AUSTRALASIAN ANTARCTIC EXPEDITION
1911-14

UNDER THE LEADERSHIP OF SIR DOUGLAS MAWSON, D.Sc., F.R.S.

SCIENTIFIC REPORTS.

SERIES A.

VOL. IV.

GEOLOGY.

PART 2.

PETROLOGY OF ROCKS FROM QUEEN MARY LAND

BY

S. R. NOCKOLDS, Ph.D.

WITH THIRTY-FOUR TEXT-FIGURES AND ONE PLATE.

PRICE: EIGHT SHILLINGS AND SIXPENCE.

Wholly set up and printed in Australia by
THOMAS HENRY TENNANT, GOVERNMENT PRINTER, SYDNEY, NEW SOUTH WALES, AUSTRALIA.
1940.

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PART 2.

PETROLOGY OF ROCKS

FROM

QUEEN MARY LAND

BY

S. R. NOCKOLDS, Ph.D.

[A.A.E. Reports, Series A, Vol. IV, Part 2, Pages 15-86.
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Issued March, 1940.

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PETROLOGY OF ROCKS FROM QUEEN MARY LAND.

BY

S. R. NOCKOLDS, Ph.D.

(*University of Cambridge*).

WITH THIRTY-FOUR TEXT FIGURES AND ONE PLATE.

SECTION I.

REPORT ON ROCKS FROM EASTERN QUEEN MARY LAND.

I. INTRODUCTION.

The following is a report on a series of rock specimens collected in Eastern Queen Mary Land by A. D. Watson, one of the geologists of the Australasian Antarctic Expedition (1911–14). These specimens were collected during a spring depot-laying sledge journey and during an extended summer sledging journey to the region east of the Queen Mary Land Base Station which was known as the "Grottoes." Most of the specimens were collected *in situ*, others from moraines. Unfortunately the localities of the rock specimens described in Part I of this contribution are not available.* In the following pages an attempt has been made to arrange the rocks as definitely as possible under distinct headings. This general description is followed by comparison with other areas of the Antarctic, more especially those near Queen Mary Land itself. An asterisk after the number of the specimen shows that it has been sectioned. An outline sketch map of the region from which the Queen Mary Land rock collections were made is included herewith as figure (1).

II. THE IGNEOUS ROCKS.

A. The Granites.

(a) *Biotite Granites.*

(i) Nos. 1307, 1309, 1311 (all *in situ* from outcrops on the coast between Delay Point and Cape Charcot). In hand specimen this is a dull pink aplitic granite composed of red felspar, colourless quartz and subordinate chlorite and biotite. Under the microscope the rock is found to be of even grain and consists essentially of microcline, quartz, plagioclase and a certain amount of biotite (Fig. 2). Microcline is the most abundant constituent in subhedral crystals and irregular areas. It appears to have been the last mineral to crystallise and encloses, either partially or wholly, all the other constituents. Quartz is almost as abundant, occurring in irregular grains and patches.

* The detailed list of localities of the rocks collected in Eastern Queen Mary Land was lost in transit from Australia to England. It was not until long after the manuscript was received (1929) from Dr. Nockolds for publication that we were able to get the specimens re-identified. This was done in 1937 by A. D. Watson himself. I have now inserted the localities from which they were obtained after the rock numbers appearing in Section I of this report. [D. M., Ed.]

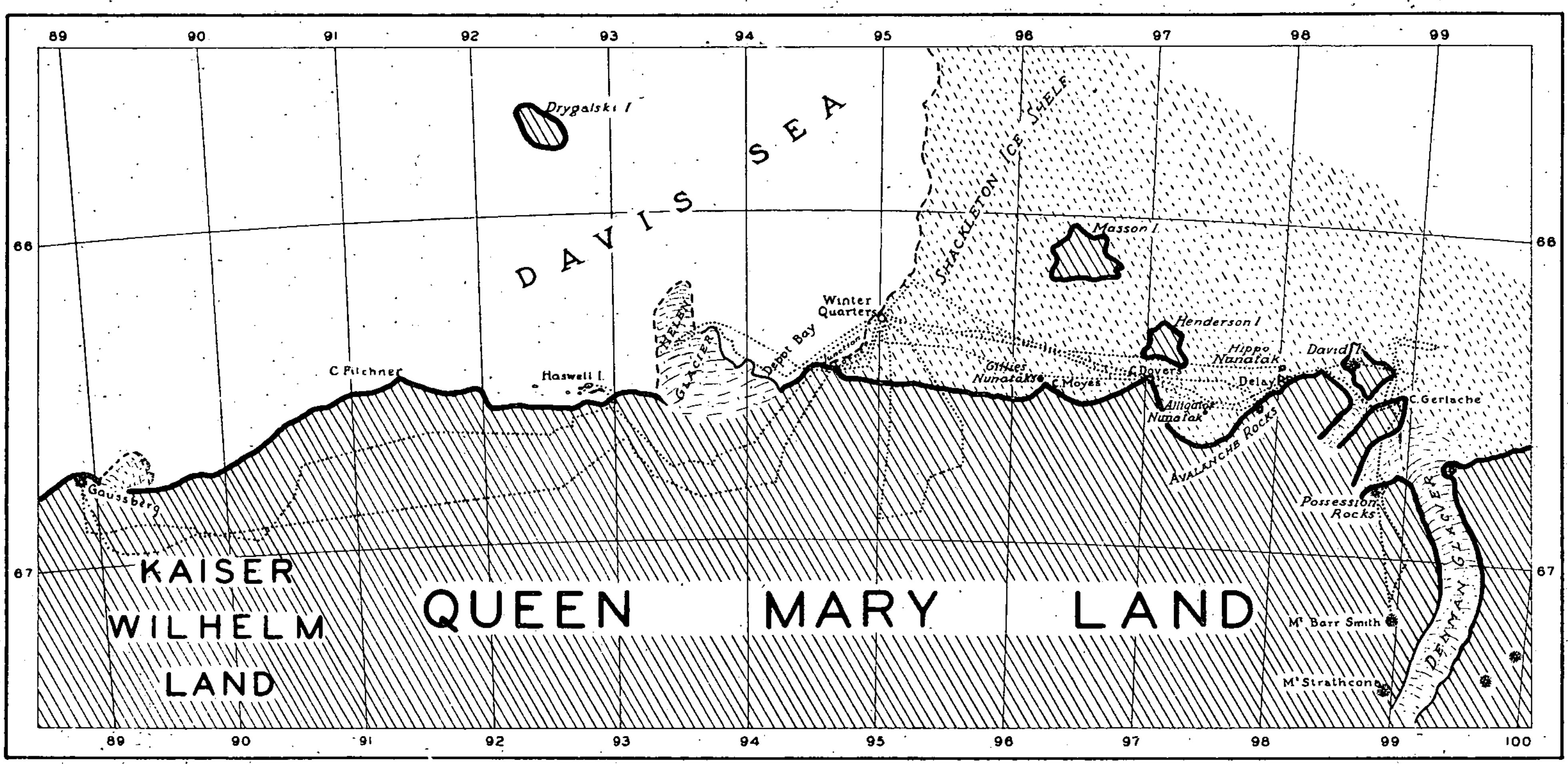

Fig. 1.

Locality Map.

It shows undulose extinction and may be cracked. Plagioclase felspar is a subordinate but fairly abundant constituent. The crystals are subhedral and it may also occur as irregular grains. It is extensively sericitised rendering determination difficult, but it would appear to be of approximately the same composition as that in the porphyritic hornblende granite, namely an acid andesine. Some of it is faintly zoned towards the exterior of the crystal. Biotite, mostly chloritised, occurs in small quantity. Magnetite (some of which is secondary and due to the chloritisation of the biotite) and a little apatite are accessory constituents. In addition, there are one or two grains of orthoclase and a little allanite is present.

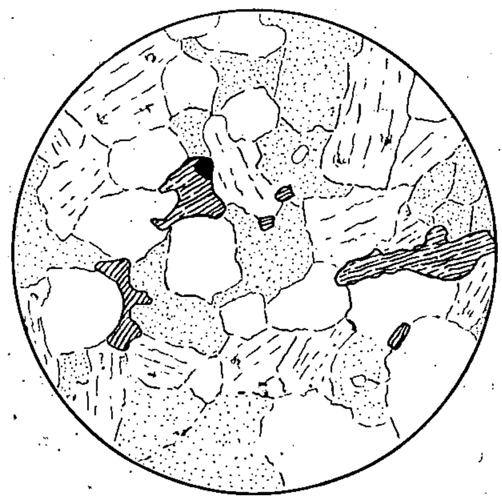

Fig. 2.

Biotite granite (1307). The figure shows biotite, magnetite, quartz, plagioclase and microcline (light stippling).

(ii) No. 1377* (*in situ*, from the summit of the Hippo Nunatak). In hand specimen this is a medium pink fine grained granite, composed of pink felspar, slightly smoky quartz and very subordinate biotite. In thin section abundant quartz is present in large and smaller grains, very free from inclusions and all showing a certain amount of undulose extinction. The quartz is moulded by orthoclase, microcline, microcline-microperthite or plagioclase. Although a few of the microcline, orthoclase and plagioclase crystals are of medium size, the felspars as a whole are fairly fine grained. Microcline is the most abundant felspar moulding and enclosing quartz, plagioclase and orthoclase. Vermicular intergrowths between it and quartz are abundant. Most of it is microperthitic. Plagioclase is the next most abundant felspar and is an acid oligoclase. Twinning on the Albite Law is the rule. Occasionally it forms vermicular intergrowths with quartz. Orthoclase is not abundant. The remaining constituents are a little biotite in small flakes associated with magnetite and pleochroic from a pale straw to an almost opaque brown; it may be chloritised. Finally a little zircon is present.

(b) *Hornblende Granite.*

No. 1382* (from the Hippo Nunatak). A pink rather fine grained granitic rock composed of pink felspar, white felspar and colourless quartz with subordinate biotite and a little hornblende. One surface of this specimen, which appears to be a joint face, has large elongated crystals of dark green hornblende embedded in the usual fine grained granite. These may be as much as an inch and a half long.

In thin section, the texture lies about half way between true granitic and true granulitic. This is largely due to the tendency of the microcline to occur as grains and in irregular areas. The microcline is the most abundant constituent occurring as hypidiomorphic crystals, as grains of various sizes and as irregular areas filling up the interstices between the other constituents. The crystals may show simple Carlsbad twinning. The microcline encloses grains of quartz and plagioclase and small flakes of biotite. Quartz is almost as abundant in grains and irregular patches showing a certain amount of undulose extinction. It is, on the whole, remarkably free from inclusions. Plagioclase is found in subordinate quantity. It is present in small hypidiomorphic crystals or grains which show albite, and sometimes Carlsbad twinning. It has the composition of an oligoclase and includes small grains of quartz. Myrmekitic intergrowths with quartz occur, and it also sometimes contains fusiform or irregular inclusions (on a minute scale) of a colourless mineral of lower refractive index. Lacroix (Rec. Geol. Sur. Ind., vol. 24, p. 168) has referred similar inclusions to quartz and regards them as a special form of " quartz de corrosion." All the felspars are slightly sericitised. Biotite occurs in very moderate quantity. The flakes are strongly pleochroic from pale straw to deep muddy brown. A little green hornblende is associated with it which is pleochroic from light yellow brown to deep green. A certain amount of brown sphene is present and there is also a little magnetite, apatite, zircon and orthite.

(c) *Porphyritic Hornblende Granite.*

Nos. 1370*, 1371* (both from the western of the two Gillies Nunataks) and 1378* (from the summit of the Hippo Nunatak). In hand specimen this type is a massive rock with large porphyritic flesh-pink felspars (averaging about ¾ in. in length) showing simple Carlsbad twinning. These phenocrysts are set in a medium grained matrix of white plagioclase felspar (often with the Albite twinning lamellae plainly visible), colourless quartz and fairly abundant biotite with some hornblende. The rock bears a decided resemblance to the famous Shap Granite (Westmorland) in appearance.

