H. W.

No. 158S. SIDERYTE *(and hematite).*

N. E. ¼ S. E. ¼ sec. 33, T. 58–17, Mesabi range.
Ref. Annual Report, xxii, page 131; Bulletin x, page 53.

Meg. Banded taconyte slate.

Mic. The slide consists of two parts: one is largely made up of closely set, narrow bands of *hematite* which are irregular, wavy and interrupted, and which contain, between the bands, a few grains of *quartz* and areas of *siderite.* Between the bands are other equally narrow and interrupted bands which are translucent, though specked finely with hematite, and between the nicols are almost dark. These appear to be composed of amorphous or very finely globular quartz. The other part of the slide has a scant background of the same kind of globular quartz, but, as it is thickly

set with granules and minute groups of *siderite*, the light which passes is sufficient to make the field quite illuminated. This slide shows a condition of the iron ore of the Mesabi range. One section.

Age. Animikie.

Remark. Macroscopically this sideryte forms granular bands or layers alternating with hematitic layers, the whole being probably originally water-deposited, but the hematitic bands cotemporaneously mingled with more volcanic ash and devitrified glass. This sideryte exists in quantities sufficient to make it of commercial value. It has the outward appearance of a fine, gray, stratified sand. N. H. W.

No. 205S. Quartzyte.

N. W. ¼ N. W. ¼ sec. 36, T. 58–21, Mesabi range.
Ref. Annual Report, xxii, page 132.

Meg Granular quartzyte, grayish red.

Mic. Originally clastic, round grains of *quartz* have been enlarged by secondary silica in crystalline agreement with the various grains, making a compact rock. Amongst these are a few of *microcline* and of other feldspars equally rounded but not apparently enlarged. There is a dark narrow border of rejected debris which separates the enlarged grains from each other, and a less distinct one that separates the original grains from their enlargements. One section.

Age. Pokegama (base of the Animikie).

Remark. The "rejected debris" mentioned is sometimes in roundish shapes as if it had constituted original grains. It appears to be devitrified glass. It is usually crowded with indistinct, minute crystalliths and is largely isotropic. N. H. W.

No. 226S. Quartzyte.

S. W. ¼ N. W. ¼ sec. 35, T. 58–21.
Ref. Annual Report, xxii, page 133.

Meg. Gray quartzyte.

Mic. Similar to No. 205S, but less coarse. The intergranular substance is green and apparently *chlorite*, and more abundant than in No. 205S. There are also a few minute *zircons*. One section.

Age. Pokegama (base of the Animikie).

Remark. This greenish substance is finely scaly, like chlorite. It may have resulted as a detritus from ferromagnesian Archean rocks. N. H. W.

No. 227S. Hornblende Schist.

N. W. ¼ N. W. ¼ sec. 35, T. 58–21.
Ref. Annual Report, xxii, page 133.

Meg. Fine, dark, schistose, hornblendic.

Mic. In this schist with much *hornblende* are *zoisites* which are small and usually permeated by inclusions, among which is a vermicular form of *quartz(?)* in the fashion of a micropegmatyte. *Epidote, muscovite, sphene* are accessory, the last surrounding small grains of *ilmenite.** One section.

Age. Keewatin, metamorphosed. N. H. W.

No. 228S. Mica Schist.

N. W. ¼ N. W. ¼ sec. 35, T. 58–21.
Ref. Annual Report, xxii, page 133.

Meg. Muscovite schist.

Mic. *Quartz* is abundant; *muscovite* and *biotite* with a little *chlorite* give the rock a schistosity, and *epidote* lies nearly parallel with the structure, elongated sometimes positive and sometimes negative (as cut) and showing conspicuous cross fractures. One section.

Age. Keewatin, metamorphosed. N. H. W.

SPECIMENS COLLECTED BY A. D. MEEDS.

No. 8M. Mica Schist. *(Siliceous.)*

S. E. ¼ S. E. ¼ sec. 35, T. 60–13, two miles south of Iron lake.
Ref. Annual Report, xxii, page 88.

Meg. Dark, granular, hardly schistose.

Mic. In an interlocking, rather coarse mosaic of *quartz, oligoclase* and perhaps other feldspars, are enclosed many *biotites*, which cut the quartzes independently, and occasional *muscovites*, the latter being apt to be clustered in or about certain feldspar grains. The quartz varies greatly in granular dimension. Some of the larger grains often involve many small ones which are globular, and so small sometimes or so nearly amorphous that in convergent light they transmit little or no light between crossed nicols. One section.