Under the microscope (1371*) the large phenocrysts are seen to be composed of microcline-microperthite. They enclose small grains of quartz and crystals of plagioclase. The ground mass in which these phenocrysts occur is essentially granular and composed of plagioclase felspar, microcline, quartz and biotite. Of these the plagioclase felspar is the most abundant, occurring considerably in excess of quartz and microcline. For the most part it is subhedral, but may also be present in grains. One or two of the crystals have been bent to a certain extent and a slight development of secondary twinning was found in these. In composition this plagioclase corresponds approximately to the formula $Ab_{67}An_{33}$, but some is probably more acid than this. It has been sericitised to a varying extent and includes biotite, other plagioclase grains and minute needles of rutile. Myrmekitic intergrowths with quartz are sometimes present at the edge of a grain or crystal.

Microcline occurs as grains and as irregular patches filling up the interstices between the other minerals. Quartz is also present as grains and as irregular areas between the other constituents. It is more abundant than microcline. Strain shadows are a constant feature. It would appear that there have been two periods of crystallisation for the microcline and quartz of the ground mass. The first, when they separated out as definite grains; the second, when they filled up the remaining space between the other constituents.

Biotite is fairly abundant in medium sized flakes which show a tendency to cluster together. It is strongly pleochroic in shades varying from medium straw colour to a dark " muddy " brown. It is decidedly biaxial with small optic angle. In places it is partly chloritised. It includes a very little zircon (with the usual pleochroic haloes). The hornblende seen in hand specimen was not present in the section. Accessories include apatite, zircon, rutile and a little magnetite. Of these the most abundant is apatite, the bulk of which occurs in association with the biotite. A small amount of secondary sphene is found as an alteration product of the biotite.

Another section (1370*) of the same rock showed that the microcline-microperthite and microcline were replaced by microperthite and orthoclase. The plagioclase was rather more abundant and there was a little antiperthite. A certain amount of green hornblende was associated with the biotite. A little sphene and zircon were present as accessories together with orthite.

In the third section (1378*) the phenocrysts are of microperthite, sometimes showing incipient cross-hatching. The alkali felspar of the ground mass includes microcline, microperthite and orthoclase. The most striking feature of this section is the relative abundance of an almost colourless sphene sometimes enclosing a core of ilmenite. It occurs in irregular grains, and it is interesting to note that it occurs in association with biotite rather than hornblende. In addition to the ilmenite there is a little magnetite present. Orthite in prismatic crystals is an accessory constituent.

(d) *Fine and Coarse Grained Granite with Inclusions.*

Two varieties of granite come under this heading, a fine grained variety and a coarse grained, almost pegmatitic, variety. Both carry inclusions of dark basic rock in places, but as the alteration of the inclusions has been different in each, it will be convenient to treat of them separately. So far as could be gathered from the material collected the coarse variety veins the fine.

(i) The fine grained variety and its inclusions—Nos. 1328,* 1329* and 1330* (all from the summit of Mt. Barr Smith). Where free from inclusions, this variety is a pink, fine grained granite of even texture and composed of pink felspar, colourless quartz and small black flakes of some ferro-magnesian mineral. In thin section it consists of a granular aggregate of microcline, a little orthoclase, a very little plagioclase ($Ab_{75}An_{25}$) and quartz (Fig. 3). The microcline is abundant and includes numerous grains of quartz. There are signs of crushing brought out by the fairly abundant quartz which shows strain shadows and the beginning of granulation. A little brown biotite and a little magnetite complete the section.

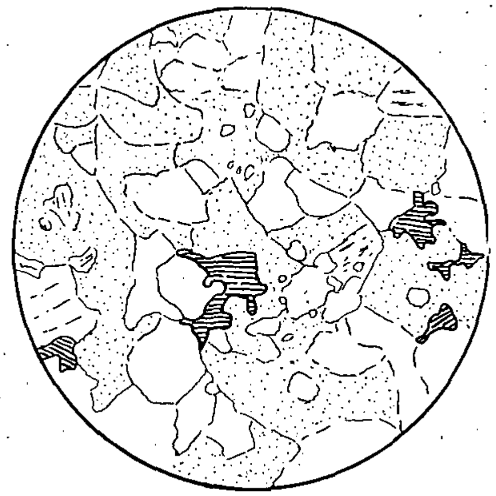

Fig. 3.

Biotite granite (1328) with biotite, quartz, some plagioclase and microcline (light stippling).

The inclusions are dark and aphanitic. In some instances they are rounded and much elongated, giving the rock a rather banded appearance. The least altered examples still retain a fine dolerite texture. The original lath shape of the felspars is still retained for the greater part and they have the composition of a basic andesine. The interstices between them are filled with granules of hypersthene which is rather feebly pleochroic, and flakes of strongly pleochroic brown biotite. A trace of green hornblende is also present. Towards the margin the grain size increases rapidly. The lath shape of the felspars is destroyed, quartz from the surrounding granite makes its appearance and the two rocks merge into one another (Fig. 4). This surrounding granite has lost much of its microcline, and is composed almost wholly of quartz, plagioclase, hypersthene (which may be partly altered to delessite) and biotite. Allanite has been found in this granite.

Other examples show inclusions in a more advanced stage of dissolution. In these the doleritic texture is lost, and the grain is much coarser. In addition, quartz replaces part of the felspar. The surrounding granite has the same composition as before, and the hypersthene and biotite become gradually less abundant as the distance from the inclusions increases. Both in the inclusions and in the surrounding granite, the plagioclase is a basic one, varying between basic andesine and acid labradorite.

In hand specimen the noticeable changes that are apparent in the granitic portions of the inclusion-bearing specimens when compared with the normal inclusion-free specimens are (*a*) the increase in the ferro-magnesian content, and (*b*) the gradual loss of the pink colour as the inclusions are more and more completely absorbed.

Fig. 4.

Junction of doleritic xenolith with fine grained granite (1330). On the left the xenolith is seen, composed of biotite, hypersthene and plagioclase. On the right the fine grained granite now composed of biotite, hypersthene, plagioclase and quartz.

This is a most interesting case of local contamination between an acid and a basic rock. Chemically the main change involved would appear to be a transference of potash to the inclusions with a reciprocal transference of lime to the granite. This has gone on until, in the end, both the inclusion and the granite surrounding it come to have the same mineral composition.

(ii) The coarse grained variety and its inclusions—Nos. 1342, 1343 (from the higher outcrop at Cape Gerlache), 1347,* 1348, 1349* (from top of Watson Bluff), and 1368,* 1369* (from the easternmost of the two Gillies Nunataks). In the coarse grained variety the inclusions, although probably of the same original nature as those in the fine grained variety, have undergone a very different type of alteration. The inclusions are, in the first place, of coarser grain.

In thin section a typical inclusion is seen to consist of abundant granular felspar poikilitically enclosed by equally abundant hornblende and a little biotite (Fig. 5). The felspar is, for the most part, untwinned or else shows only a shadowy Carlsbad twinning. There appears to be two varieties present. One has shadowy extinction, contains minute colourless, fusiform inclusions, has a refractive index less than Canada Balsam and is not very abundant. This is probably microperthite. The other has sharper extinction, a refractive index greater than Canada Balsam, is abundant and appears to be a basic oligoclase. Numerous needles and stout prisms of apatite are enclosed in these felspars and also a fair number of magnetite grains. The hornblende is present in large poikilitic plates surrounding and enclosing the felspar. It is strongly pleochroic with $X =$ pale yellow brown, $Y =$ dark brownish, $Z =$ deep brown green and with $Z \wedge c = 17°$. It encloses magnetite. Biotite, which is not abundant, is also poikilitic and has apparently replaced hornblende. It is strongly pleochroic from a pale straw colour to a deep chocolate brown.

Fig. 5.

Doleritic xenolith enclosed in coarse grained granite (1347) and composed of hornblende and plagioclase with minor amounts of microperthite. Notice the large poikilitic hornblendes and the abundant needles of apatite.

The granite surrounding these inclusions contains an abundance of ferro-magnesian material which has obviously been derived from their partial absorption. This granite has a tendency to assume a grain size intermediate between that of the inclusions and that of the normal granite.

Even in the normal granite, there is evidence that part at least, of the ferro-magnesian minerals has been derived from the complete incorporation of inclusion material. This normal type is a pale pink coarse grained rock, composed of abundant large simple twinned felspars of a flesh pink colour, with the addition of slightly smoky quartz and moderately abundant ferro-magnesian minerals which have a decidedly patchy distribution. Both biotite and hornblende are present.

In thin section the rock is found to be a coarse grained granite with large hypidio-morphic crystals of microcline-microperthite, a fair amount of quartz, subordinate plagioclase, biotite and hornblende (Fig. 6). The microcline-microperthite has abundant fusiform inclusions of albite. The plagioclase is a medium oligoclase. Quartz is fairly abundant in both large and small irregular grains and may show undulose extinction. Myrmekitic intergrowths between it and plagioclase occur but are not common. The ferromagnesian constituents include both hornblende and biotite, but they are not particularly abundant. In some parts of the section, biotite occurs alone but generally associated with abundant apatite in stout prisms and a little magnetite. In other parts, it is present associated with hornblende in large patches.

Both the hornblende and the biotite are exactly similar in their properties to that occurring in the inclusions. This similarity is enhanced by the fact that they are still poikilitic in habit, but surround and enclose quartz and felspar instead of felspar alone. Apatite is extremely abundant in the immediate vicinity of these patches and there is a fair quantity of magnetite. There can be little doubt that these patches represent the final remnants of inclusions similar to those just described.

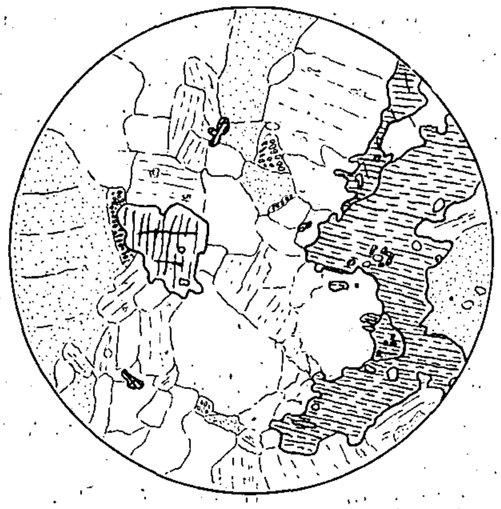

Fig. 6.

The coarse grained granite (1369) with a large flake of biotite, minor hornblende, plagioclase, quartz, microcline-microperthite (light stippling) and myrmekite.

As these two varieties of granite are so closely associated, it seems reasonable to assume that the basic rock (dolerite) which gave rise to the inclusions was the same for both granites. How then, may the different types of alteration be accounted for ?

In the fine grained variety hypersthene is developed in the inclusions and there is a complete absence of apatite. In the coarse grained variety hornblende is developed in the inclusions and apatite is abundant. The evidence in the fine grained variety points to a small content of volatiles, in the coarse grained variety it points to a large content. This, then, would account for the observed differences. In the comparatively " dry " variety, hypersthene developed rather than hornblende, the felspar did not change its composition to any great extent and the grain size is less than in the coarse grained variety. In the latter hornblende developed abundantly, the felspars of the inclusion became more acid and the grain size was much increased.

This has a rather interesting sequel. We have seen that in the comparatively " dry " variety, potash was transferred to the inclusions, but the felspars were not acidified by an influx of soda. Apparently it was only when larger amounts of volatiles were present that soda could enter the inclusion and render the felspars less basic. This is in accordance with the work of H. H. Read (Q.J.G.S. 1923, pp. 479–481) at Arnage. There, when dealing with sedimentary xenoliths in a basic magma, he found that potash had a greater tendency than soda to migrate from an acid xenolith to a basic magma. Whether the two cases are strictly comparable is, perhaps, open to doubt. But it is significant that the same facts should be observed in both cases; in the one case a basic rock included in an acid one, in the other, an acid xenolith included in a basic rock.

B. Pegmatites, Quartz, and Quartz-Tourmaline Rocks.

(a) *Pegmatites.*

Only one pegmatite is present in the collection. This is No. 1310 (from an outcrop on the coast between Delay Point and Cape Charcot), a fairly coarse grained pegmatite composed of large flesh coloured crystals of felspar, showing simple Carlsbad twinning, and irregular areas of pale smoky quartz. There is, in addition, a very little black mica.

(b) *Quartz Rocks.*

No. 1321 (from the outcrop of Watson Bluff). A medium grained, pale grey rock composed of granular quartz with a certain amount of chloritised biotite.

No. 1336 (from the eastern spur of Mt. Barr Smith). A white rock composed of milky quartz in large irregular grains embedded in a finer grained mosaic of the same material. Very subordinate biotite is present. This biotite gives an ill-defined foliation to the specimen which has probably been crushed.

(c) *Quartz-Tourmaline Rocks.*

No. 1337 (from the south-eastern spur of Mt. Barr Smith). A small fragment of granite. This is composed of white decomposed and slightly kaolinised felspar, with subordinate colourless quartz. A little black mica is present and there is a fair amount of tourmaline occurring as stout black prisms and as fine needles.

Nos. 1338, 1341 and 1340* (all from the south-eastern slopes of Mt. Barr Smith). These three are all of similar nature. They are composed of abundant quartz and tourmaline in graphic intergrowth, with subordinate felspar.

The section (Fig. 7) shows that the quartz occurs as grains having marked undulose extinction and much cracked. It may include minute crystals of tourmaline. The tourmaline is remarkable in being most opaque in thin section; only small patches within the crystals are translucent and it is also translucent at the margins. It is then of a deep blue or dirty blue-green colour. A few of the crystals are slightly pleochroic but the bulk do not show this feature. This is due to the fact that they are all orientated in the same direction and the section has cut through them almost parallel to their basal planes. This further shows that, in contrast to what was deduced from the hand specimen, the tourmaline is acting as host to the quartz, although the latter mineral is the more abundant of the two. Reddish iron staining is common just at the margin of the tourmalines. One small crystal embedded in quartz was pleochroic from pale bluish brown to opaque. These facts, together with its rather high refractive index, point to the tourmaline being somewhere near schorlite in composition.

Fig. 7.

Quartz-tourmaline rock (1340). The tourmaline has the same orientation throughout the figure and is so deeply colouted as to appear black except at the edges.

C. The Tonalitic Rocks.

One or two specimens in the collection are of tonalitic nature. These are dealt with here. No. 1300* (from outcrop at Delay Point) is a dark massive rock of medium grain, composed of abundant greenish felspar, subordinate quartz with hornblende and biotite.

Of the salic constituents, plagioclase felspar is the most abundant. There appear to be two plagioclases present. One (the more abundant) occurs in normal sized hypidiomorphic crystals and is an oligoclase. The other is present in smaller and less abundant grains and is an acid labradorite.

Quartz is present in some quantity, but hardly abundant enough to use term "granodiorite" for this rock. It is present as irregular grains, often filling up the interstices between the other constituents. It may show slight undulose extinction. Myrmekitic intergrowths between it and plagioclase occur but are not common. There is little orthoclase.

Both hornblende and biotite are abundant in close association with each other. The hornblende is a brownish-green variety, pleochroic in shades varying from pale brownish-green to a darker brownish-green. Lamellar twinning on (010) is common. It often encloses a core of fibrous actinolite in which small relics of a monoclinic pyroxene may occasionally be seen. The biotite is present in flakes intimately associated with the hornblende. It is strongly pleochroic from a pale straw colour to a deep reddish brown. Both the hornblende and biotite tend to be poikilitic and may enclose quartz and felspar either partially or wholly. Abundant magnetite is enclosed in or associated with the hornblende and biotite. There are also No. 1305* (from outcrop between Delay Point and Cape Charcot). A massive, dark, rather fine grained rock. Felspar, hornblende and biotite can be made out. One side of the specimen is coarser and there are moderate sized crystals of pinkish felspar and hornblende.

Under the microscope, the texture is seen to be granitic. The salic constituents make up rather less than half the rock. Of these by far the greater part is plagioclase felspar. It is a basic oligoclase. Orthoclase and quartz are both present, but in quite subordinate amounts.

The ferro-magnesian minerals are abundant and include both hornblende and biotite. They are present in roughly equal proportions, intimately associated and possess an ill-defined sieve structure, enclosing small grains of quartz and felspar. The hornblende is a green variety occurring in ragged plates and flakes, pleochroic from light yellow green to dark apple green and with $Z \wedge c = $ ca. 20°. The biotite plates are pleochroic from pale straw to deep brown. A little magnetite is present and there is an abundance of apatite in needles and stouter prisms. This abundance of apatite renders it highly probable that this rock is an inclusion in some other more acid rock.

No. 1386* (from the Hippo Nunatak). A dark medium grained rock of tonalitic aspect, with abundant greyish felspar, hornblende and biotite.

In thin section the texture is granitic (Fig. 8). Quartz is found to be present in irregular areas filling up the interstices between the other constituents. It is present in strictly subordinate amounts. Felspar is the most abundant constituent. The bulk of it is a somewhat basic andesine, but some oligoclase is also found.

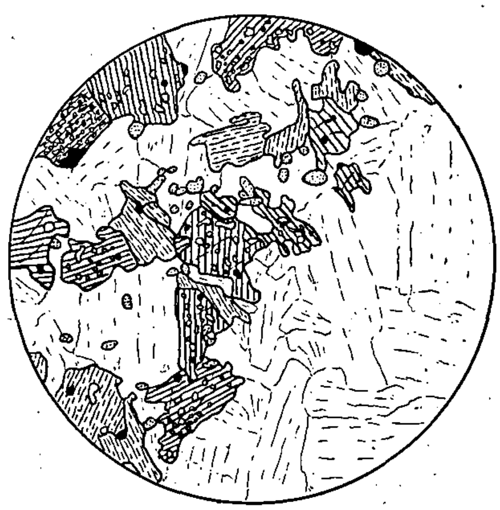

Fig. 8.

Tonalitic type (1386), probably a hybrid. The figure shows abundant hornblende, subordinate biotite, noticeable apatite and magnetite, plagioclase and a little quartz. Notice the sieve structure of the hornblende.

Biotite and hornblende are closely associated together and occur in about equal quantities. They tend to have a rather patchy distribution in the section. The biotite occurs in plates, pleochroic from a medium straw to an almost opaque muddy brown. The hornblende is a green variety and shows pleochroism from a pale yellow brown to a deep green. It encloses numerous small irregular areas of quartz, giving it an ill-defined sieve structure. Ilmenite, in moderate amount, is associated with the hornblende and biotite, as also are sphene and magnetite but in smaller quantities.

The striking feature of the hornblende-biotite aggregates is the large amount of apatite which is present in stout needles and grains. It is either abundantly enclosed in the hornblende, or, more commonly, the biotite, or else occurs in their immediate vicinity.

The rock might be termed a quartz-diorite, but the rather patchy distribution of the ferro-magnesian elements, their sieve structure and the abundance of apatite in their vicinity, all go to show that the hornblende and the biotite were probably largely derived from some foreign source, and that the rock is therefore a hybrid one.

D. The Trondhjemitic Type.

The specimen to be mentioned here is a rather abnormal type, which seems to be related to the trondhjemites.

No. 1379* (from the summit of Hippo Nunatak). A dark medium grained rock composed of felspar and biotite. A portion of the specimen is pegmatitic in character, with large brownish felspars and abundant plates of black mica.

In thin section the rock contains abundant felspar and biotite. The texture is granitic. Felspar is the most abundant constituent, all of it being plagioclase. It appears to be a medium oligoclase. Biotite is almost as abundant, in irregular laminae and flakes which occasionally are slightly bent. It is strongly pleochroic from medium straw to an almost opaque, muddy brown. Associated with the biotite, there is a good deal of apatite in large grains, and one or two very small ragged flakes of a green hornblende. In addition, a few small grains of sphene are present.

E. The Charnockite Series.

Under this heading a group of rocks is described which all have a family resemblance in hand specimen, whether acid, basic or ultrabasic, and which can compare fairly closely with the Charnockite Series of India as described by Sir T. Holland (Mem. Geol. Sur. India, vol. 28, pp. 119–249).

No. 1389* (from the outcrop at Avalanche Cliff). A massive, rather fine grained and finely banded, brownish rock, with smoky quartz, pale brown felspar and some black ferro-magnesian material (apparently largely biotite).

Under the microscope the rock has a granular appearance with long "ribbon" quartzes (unstrained) elongated in the direction of banding (Fig. 9). Quartz is also abundant in grains. Of the felspar, plagioclase is perhaps rather more abundant than the alkali felspar, which is orthoclase with a strong tendency to become microperthite. The plagioclase is an acid oligoclase. Both include small grains of quartz.

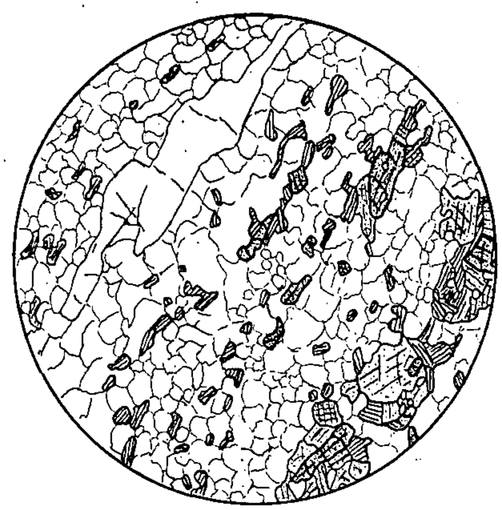

Fig. 9.

Acid charnockite (1389) showing hypersthene, biotite and minor diopsidic pyroxene in a fine matrix of quartz, orthoclase and plagioclase. Notice the long "ribbon" quartz grain elongated in the direction of banding.

Biotite is the most abundant ferro-magnesian constituent, occurring in small flakes which are strongly pleochroic from a medium straw to an almost opaque brown. These flakes have a tendency to lie parallel, thus giving the banded appearance noticed in hand specimen. Almost as abundant is a pale green faintly pleochroic diopsidic pyroxene in irregular grains and usually associated with the biotite and hypersthene. This latter mineral is only present in subordinate amount in small prisms and grains. It is faintly pleochroic in pinks and greens. Often it is partially altered to the green chloritic substance called by Holland (op. cit. p. 141) delessite. A little apatite and zircon are present as accessories.

No. 1390* (from the outcrop at Avalanche Cliff). This is very similar in hand specimen, but the banding is not so well displayed. In thin section it is similar to the above. The ferro-magnesian minerals are not so abundant, however, and, in general, it appears to be a slightly more acid type. In this instance the microperthitic-orthoclase is rather more abundant than the plagioclase. There is a certain amount of biotite in small flakes with a little associated hypersthene, usually partly altered. Diopsidic pyroxene, noticed in the specimen above, is absent.

No. 1391* (from the outcrop at Avalanche Cliff). This is similar in hand specimen and in thin section to No. 1390 except that the hypersthene is rather more altered.

No. 1392* (erratic from the moraine line from Avalanche Cliff). This specimen is more massive, rather coarser in grain and darker in colour. Otherwise similar to the above. In thin section it is also similar, but rather richer in biotite, hypersthene (here completely altered to delessite) and apatite.