Age. Animikie.

Remark. The structure is granular and much like that of muscovadyte.

N. H. W.

* *Gneiss à Pyroxène.* Lacroix, p. 57, fig. 22.

No. 21M. Quartzyte.

Sec. 18, T. 59–14, near Mesabi station.
Ref. Annual Report, xxii, page 88.

Meg. Micaceous quartzyte, fine grained.

Mic. Interlocking quartz, as in No. 8M, but more angular, with some *oligoclase*, makes up the most of this rock; the interlocking structure, however, is secondary, the rock having been originally a clastic one. There is a band of darker color crossing the slide, caused by finer quartz grains and by the presence of dark minerals (iron, *hornblende* and *sphene*) accompanied by some *mica* which lies parallel to the band. One section.

Age. Animikie. N. H. W.

ROCKS COLLECTED BY A. H. ELFTMAN.

No. 158E. Diallage.

Sec. 26, T. 61–11, Harris lake.
Ref. Annual Report, xxii, page 185.

Meg. Dark-green, nearly black pyroxene, conspicuously cleaved.

Mic. One section was made approximately parallel to a cleavage (100) and shows an optic axis nearly perpendicular. The extinction is not exactly parallel with the other cleavages. The crystal is crowded with dark inclusions in plates between the basal cleavages and more scattering ones in the clinopinacoidal cleavages (010). It is not perceptibly pleochroic. The crystal includes, however, small quantities of *plagioclase*, *magnetite* and *biotite*. One section.

Age. Cabotian.

Remark. Owing to the orientation of the section the diallagic lamellation (100) is not visible. N. H. W.

No. 178E. Gabbro *(with hypersthene)*.

N. E. ¼ sec. 9, T. 58–10, Greenwood lake.
Ref. Annual Report, xxii, page 186.

Meg. Rather coarse-grained gabbro.

Mic. The rock presents a fine show of various minerals. The *augite* and *olivine* were apparently slightly earlier than the feldspar, the former having taken on the diallagic parting and been resorbed while still in the magma, thus presenting roundish grains of various sizes, sometimes very small. The *hypersthene* was latest of the

mineral generations. This surrounds the diallages completely, and also partly embraces some of the olivines. It has four cleavages, and is plainly pleochroic. The diallage has also the four cleavages, viz., two 110 and the vertical pinacoidal cleavages. Its small optic angle contains n_g, and measures about 45°, which is a peculiarity of augite seen in the gabbro from the larger masses in the central parts of the great gabbro area. The rock embraces but little magnetite. Two sections.

Age. Cabotian. N. H. W.

No. 429E. Diabase *(with olivine).*

Top of the high Sawtooth ridge west of Temperance river.
Ref. Annual Report, xxiv, page 159.

Meg. Dark diabase, rather coarse.

Mic. The *augite* has a pinkish-purple color and is ophitic in its relation to both *olivine* and plagioclase, while the *olivine* has the same relation to the plagioclase, a structure not very common. One section. Compare No. 258.

Age. Cabotian. N. H. W.

No. 455E. Diabase *(with olivine).*

Near Poplar river, from the hill west of the hay marsh, and known as "the rock pile."
Ref. Annual Report, xxiv, page 159.

Meg. Dark gray, rather coarse.

Mic. A coarse ophitic rock, with some *olivine*, the olivine showing the common alteration along fissures and about the margins, producing the familiar yellow substance which is supposed to represent bowlingite. One section.

Age. Cabotian(?) N. H. W.

No. 456E. Diabase. *(Coarsely porphyritic.)*

South slope of the first Sawtooth hill north of Lutsen (Poplar river).
Ref. Annual Report, xxiv, page 159. (Compare No. 796.)

Meg. Coarse diabase, with conspicuous tabular crystals of labradorite.

Mic. The porphyritic *plagioclases* which are taken for *labradorite*, are accompanied by many of the second consolidation. *Augite* is in rather small amount, and in form of small grains which are for the most part of independent forms, but one is rarely cut by one of the second-date plagioclases. Olivine once existed in this rock, but is now altered to a yellowish substance. Magnetite not abundant. One section.

Age. Cabotian. N. H. W.