No. 1313* (from the outcrop at Cape Charcot). This rock is lighter in colour than the others, and shows an ill-defined banding. As far as the salic minerals are concerned, there is little difference between this and the other sections (Plate III, Fig. 1). Quartz and orthoclase are, perhaps, a little less abundant. Biotite is absent, and the ferro-magnesian constituents are a certain amount of pale diopsidic pyroxene and a little faintly pleochroic hypersthene. A little magnetite and apatite occur as accessories.

Three other specimens are present in this collection, namely, Nos. 1316 (from Cape Charcot) and 1374 and 1375 (from the southern portion of the Hippo Nunatak). These have not been sliced, but Nos. 1375 and 1316 resemble 1313 mentioned above, whilst 1374 is like 1391.

So far we have dealt with the more acid members of the series, but there are also a number of more basic varieties. These will now be described.

Nos. 1315,* 1317* (both from Cape Charcot). These are massive rocks of rather fine grain and similar in general appearance to all the others, but almost black in colour. They contain the usual brownish felspar and abundant dark minerals, the bulk of which would appear to be hornblende.

In thin section the rock is seen to be a granular aggregate of felspar and hornblende with a subordinate amount of pyroxene (Plate III, Fig. 2). Hornblende is the most abundant constituent. It is a greenish brown variety, strongly pleochroic from a pale yellow brown to a dark brownish green. The felspar is almost as abundant as the hornblende in 1315, and rather more abundant than in 1317. By far the greater part of it is an acid labradorite. A certain amount of the felspar is untwinned, has a lower refractive index and is a microperthitic orthoclase. The pyroxene is present in subordinate but moderate amounts. Most of it is the usual pale green diopsidic variety, but some moderately pleochroic hypersthene is also present.

No. 1373* (from the southern portion of the Hippo Nunatak). Dark and massive in hand specimen, and very similar to the others above.

The similarity in the hand specimen is not continued in thin section. The texture is still granular but an almost colourless monoclinic pyroxene is now the most abundant constituent. Slightly less abundant are hypersthene (sometimes altering to delessite along cleavage planes and cracks) and flakes of a rich red-brown biotite. One grain of hypersthene showed lamellar twinning. This is interesting as twinning in hypersthene is rare. The twinning is, as far as could be ascertained, the normal one for this mineral, namely on (101). There is a certain amount of felspar present which includes both oligoclase and microperthitic orthoclase. A little ilmenite, apatite and zircon are present as accessories. In addition, there is a small amount of greenish brown hornblende which occurs as an alteration product of the monoclinic pyroxene.

No. 1376* (from the northern portion of the Hippo Nunatak). This is darker and rather finer grained in hand specimen.

Under the microscope the rock is found to be a granular aggregate of pyroxenes and hornblende with subordinate biotite (Plate III, Fig. 3). Pyroxene is the most abundant constituent. It includes an almost colourless monoclinic variety, which is the more frequent of the two, and a faintly pleochroic hypersthene. The pyroxene occurs in smaller grains than the hornblende, which is a greenish brown variety, strongly pleochroic from a pale straw colour to a deep greenish brown. Biotite, of a rich red brown colour and strongly pleochroic, is a subordinate constituent. A little ilmenite is present. There is no felspar.

No. 1314* (from Cape Charcot). This bears a family resemblance to all the above, but is very dark in colour, massive and fine grained.

In thin section the rock is found to consist almost wholly of a colourless monoclinic pyroxene with quite subordinate green-brown hornblende. This hornblende is pleochroic from a pale green brown to a darker green brown. The texture is granular. No hypersthene, biotite or felspar were present, but it is always possible that the section was not typical of the rock as a whole. In any case, there is no doubt that the rock belongs to this series.

We have here a set of rocks, acid, basic and ultrabasic, which all show a family resemblance both in hand specimen and thin section. The series, as a whole, shows abundant resemblances to the Charnockite Series of India with one or two minor differences. The resemblances include the uniformity of appearance in hand specimen, the granular texture, the acid labradorite in basic types, the pale green or almost colourless monoclinic pyroxene, the brown-green highly pleochroic hornblende, the fact that zircon and apatite are nearly always present in small quantities and the complete absence of sphene. The differences are minor ones, such as the absence of microcline, the absence of acicular inclusions in the quartz and the absence of myrmekitic intergrowths between quartz and felspar.

Although all the specimens described above resemble the typical series in that they show no signs of crushing, yet there is one specimen in the collection, namely No. 1332* (from the summit of Mt. Barr Smith) which does show definite crushing effects.

In hand specimen this resembles the more acid members of the above. In thin section the granular texture is not quite so well developed as usual and there is little plagioclase felspar. Otherwise it is similar to the more acid varieties. The quartz is much strained, however, and granulated in parts. A certain proportion of the microperthitic orthoclase is replaced by microcline and myrmekitic intergrowths are not uncommon. In addition, some of the biotite forms synantectic intergrowths with quartz. An interesting feature is the occurrence of an irregular clot of small plagioclase grains and ilmenite. The plagioclase is a basic labradorite.

Finally, there is a specimen which probably belongs here, and which shows a well-defined schistosity in hand specimen. It is of basic character.

No. 1326* (from the summit of Mt. Barr Smith). Under the microscope this specimen is seen to be an aggregate of pyroxene, biotite, and felspar, all of which are much elongated in the direction of schistosity (Plate III, Fig. 4). The pyroxene includes both a colourless monoclinic variety, and faintly pink hypersthene. Owing to the feeble colour of the latter, it is rather difficult to judge the relative proportions, but there is little doubt that the hypersthene is the more abundant of the two. Together the pyroxenes form over 50 per cent. of the rock.

The bulk of the rest is made up of felspar which is a plagioclase twinned on the pericline and, more rarely, on the albite law. Occasionally it shows only a shadowy twinning. An interesting point is that, owing to the large development of pericline twinning the direction of greatest elongation of the felspar grains is usually almost at right angles to the twin lamellae. It is an acid labradorite ($N = 1{\cdot}665$).

The only other constituent is biotite, occurring in moderate amount, and pleochroic from a pale straw to a medium red-brown. It is associated with the pyroxene.

F. Other Hypersthene-bearing Rocks.

Here are placed several specimens, which, although apparently not belonging to the Charnockite Series or to the contaminated rocks discussed under the granites, all carry hypersthene in varying quantities.

Nos. 1345* (from the base of Watson Bluff) and 1357,* 1358* (from the rock outcrop towards the northern end of the eastern fall of David Island). All very much alike microscopically, being medium grained, dark, gabbro-like rocks and showing pale brownish felspar and dark minerals which include biotite and pyroxene.

No. 1357.* This rock is of granitic texture, and holds plagioclase, orthoclase, quartz, biotite, hypersthene and a colourless monoclinic pyroxene.

Plagioclase is the most abundant constituent. The bulk is an andesine, but there is also a subordinate amount of an acid oligoclase. Myrmekitic intergrowths between plagioclase and quartz are not uncommon. Orthoclase and quartz (sometimes showing undulose extinction) are present in minor, but quite appreciable quantities. The orthoclase often has numerous minute fusiform inclusions of a colourless mineral of higher refractive index.

The ferromagnesian minerals are present in some quantity, biotite and pyroxenes occurring in about equal amount. Individually, biotite is the most abundant in ragged flakes associated with the pyroxenes. It is strongly pleochroic from a medium straw to a deep chocolate-brown. Of the two pyroxenes, hypersthene is dominant. It is only feebly pleochroic and may be partially altered to delessite. It sometimes shows the characteristic schiller structure. The monoclinic pyroxene is a very pale green variety and is occasionally intergrown with the hypersthene. It is quite subordinate in amount. A fair amount of ilmenite, some apatite and a very little rutile are present as accessories.

No. 1358* is very similar in general character to the last. The dark minerals are more abundant, however, and the dominant one is now hypersthene instead of biotite. The plagioclase has the same composition as before, but includes numerous very minute rod of some iron ore and granules of the pale monoclinic pyroxene. Apatite is more abundant than before but orthoclase, and more especially quartz, are rather less abundant.

No. 1345* is similar to the last but slightly more basic and with less biotite. The plagioclase is an acid labradorite enclosing fusiform bodies of a lower refractive index. These may, perhaps, be quartz. Apart from this, both quartz and orthoclase have disappeared. Of those three rocks, the last might be called a norite, whilst the first two appear to be hybrids.

The next three rocks were all collected from the same locality and have a similar appearance. They are dark fine grained rocks composed entirely of ferromagnesian minerals with a very little felspar. No. 1354 has a well defined schistose appearance, the other two are massive.

No. 1356* (from the middle of the eastern half of David Island). The section shows large crystals of hypersthene in a matrix of brown hornblende, small granules of almost colourless pyroxene and a little deep fox-red biotite.

The hypersthene shows large prismatic crystals, partially altered to the brown hornblende and only faintly pleochroic. These crystals have the appearance of relic crystals.

The hornblende is abundant in grains and small prisms. It is strongly pleochroic from a very pale brown to a bright medium brown with $Z \wedge c = 25°$. The granular pyroxene is also abundant. It is an almost colourless monoclinic variety. A little granular hypersthene is associated with it. The biotite is present in small flakes strongly pleochroic from almost colourless to a deep fox-red. Finally, there are a few grains of plagioclase felspar, apparently labradorite.

No. 1355* (from middle of the eastern half of David Island). Similar to the last, but the large hypersthene crystals are less abundant.

The hornblende is still present in abundance, but its colour has now a more greenish tinge, and it is pleochroic from a pale brown to a dark greenish brown. Granular hypersthene is more abundantly associated with the monoclinic pyroxene and biotite is more abundant.

No. 1354* (from middle of the eastern half of David Island). Hornblende is still abundant but with a lighter colour. Biotite is present in greater quantity and no large crystals of hypersthene are present. It is possible that these three rocks are metamorphosed ultra-basic members of the Charnockite series.

Finally there is a specimen which stands by itself. This is a rather fine grained rock showing abundant hornblende and biotite with very subordinate felspar.

No. 1312* (from outcrop on the coast between Delay Point and Cape Charcot). The section shows abundant hornblende in crystals which are pleochroic from a pale yellow green to a dark apple green. Biotite is the next most important constituent. in flakes which are pleochroic from almost colourless to dark brown. Subordinate pyroxene is associated with the hornblende and biotite. The bulk of this is a feebly pleochroic hypersthene but a little of it is apparently monoclinic. A very little felspar is present, both in twinned and untwinned grains.

III. THE METAMORPHOSED IGNEOUS ROCKS.

A. Acid Igneous Gneisses.

These are all fine grained granitic rocks with a more or less well defined foliation. They may be divided into four distinct groups which differ noticeably in appearance in hand specimen.

(*a*) Group, Nos. 1319*, 1320, 1322 (all from Cape Gerlache). In hand specimen these are brownish rocks, showing elongated smoky quartz grains and abundant pale brownish felspar. One specimen, No. 1320, contains a certain amount of biotite in small flakes, which has apparently been chloritised.

In thin section the rock shows relics of large crystals of microperthite and large quartz grains showing pronounced undulose extinction and much elongated in the direction of foliation. These are set in a granular groundmass of microperthite, microcline and quartz (only slightly strained) with subordinate plagioclase felspar which has the composition of an acid oligoclase. Myrmekitic intergrowths of quartz with plagioclase are fairly common. A little magnetite and a very little zircon are present as accessories, and a little orthite was noticed.

(*b*) Group, Nos. 1334, 1335* (both from eastern spur of Mt. Barr Smith). These are banded, fine grained grey rocks with bands of white felspar and colourless quartz alternating with thinner and darker bands composed of quartz, felspar, black mica and muscovite.

The texture, as seen under the microscope, is granular (Fig. 10). Quartz (mostly unstrained) and microcline are both abundant and make up the bulk of the rock. Subordinate orthoclase and a little oligoclase are also present, however. The biotite and muscovite are fairly abundant. The banding noticed in the hand specimen is not so conspicuous in the slide. All the same, the biotite and muscovite flakes tend to lie parallel to each other and to occur in bands which give the section a definite foliated appearance. The biotite is pleochroic in shades from a medium straw to a dark muddy brown. On the whole, it is more abundant than the muscovite with which it is often intergrown. Occasionally, along the cleavage planes of the muscovite there are small granules of a mineral which appears to be ill-developed sphene. This suggests the possibility that some of the muscovite may have been derived from biotite, a feature that is not unknown (see, for instance, D. R. Grantham, "Petrology of the Shap Granite," Proc. Geol. Assoc., London, vol. XXXIX, 1926, p. 307).

Fig. 10.

Acid Igneous Gneiss (1335) with muscovite, biotite, quartz and microcline (light stippling).

(*c*) Group, Nos. 1306 (from outcrop on the coast between Delay Point and Cape Charcot), 1323, 1325* (*in situ*, from Possession Nunatak), and 1350, 1351, 1352* (from outcrops at south end of eastern fall of David Island). All the pink granitic gneisses have been placed in this group. No. 1325* differs rather from the others and will be described separately.

In hand specimen these are pink, fine grained rocks composed essentially of pink felspar, quartz and biotite, the latter occurring in irregular wisps which give these rocks their foliated appearance.

A thin section shows these rocks to be granular in texture. There is a good deal of irregular variation in grain size, however. Quartz is the most abundant constituent in moderate sized grains which are elongated in the direction of foliation and also in smaller and more regular grains. They show undulose extinction and are cracked in places. Sometimes roughly parallel bands of dusty inclusions are present.

Felspar is also abundant and granular in habit. The bulk is of orthoclase though there is also a certain amount of cryptoperthite and faintly twinned plagioclase (oligoclase). Some of the orthoclase shows incipient cross-hatching and one or two definite grains of microcline are present. The biotite, which is moderate in amount, is present in small flakes strongly pleochroic from a medium straw colour to an opaque muddy brown. The flakes tend to lie parallel and thus account for the foliation produced in the rock. Apatite, magnetite and zircon occur as accessories, but are not abundant.

No. 1325*—in hand specimen a well banded, fine grained gneiss, with alternating pink and black bands. The pink bands are formed of felspar and quartz, the black bands appear to be largely of biotite with subordinate quartz.

In thin section the rock shows an alteration of bands composed largely of biotite with subordinate hornblende felspar and quartz, with wider bands composed essentially of quartz and felspar. Quartz is present as large irregular grains and as smaller grains. All show undulose extinction, but the larger grains give more indication of it and have often been partially granulated. The felspars include both orthoclase and plagioclase. A few large crystals of both remain with their outlines partially destroyed, but the bulk is granular. Plagioclase is rather more abundant than orthoclase and has the composition of an acid oligoclase. Biotite, strongly pleochroic from medium straw to dark muddy brown, is abundant in flakes forming sinuous bands which cross the slide. It is accompanied by a little green hornblende from which it seems to have been derived. A little apatite and zircon are present as accessories.

(*d*) Group, Nos. 1363,* 1364* (both from Alligator Nunatak). These are black and white banded gneisses. The white bands are composed of quartz and felspar, the dark bands largely of biotite. In No. 1363 there are occasional augen of pink garnet.

Under the microscope (No. 1363*), the bands lose much of their distinctness, but the biotite tends to cluster along bands which mark out a rude foliation. A feature of this rock is its fresh-looking appearance and absence of signs of crushing. It has probably been almost completely recrystallised. One or two large grains of quartz are present and these have been elongated in the direction of foliation and are much strained. The bulk of the quartz is granular, shows no sign of strain and is abundant though not so abundant as plagioclase. Myrmekitic intergrowths with plagioclase are common in parts. Of the felspar the bulk is plagioclase (andesine), but orthoclase is present in some quantity. Both varieties occur in grains often enclosing quartz. They are fresh except in the vicinity of chloritised biotite, when they have been sericitised. Brown biotite is present in some abundance and usually has a very fresh appearance. In one or two places it has been chloritised (with development of secondary sphene) and the felspars round it have been sericitised. With it is associated a little colourless monoclinic pyroxene in small irregular grains and sometimes altered to a green hornblende. In one instance, it was found that a small grain of monoclinic pyroxene had a core of colourless orthorhombic pyroxene. A fair amount of apatite, a little zircon and magnetite are present as accessories. The garnet noticed in the hand specimen was not present in the slide.

No. 1364* is similar to the above, but coarser in grain. The felspars have been badly sericitised, but orthoclase seems to be rather more abundant, and the plagioclase to be more acid. Pyroxene is not present, but the green hornblende is more abundant than in the preceding example.

Taking these gneisses as a whole, cataclistic structures are not at all common. In all probability they have been largely recrystallised under regional conditions and at considerable depth.

B. The Metamorphosed Dolerites.

One or two specimens in the collection are dark, massive, aphanitic rocks, which were originally of doleritic type: these will now be described.

No. 1301* (from Delay Point). This shows abundance of biotite and a well defined schistosity in hand specimen.

In thin section the rock contains an abundance of strongly pleochroic small biotite flakes which lie roughly parallel to each other and thus produce the schistosity noticed in hand specimen. The flakes are pleochroic from a pale straw to an almost opaque muddy brown. Subordinate granular pyroxene is associated with the biotite. It is a pale green monoclinic variety. The remainder of the section is composed of grains of felspar. Some is twinned on the Albite law, but the bulk is untwinned. It all appears to be plagioclase and the maximum extinction angle obtained on symmetrical albite lamellae was 16° indicating that the felspar is, at least, as basic as andesine. The felspar encloses numerous small needles of apatite.

The abundance of biotite and apatite point to the rock being a product of thermal metamorphism, and it is probably an inclusion.

No. 1308* (from outcrops on coast between Delay Point and Cape Charcot). A massive, black, fine grained rock in hand specimen.

In thin section it is found to be a granular aggregate of hornblende, biotite, magnetite and felspar. It is a good deal coarser in grain than the last specimen. Felspar is the most abundant constituent in colourless grains, the bulk of which are twinned on the Albite law. In composition it is an andesine. The felspar grains hold numerous inclusions of apatite with smaller quantities of rutile and zircon. The hornblende and biotite are present in intimate association and in roughly equal proportions. The hornblende is green in colour, strongly pleochroic from pale yellow green to deep green, and with $Z \wedge c = 21°$. The biotite flakes show a slight tendency to lie parallel and are pleochroic from a pale straw to a deep brown. Magnetite, in irregular grains of all sizes, is also an abundant component, being almost as common as the hornblende or biotite.

There can be little doubt that this, also, is a thermally metamorphosed rock, and the abundance of apatite points to its being an inclusion in the same manner as 1301.

No. 1327* (*in situ*, at the summit of Mt. Barr Smith). Black massive aphanitic rock in hand specimen.

Under the microscope, the original fine grained doleritic texture is still easily recognisable from the occurrence of the lath-shaped felspars. These laths are of basic labradorite. The original augite has now completely changed to an aggregate of dull green moderately pleochroic hornblende grains with subordinate granules of a colourless monoclinic pyroxene. There are also a certain number of hypersthene granules which are only faintly pleochroic. A little magnetite is also present.

This, again, is a thermally metamorphosed very fine grained dolerite.

No. 1333* (*in situ*, from the summit of Mt. Barr Smith). In hand specimen, this is a black, massive, aphanitic rock. In thin section it was found to have a quite well developed schistose structure, which was not noticeable in hand specimen.

A few original lath-shaped felspars are left, but the bulk is now granular. The rare laths are sometimes bent. Most of the felspar is untwinned and is labradorite. Sometimes the felspars include minute flakes of biotite. The felspars make up perhaps rather less than 50 per cent. of the rock, and the rest is composed of ferromagnesian minerals. Of these, hornblende is by far the most abundant. It is pleochroic in shades of green varying from light yellow green to medium yellow green. It is the tendency of the ill developed prisms and grains to lie parallel, that gives the schistose appearance in thin section. Magnetite occurs in association with it. Quite subordinate amounts of a pale brown biotite in small flakes and a granular colourless monoclinic pyroxene accompany the hornblende. In places, these three minerals tend to segregate into small areas which have a coarser grain than the remainder of the rock. It would appear that the stress element was also operating during the recrystallisation of this rock and thus it is probably a product of regional rather than pure thermal metamorphism.

The next three rocks all come from the same locality and show stages in the impregnation of doleritic material by a more acid magma.

No. 1385* (from the summit of the Hippo Nunatak). A dark, massive aphanitic rock in hand specimen.

In thin section the primary fine grained doleritic texture is still easily visible, although in parts the texture is now granoblastic (Plate III, Fig. 5). Felspar is the most abundant constituent. It occurs, for the greater part, with its original lath-shaped outlines, which are usually scalloped along their edges. One or two relics of phenocrysts occur. A fair amount of the felspar is now granular. The felspar laths are of labradorite, the grains are rather more acid and are of andesine. Both grains and laths, but more especially the latter, have many minute dusty inclusions and globules of biotite enclosed in them. In places, needles of apatite are included. Hornblende is abundant in irregular grains and prisms. It is pleochroic in shades varying from pale yellow green to deep green with $Z \wedge c = 21°$. Biotite is subordinate to hornblende in flakes which are strongly pleochroic from a pale straw to a deep brown. Finally, a certain amount of magnetite is present.

No. 1381* (from the summit of the Hippo Nunatak). A dark, rather fine grained schistose rock. An abundance of biotite and felspar with some quartz can be made out.

Under the microscope the rock is seen to contain abundant biotite and hornblende with felspar and some quartz. The quartz and felspar together about equal the biotite and hornblende in quantity. The bulk of the felspar is andesine showing Albite twinning and occurring in grains. One or two porphyritic crystals are present. There also appears to be a certain amount of oligoclase. Quartz is present in moderate abundance as small unstrained grains. There is a rather coarser band which crosses the slide and in which biotite and hornblende are not so abundant. It is composed mainly of a quartz and a plagioclase which appears to be oligoclase. Both the felspars and the quartz include many minute colourless needles in places. These are taken to be apatite. Both biotite and hornblende are abundant. The biotite flakes are strongly pleochroic from medium straw to an almost opaque brown, and give a pronounced schistosity to the section. The hornblende is a green variety strongly pleochroic from a pale yellow brown to deep green. It is closely associated with the biotite in small irregular crystals and grains. A certain amount of granular sphene is present, sometimes with an ilmenite core.

The rock, as a whole, gives the impression of being a metamorphosed dolerite similar to No. 1385, which has been injected with granitic material. Further support for this view is given by No. 1380* (from the summit of the Hippo Nunatak). In hand specimen this shows a block of material similar to No. 1381, embedded in a pink, medium grained, rather highly biotitic granite which has been injected into it in places. A vein of pink, slightly coarser granite which is almost completely biotite free, traverses both the biotitic granite and its included block.

In thin section the texture of the biotitic granite is essentially granular and the rock is composed of quartz, plagioclase felspar and biotite with a smaller amount of microcline. The quartz is abundant in grains of varying size which all show undulose extinction. The plagioclase, a basic oligoclase, is about as abundant as quartz. In one or two places it contains small colourless inclusions, almost rectangular in shape and of lower refractive index, which may be orthoclase or quartz. Both quartz and felspar include abundant minute needles of apatite. The plagioclase has been sericitised to a certain extent. Microcline is present in some quantity but is not so abundant as plagioclase. The biotite is present in flakes which have the same characteristics as those in No. 1381. No hornblende is present but there is some almost colourless sphene. In addition to the apatite needles noted above, a few stout grains of the mineral also occur. Orthite is present as an accessory constituent.

The vein of slightly coarser granite which traverses the biotitic granite and the included block, is composed of abundant microcline, less abundant quartz showing undulose extinction, and quite subordinate plagioclase which appears to be an acid oligoclase. All the felspars are sericitised to a certain extent, and myrmekitic intergrowths between quartz and plagioclase are not uncommon.

It looks very much as if the biotitic granite had originally much the same composition as the granite which veins it, and as if most of its biotite and plagioclase had been derived from inclusions similar in nature to No. 1381. Unfortunately there is not enough material either to prove or disprove this conclusion.

C. Garnet Amphibolite.

No. 1324* (*in situ*, from Possession Nunatak). A dark, massive, rather coarse grained rock composed essentially of pink garnet and brown green hornblende. The pink garnet occurs in irregular much cracked grains. As usual, it has numerous inclusions which include small grains of quartz, felspar, hornblende, pale green pyroxene, ilmenite and magnetite. It is an almandine garnet. The hornblende is abundant in grains and irregular prisms. It is a brown green variety, having X = light yellow green, Y = dark greenish brown, Z = dark green and with $Z \wedge c = 21°$. Closely associated with the hornblende but occurring in subordinate amount is a pale green, slightly pleochroic, diopsidic pyroxene with $Z \wedge c = 42°$. Sometimes it can be found altering into hornblende. A fair amount of ilmenite, a little magnetite, quartz and a basic plagioclase are also present.

The vein which traverses the specimen, is composed of quartz in interlocking grains which show signs of strain, and partial crushing. It is obviously of later date than the main body of the rock and contains a small quantity of hornblende, diopside, ilmenite and garnet which it has carried along with it.

The rock may be termed a garnet amphibolite, derived from a basic igneous rock. The lack of plagioclase can be accounted for by supposing the original pyroxene and plagioclase to have reacted to form garnet. This is the normal course of events in those garnet amphibolites, which, with a higher grade of metamorphism, would become eclogites.

D. The Chlorite-Epidote-Albite Rocks.

Under this heading are included a set of rocks characterised by the formation of secondary albite, epidote, chlorite and sphene. The first five specimens were originally of granitic nature. Nos. 1383 and 1378 (both from the summit of the Hippo Nunatak) have been derived from material of gabbroic composition, and No. 1384 (from the summit of the Hippo Nunatak) probably from a granodiorite. It is interesting to note that rocks of granodioritic and doleritic nature were obtained from locality 26, and thus were probably in association with the specimens noticed above.

No. 1360* (from the outcrop on the northern end of David Island). In hand specimen this is a pink, coarse grained granitic rock with pink felspar, subordinate colourless quartz and a little chlorite and epidote.

The section shows abundant signs of severe crushing. The quartz which is present in large grains, is badly strained and granulated at its margins. Felspar is the most abundant constituent, the bulk of it being microperthite, but oligoclase is present in subordinate amount. It is sericitised and granulated in places and takes part in abundant myrmekitic intergrowths with quartz. Epidote, chlorite and secondary brown sphene occur associated together. The chlorite is pleochroic from pale to bright green and gives ultra-blue interference colours. The epidote is slightly pleochroic from pale yellowish to a darker yellow. These two minerals and the sphene accompanying them occur in thin veins traversing the quartz and the felspars. It is particularly noticeable that they follow the lines of crush which traverse the section.

No. 1367 (from the Alligator Nunatak) is a small fragment rather similar to the above but much richer in epidote and very poor in chlorite. It shows pink sericitised felspar and abundant milky quartz. Bands of yellow green epidote vein this last mineral.

Nos. 1359 (from the north end of David Island) and 1365, 1366* (both from the Alligator Nunatak). These are all very similar in hand specimen. They are medium grained rocks, composed of a white opaque felspar, colourless quartz and subordinate green chlorite with associated epidote, occurring in veins. In two of the specimens (Nos. 1365 and 1366) the veins tend to run parallel, giving the rock a banded appearance.

In thin section the rocks are composed, for the most part, of large irregular grains of quartz and smaller hypidiomorphic crystals of plagioclase. The quartz shows strain shadows and, along lines of crush and at the margins of the grain, it has often been granulated. The larger grains are usually cracked. The plagioclase is an oligoclase. It is slightly sericitised and also contains a considerable number of minute dusty inclusions, the nature of which could not be determined even under the $\frac{1}{8}$ in. objective. This oligoclase has been albitised to a varying extent. The secondary albite occurs as irregular patches within the crystals, and has an enormous number of the dusty inclusions noticed above, rendering it almost completely turbid. The plagioclase has also been granulated in places, and sometimes a crystal has been broken and injected by a mosaic of granular quartz.

As noted above, the chlorite tends to occur in definite bands. These are also lines of greatest crush. This chlorite is pleochroic from a pale yellow-green to a light apple green, with ultra-blue and brown interference colours. It appears to have positive elongation but, unfortunately, no interference figure could be obtained. It is probably a negative penninite. A fair proportion is vermicular in habit. Epidote is associated with, but not so abundant as, the chlorite in prisms and small grains. It is almost colourless. A certain amount of clinozoisite also occurs with it. Accompanying both the chlorite and the epidote there is a moderate amount of pale brown sphene, occurring for the most part in irregular grains. There are also one or two small grains of apatite.

No. 1383* (from the summit of the Hippo Nunatak). In hand specimen a fairly coarse aggregate of pale pink albite, yellow-green epidote and dull green chlorite. There is a decided banding of the constituents, layers rich in albite and epidote alternating with ones rich in albite and chlorite.

The section has been cut from an epidote-rich band and shows abundant elongated crystals and grains of epidote (Fig. 11). The crystals are elongated parallel to *b* and often show good (001) cleavage. Other crystals have a distinct (100) cleavage and, in some instances, there is a parting which would appear to be parallel to (010). The distribution of colour in the crystals and grains is very irregular, but for the most part they are only faintly pleochroic. There is a certain amount of clinozoisite present which may show the striations parallel to *b*. It also gives a positive interference figure.

Fig. 11.

Chlorite-Epidote-Albite rock (1383). The section has been cut from an epidote rich band and shows abundant epidote in crystals and grains, a little sphene, a little quartz, a very little chlorite and turbid crystals of albite (interrupted shading in the figure).

Large grains of albite partially enclose the epidote. They show patchy twinning and extinction and are, no doubt, of secondary origin. The grains include abundant minute elongated dusty rods (possibly of some iron ore) which gives the albite a pronounced schiller structure. A little secondary brown sphene and a little dull green chlorite complete the section.

No. 1384* (from the summit of the Hippo Nunatak). This is darker than the foregoing and with less epidote, but with fairly abundant biotite and smoky quartz.

Under the microscope abundant partially chloritised biotite is seen, associated with epidote and secondary sphene. The chlorite is a moderately pleochroic penninite. More rarely ilmenite, with a border of secondary sphene, occurs in association with the biotite. Equally abundant is the albite which is slightly sericitised and sometimes associated with epidote and calcite. It is present in irregular grains. A moderate amount of slightly strained quartz is present, filling up the interstices between the other constituents, and there is also a fair amount of apatite.

No. 1387* (from the summit of the Hippo Nunatak). The rock has a banded appearance, due to the alteration of layers composed mainly of pink albite and very subordinate smoky quartz, with layers composed largely of dull green chlorite and yellow-green epidote.

In thin section the chlorite-epidote band contains abundant chlorite, occasionally with a biotite core. The chlorite is a penninite and quite a large amount of it is vermicular in habit. Abundant pale coloured epidote and a minor amount of colourless clinozoisite, in prisms and grains are associated with the chlorite. Ilmenite is present, surrounded by a border of secondary sphene and there is a certain amount of independent brown sphene. Apatite is rather abundant in stout prisms and, finally, a few grains of albite occur. Adjoining this is a band composed of large interlocking grains of albite with the patchy twinning and schiller structure noticed above, with very subordinate quantities of apatite, sphene and epidote.

Although some of these specimens show marked signs of crushing, it would not appear that shearing alone has been responsible for the changes which they have undergone. The fact that in two of the most altered specimens vermicular chlorite is found, points to the conclusion that solutions must also have been active, as the chlorite was almost certainly deposited in the colloidal form.

IV. METAMORPHOSED SEDIMENTS.

Only one example of a metamorphosed sediment was found in the collection. This is No. 1339* (from the south-eastern slope of Mt. Barr Smith). Medium grained, grey rock in hand specimen, composed essentially of slightly smoky quartz with subordinate biotite flakes, and with a darker band of pink garnet, muscovite, biotite and quartz.

In the lighter portion of the rock, quartz is by far the most abundant constituent, occurring in interlocking grains which form a coarse mosaic. These grains are much strained and cracked, and, in many places, have been partially granulated, especially along their margins. In other parts, a portion of the grain has recrystallised as a finer grained aggregate. Biotite is present in moderate amount, occurring as small flakes strongly pleochroic from medium straw to opaque muddy brown. A little magnetite is associated with it. Muscovite occurs in strictly subordinate quantity, often intergrown with the biotite. It sometimes assumes a fibrous habit and then resembles sillimanite rather strongly. Minor amounts of sillimanite are present as small needles enclosed in quartz and muscovite. In the darker band, the pink almandine garnet is abundant in irregular, much cracked grains which are usually free from inclusions. Biotite and muscovite have a coarser grain and are a good deal more abundant than in the lighter portion of the rock. Quartz is much less abundant.

It is apparent that the rock is a metamorphosed, rather impure quartzite carrying bands of more argillaceous nature, which have now given rise to a garnetiferous mica schist. The lighter portions of the rock may be termed quartz-biotite-muscovite schist with accessory sillimanite.

V. THE PSEUDOTACHYLYTE.

No. 1362* (erratic from the moraine line from Cape Charcot). The hand specimen is obviously a boulder from a moraine. The bulk is composed of a pink, granitic, rather fine grained gneiss with pink and subordinate white felspars, colourless quartz and abundant wisps of chlorite which largely produce the recognisable foliation. Cutting right across this pink gneiss and nearly at right angles to the general direction of foliation there is a black, opaque vein, holding minute inclusions of pink felspar and colourless quartz.

At the base of the specimen, this band has a width of one inch but, at the top, it has dwindled to four-tenths of an inch. Often it is bordered by a greenish zone lying between it and the gneiss, this zone having a width of about one-tenth of an inch. The accompanying sketch (Fig. 12) made from a polished surface, will, perhaps, serve to make the relations clear.

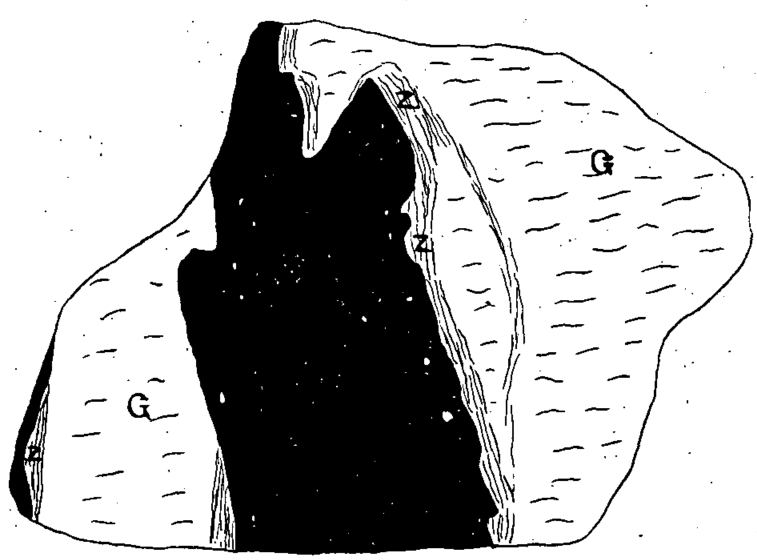

Fig. 12.

Sketch showing relations of the pseudotachylyte to the gneiss. Pseudotachylyte is shown in black. G. is the granitic gneiss; Z. is the greenish zone lying between the two.

Three sections have been cut, one of the pseudotachylyte itself and two of its contact with the surrounding gneiss.

(a) *The Pseudotachylite itself* (*Plate III, Fig.* 6).

The matrix of the pseudotachylyte is crowded with minute black specks (presumably magnetite). These are so numerous that the matrix is not resolvable even under high powers. This matrix also holds fairly abundant larger grains and crystals of magnetite and some epidote which may be secondary. The pseudotachylyte shows signs of an irregular banding, jet black streaks alternating with rather lighter streaks. This can only be noticed in certain areas. Embedded in this matrix are small inclusions of quartz and felspar. The felspar includes both orthoclase and an acid plagioclase in fragments which are usually rounded. The fragments of quartz are usually angular. Sometimes they can be found partially replaced by a pale green chlorite or by calcite. These inclusions vary in size from quite large grains to minute fragments. They have obviously been derived from a rock similar in composition to the surrounding gneiss.

The most striking feature of the pseudotachylyte, however, is the occurrence of large numbers of elliptical vesicles; occasionally the vesicles are irregular in shape. These are now filled with calcite, a pale green chlorite and, much more rarely, epidote and quartz. They may be filled with any of these minerals alone, or with calcite and chlorite, epidote and chlorite, or chlorite and quartz.

Veins and fissures traverse the pseudotachylyte which are filled with calcite and chlorite and, occasionally, a little quartz. Sometimes these veins connect up with the vesicles and in these cases are probably the channels from which the latter are filled.

(b) *The Contact with the Gneiss.*

At its actual margin the pseudotachylyte has a narrow brown selvage, contrasting strongly with the black colour of the main body. This difference is due to the fact that here the black magnetite specks have become brown. Presumably they have been oxidised. This might be accounted for by the moisture contained in the surrounding gneiss at the contact. Under the local conditions of high temperature, the reaction $2(FeO\ Fe_2O_3) + H_2O \rightleftharpoons 3Fe_2O_3 + H_2$, would be in the direction of the top arrow.

The gneiss with which the pseudotachylyte is in contact has been badly crushed. The quartzes show marked strain effects and have usually been shattered and partially granulated. The felspars also have been crushed and extensively sericitised. Where the felspar is a plagioclase, calcite accompanies the sericite. The original ferromagnesian material is now represented by abundant pale green chlorite, accompanied by magnetite and large irregular grains of brown, slightly pleochroic secondary sphene. It thus seems probable that the original material was a titaniferous biotite. The pale green chlorite is intimately associated with crushed felspar and winds round remnants of quartz and felspar grains. On nearing the contact, the gneiss becomes more finely granular, consisting then of a minutely granular aggregate of quartz and some felspar in more or less angular fragments, with secondary sphene and chlorite of much the usual size, associated with a little epidote and plates of calcite, some of which may be of later date. It is this material which makes up the greenish zone surrounding the margin of the pseudotachylyte. In this zone also angular fragments of the pseudotachylyte are found, sometimes with the brown selvage, and forming a sort of breccia. This must represent a portion of the pseudotachylyte which solidified and was then broken up and embedded in the finely crushed portion of the gneiss, either slightly before or, more probably, during the intrusion of the main pseudotachylyte band. A diagrammatic sketch (Fig. 13) reproduces the salient features of this contact zone.

Fig. 13.

Diagrammatic sketch showing contact relations between the pseudotahcylyte and the gneiss (much enlarged). G. is the crushed granitic gneiss passing into Z., the greenish zone, carrying angular fragments of the pseudotachylyte. The black band at the top is the main pseudotachylyte with its narrow brown selvage against the greenish zone.

In a second section taken across the contact, a portion of the main pseudotachylyte has been brecciated and the fragments are cemented by calcite which was deposited at the same time as that found filling the vesicles. This brecciation may be an autobrecciation, analogous to that occurring in lavas.

This pseudotachylyte is particularly interesting because it is, as far as the writer is aware, the first example to be recorded from the Antarctic regions. Indeed, pseudotachylytes are rare, as far as records go, in the whole of the Southern Hemisphere. The most complete description of these rocks is to be found in the monograph by Hall and Molengraaff on the Vredefort Mountain Land in the Southern Transvaal and Northern Orange Free State (Shaler Memorial Series, Amsterdam, 1925, pp. 93–114). In this abundant references to other known occurrences all over the world are given. It is natural to compare the present occurrence with the examples from South Africa. In its general characters, the rock agrees well with certain of the varieties described, and it would appear to fall into Shand's Class (*b*) (" The Pseudotachylyte of Parijs," Quart. Jour. Geol. Soc., vol. 72, 1916, p. 212). In certain features, however, it seems to differ from other recorded examples.

With regard to salvages, Hall and Molengraaff (op. cit. p. 104) state that veins of pseudotachylyte with well developed selvages almost invariably carry inclusions of rocks foreign to their encasing country rock. This, as we have seen, is not the case in our present example. The selvage doubtless proves that the pseudotachylyte was generated some distance away and intruded into rocks which were at a lower temperature, but it is apparent from the inclusions that it was generated from gneiss similar in composition to that in which it is now found. The brecciated zone at the contact would appear to be a rare or even unique feature. Moreover, the vesicular nature of the pseudotachylyte and the filling of these vesicles with secondary minerals, appears to be an absolutely unique feature of this particular example. There can be no doubt that it was highly charged with gases which must have helped considerably in rendering it mobile enough to be injected.

VI. COMPARISON WITH OTHER AREAS.

In comparing these rocks from Eastern Queen Mary Land with others it is natural to turn to the areas which border it on either side. These are Kaiser Wilhelm II Land on the west and Knox Land on the east.

Kaiser Wilhelm II Land was visited by the German South Pole expedition, 1901–1903. Apparently material was chiefly collected in the vicinity of Gaussberg. Material collected *in situ* was from the Gaussberg itself, which is formed of a leucite basalt with foreign inclusions of pyroxene gneiss and pyroxene granite. The moraine and iceberg material collected, however, forms a varied assemblage of plutonic and metamorphic (both igneous and sedimentary) rocks (Deutsche Südpolar Expedition, 1901–1903, vol. 2, R. Reinisch, "Erratische Gesteine," pp. 629–640). Some of the rocks described by Reinisch appear to resemble some in the present collection. For instance, he describes (p. 633) a coarse grained granite with large (2 cm.) red felspars and carrying both hornblende and biotite, which is probably identical with the porphyritic hornblende granite of Eastern Queen Mary Land.

Other specimens which bear comparison in the two regions are: Muscovite-biotite gneiss (cf. Group II—Acid Igneous Gneisses); biotite gneiss (cf. Group III—Acid Igneous Gneisses).

Possibly, too, the pyroxene gneiss and pyroxene granite included in the leucite basalt, may be compared with the Charnockite series of Eastern Queen Mary Land, as they carry hypersthene in addition to diopside. Apart from this, Reinisch describes biotite muscovite granites, biotite granites, gabbro, cordierite gneiss, calc silicate rocks, etc., most of which find no parallel in the present collection. This is the only collection of specimens which has been described from Kaiser Wilhelm II Land.

Turning eastwards, we have Knox Land, an area which is unknown at present, geologically. Following this is Wilkes Land, also unknown, and then Adelie Land.

A good deal of information is now available about the rocks of Adelie Land through the reports of Dr. Stillwell, Prof. Tilley and Dr. Browne. Only Dr. Stillwell's report on the metamorphic rocks of Adelie Land (Australian Antarctic Expedition, 1911–14, Scientific Reports, Series A, vol. III, Part 1), concerns us here. Of the various types described by him, the only ones which seem to bear close comparison with the present collection, are the hypersthene bearing rocks from Madigan Nunatak, Aurora Peak and Cape Gray. These fall into the Charnockite series and may be compared with members of that series as described in the present report.

Stillwell (op. cit. pp. 190–192, and in portion dealing with the Charnockite series of India) believes the series to be of metamorphic origin, derived originally from dolerite (the basic members) and granite (the acid members), whereas Holland looks upon them as igneous rocks consolidated under rather abnormal conditions. Without going fully into the question, because the rocks of this Series described in the present report offer no definite evidence either one way or the other, it may be remarked that if the rocks consolidated in their present condition from a magma, the presence of hypersthene in the acid as well as the basic members, shows that this magma was poor in volatile constituents. Under these conditions the rocks might easily crystallise with an evenly granular texture, a feature that is common to most aplites. The banding, so marked in most examples, may well be a primary banding (as noted by Holland) due to viscous flow during solidification. Examples which come from zones of crushing and movement, can usually be distinguished from the normal types and often carry garnet. Some of Stillwell's examples belong here. Incidentally it may be noted that the rocks of Adelie Land, as described by him, have suffered much more from the effects of movement than those of Queen Mary Land described in the present report.

Moreover, the fact that the chemical analyses of the Charnockite series bear a close resemblance to those of normal igneous rocks (*e.g.*, Charnockite itself has the chemical composition of a normal potash granite), does not either prove or disprove their metamorphic origin. They may quite well be heteromorphs, due to consolidation under differing physical conditions. One of these conditions, as we have seen, must be relative poverty in volatile constituents, another is probably high load pressure. Under these conditions, they might come to resemble kata-zone (of Grubenmann) metamorphic rocks rather strongly.

Finally, even convergence in metamorphism can hardly account for the well marked family resemblance which runs through the whole series. We have seen (in the fine grained granite and its inclusions) that metamorphism and assimilation may give locally a mineral assemblage resembling that of the Charnockites, but they can easilv be distinguished, even in hand specimen, from the members of that series. The fact that the Charnockite series has been described from various parts of the world, shows that it forms a distinct entity, and must be reckoned as igneous rather than metamorphic.

Apart from the representatives of the Charnockite series the rocks of Adelie Land do not seem to furnish us with any further comparisons.

In South Victoria Land, however, a further comparison can be made with the rocks of the basement complex. Here Mawson (British Antarctic Expedition, 1907–1909: Scientific Reports; Geology, vol. 2, 1916, p. 210) has described from Cape Irizar, a hornblende-biotite-granite identical with the porphyritic hornblende granite of this report. Further, he describes an epidotised granite south of Cape Irizar, which seems similar to No. 1360 in the present collection and which is dealt with among the Chlorite-Epidote-Albite rocks.

Hornblende-biotite granites similar to that at Cape Irizar, have also been described from Granite Harbour and the Ferrar Glacier by Prior (National Antarctic Expedition, 1901–1904: Natural History Reports; vol. 1, Geology, Part 2). He has also found the same rock as an erratic at Cape Adare (G. T. Prior, "Report on the Southern Cross Collection," 1902, pp. 322–323). This type is, therefore, fairly widely distributed in South Victoria Land, and it is extremely interesting to find it reappearing in Queen Mary Land and probably also, as noted above, in Kaiser Wilhelm II Land.

The other igneous rocks of South Victoria Land do not, however, show any close resemblance to those of Queen Mary Land; indeed, differences are marked, more especially amongst the more acid rocks. In South Victoria Land, the dominant acid rocks are of granodiorite type with oligoclase as the chief felspar. Microcline granites and alkali granites in general do not appear to be common, being only found at Mount Hope and in the Terra Nova Bay region. Another distinctive feature is the occurrence of the sphene-bearing diorites. Contrasted with this, Queen Mary Land has predominant microcline and alkali granites, a feature which is apparently continued in Kaiser Wilhelm II Land. Adelie Land appears to be intermediate between these two regions, petrologically as well as geographically.

There is thus a distinct difference in the acid rocks taken as a whole, on going westwards. We start with predominant granodiorite types and end with alkali granites. A feature of this province, if province it can be called, is the universal presence of orthite in all the acid rocks.

So much for speculation. The fact remains that in Eastern Queen Mary Land we have a set of igneous rocks, some of which, can be matched in adjoining areas, and others which, as far as is known at present, are peculiar to Queen Mary Land itself. There can be no doubt that the rocks described in the present report form part of the basal complex of Antarctica and they thus help to shed some more light on that still little known foundation.

SECTION II.

REPORT ON ROCKS FROM WESTERN QUEEN MARY LAND AND FROM KAISER WILHELM LAND.

I. INTRODUCTION.

The series of rocks about to be described* was collected from Western Queen Mary Land by C. A. Hoadley, one of the Geologists of the Australasian Antarctic Expedition, 1911–1914, during a depôt-laying sledge journey to the Helen Glacier and subsequently on an extended summer sledge journey undertaken to Gaussberg. Most of the rock specimens are small as they had to be carried long distances by sledge and the greater part of the material is erratic. The rocks were collected in the region between " The Grottoes " and Gaussberg.

II. THE IGNEOUS ROCKS.

A. Granites, Aplites and Pegmatites.

(a) *Biotite Granites.*

A fair number of specimens fall under this heading and group themselves into more or less natural associations. In the first place, three specimens, Nos. **1048**, **1049**, **1054**, all erratics from Gaussberg fall together. They are all rather pale coloured with pale pink potash felspar, white plagioclase, grey quartz and a variable but small amount of biotite. In texture they are rather fine grained but No. **1048** shows a coarse pegmatitic modification and biotite is almost absent whilst plagioclase is more abundant. Two specimens out of the three show a rough gneissose structure. In thin section, microcline is abundant often showing perthitic intergrowth and occurring either as small irregular plates, partially or wholly enclosing the other constituents, or else interstitially. Where the rock is not gneissose the quartz is granular, much cracked and strained. In the gneissose specimens the quartz grains are somewhat elongated in the direction of foliation and are free from strain. The plagioclase, usually subordinate in amount, is sericitised and epidotised to some extent but is apparently of composition $Ab_{72}An_{28}$. The biotite is decomposed and now usually represented by penninite and secondary sphene. There is a little white mica which has a yellowish tinge in parts and which is present in the form of small flakes. It is associated in places with almost colourless fluorspar. Amongst the accessories may be noted ilmenite, some sphene in small grains, apatite, zircon and a little orthite.

A rock related to the above is No. 1047, also an erratic from Gaussberg. This differs, however, in hand specimen because the potash felspar is white and because there is a greater abundance of biotite. Contrasted in thin section (Fig. 14) with those above

*This section of the report was undertaken and completed by Dr. Nockolds some time subsequent to his treatment of the rock collection from Eastern Queen Mary Land; also it was forwarded in 1934 for publication before the localities of the individual rocks of Section I were available. The report on the rocks of Eastern Queen Mary Land was completed and forwarded for publication in 1929. [D. M., Editor.]

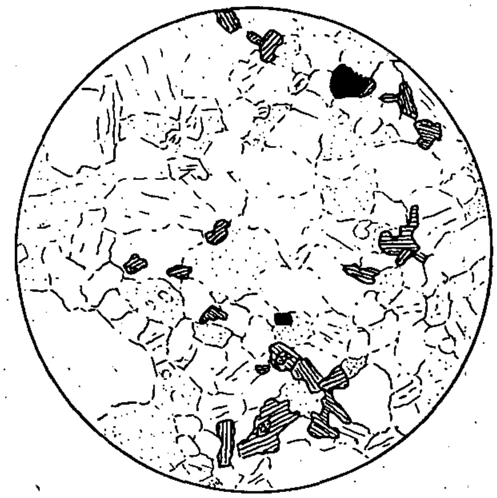

Fig. 14.

Biotite granite (1047), showing biotite, magnetite, orthite (enclosed in the biotite), quartz, plagioclase and potash felspar (light stippling).

it is found that the biotite here is quite fresh, the plagioclase is less altered and accessory orthite becomes relatively abundant. The modes of these rocks, as measured on a Leitz intergrating stage, are given below :—

	No. 1048.	No. 1049.	No. 1054.	No. 1047.
Quartz	27·3	36·8	33·0	33·8
Potash Felspar	35·0	50·3	44·0	35·6
Plagioclase	36·0	11·8	19·3	22·8
Biotite	...	0·6	2·9	6·2
Accessories	1·7	0·5	0·8	1·6

The next type of biotite granite is one in which the felspar is red in hand specimen. The quartz appears white and the dark minerals are more noticeable. Two specimens fall here: No. 1072, an erratic from Haswell Island, and No. 1042, an erratic from Gaussberg. The first is an extremely coarse rock, the second is of medium grain.

No. 1072: In thin section this rock shows large crystals of microcline-microperthite with subordinate plagioclase ($Ab_{92}An_8$) which is rendered turbid by minute dusty inclusions of haematite, and quartz in grains of smaller dimensions than those of the microcline. Biotite (now represented by a green chlorite with associated epidote and secondary sphene) is present in large flakes which are gathered together into clots. These biotite aggregates hold abundant inclusions of zircon and apatite.

No. 1042: Under the microscope (Fig. 15) abundant fresh microcline-microperthite and quartz, the latter slightly strained in places, may be seen together

Fig. 15.

Coarse biotite granite (1042) with partly chloritised biotite, magnetite, a large crystal of orthite, some highly turbid plagioclase and large crystals of quartz and microcline-microperthite.

with subordinate plagioclase ($Ab_{88}An_{12}$). This plagioclase, again, holds numerous dusty inclusions of haematite giving it a pink and turbid appearance. A certain amount of penninite, pseudomorphing biotite, magnetite, leucoxene and orthite are accessories.

The modes of these two specimens follow :—

	No. 1072.	No. 1042.
Quartz	35·0	27·9
Potash Felspar	41·1	45·4
Plagioclase	14·1	15·6
Biotite	9·2	8·9
Accessories	0·6	2·2

Two other specimens are associated together, namely Nos. 1120 and 1131; both represent loose rock taken from two bergs in Helen Glacier Bay. These are medium grained granites with abundant flesh pink potash felspar, a little grey plagioclase, abundant and very striking deep brown smoky quartz and a little biotite. In thin section (Fig. 16) they show abundant grains and hypidiomorphic crystals of microperthite, sometimes showing a faint cross hatched appearance, abundant granular quartz, subordinate plagioclase ($Ab_{70}An_{30}$), a little brown biotite with some associated zircon and apatite, and finally a little ilmenite. Purple fluorspar was noticed in hand specimen

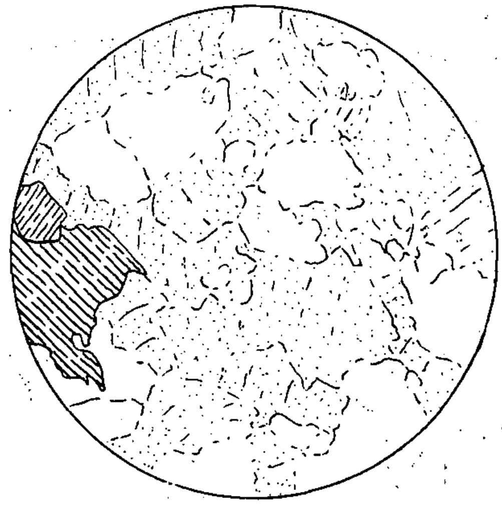

Fig. 16.

Biotite granite (1120). The figure shows biotite, a little plagioclase, quartz and microperthite (light stippling).

but was not encountered in the sections. Similarly, a few sporadic phenocrysts of plagioclase may also be found in the hand specimens but the sections had not been cut through any of them. The mode for this variety is as follows :—

Quartz	40·3
Potash Felspar	40·1
Plagioclase	13·5
Biotite	5·9
Accessories	0·2

Finally, we have to notice two further specimens both of fine grain and both of a noticeably pink colour in hand specimen. One, No. 1087, an erratic from Haswell Island, appears almost devoid of dark minerals; the other, No. 1115, taken from pinnacle berg in Helen Glacier Bay, contains them in some quantity. Both these rocks contain abundant microperthite, often showing the cross hatching of microcline, and occurring interstitially partially or wholly enclosing the other constituents. Both also contain a large amount of quartz in medium and small grains together with some plagioclase (oligoclase) much sericitised in places. A good deal of myrmekite is present where potash felspar is in contact with plagioclase. In No. 1087 the dark minerals are represented by one or two scattered flakes of partly chloritised biotite. In No. 1115 biotite is more abundant and amongst the accessories, magnetite is common in fairly large grains, there is a little apatite and, finally, one or two crystals of orthite. The mode for No. 1115 is :—

Quartz	33·5
Potash Felspar	45·0
Plagioclase	19·3
Biotite (and chlorite)	2·0
Accessories	0·2

There are one or two specimens of biotite granite which have not been sectioned: No. 1006, a rock taken from capsized ice-berg held in the bay-ice to north-east of Hut, is a pink granite of medium grain with pink felspar, grey quartz and a fair amount of biotite. It is probably of the same type as the next set of specimens only, in this, the plagioclase is reddened.

Nos. 1007, 1013, 1017, 1022—all taken from capsized berg to north-east of Hut. These are all specimens of a medium grained granite with crystals of pink potash felspar, subordinate white plagioclase, grey quartz and a fair amount of biotite.

Finally, there is a specimen, No. 1136, erratic from Haswell Island, which is a fine grained reddish granite carrying dolerite xenoliths. The specimen is of interest as it corresponds exactly with the fine grained inclusion bearing granite from Eastern Queen Mary Land. This type has already been described in detail (Nockolds, "Report on Rock Specimens from Eastern Queen Mary Land," section of this report) so that further mention of it is unnecessary.

(b) *Aplites, Pegmatites and Quartz Veins.*

Several specimens fall here, none of which have been sectioned.

No. 1043, an erratic from Gaussberg, is composed mainly of white granular, crystalline quartz. The specimen is drusy in parts with small quartz crystals projecting into the cavities. In addition, there are irregular pale green patches (often partly leached out) which consist largely of a very fine grained intimate mixture of pale green chlorite, sericite and a little granular epidote.

No. 1080, an erratic from Haswell Island, is a mass of white granular quartz with some granular pale-yellow felspar and a little biotite towards one edge of the specimen.

No. 1084, an erratic from Haswell Island, is a piece of massive greyish-brown quartz with granular texture.

No. 1102, from a vein in the rock at Haswell Island, and No. 1107, a loose rock from berg at ice foot near Haswell Island, are both specimens composed of massive greyish-brown quartz.

No. 1103, from a vein in the rock formation at Haswell Island, is a pale sugary aplite almost devoid of dark minerals and carrying a little purple fluorspar.

Finally, there is a coarse unlocalised pegmatite composed of grey quartz and large crystals of potash felspar which are of pale pink colour in some parts, pale yellow in others.

(c) *Hornblende Granites.*

No. 1082 is an erratic from Haswell Island. In hand specimen this rock is pink in colour and rather fine grained. Abundant pink felspar is present together with a fair amount of quartz and a certain amount of biotite and hornblende. Purple fluorspar is a noticeable accessory. In thin section the rock appears coarser than would be expected and fairly large crystals of microcline-microperthite are abundant enclosing small grains of quartz and partially or wholly enclosing hypidiomorphic crystals of plagioclase. At plagioclase-microperthite junctions myrmekite is often developed. Quartz is also abundant in allotriomorphic grains and the subordinate plagioclase, when fresh, is found to be somewhat zoned and mantled with more acid plagioclase. It is zoned from $Ab_{80}An_{20}$ at the centre to $Ab_{86}An_{14}$ at the margin and mantled with $Ab_{94}An_{6}$. In other parts this felspar is rendered dusty and is much sericitised with the separation of calcite and the development of some larger flakes of white mica. This alteration is especially noticeable in areas where the dark minerals have been altered to chlorite. Of these dark minerals, biotite is the more abundant in large and small flakes pleochroic from a medium straw to almost opaque brown. In places it is altered to a green chlorite with which a certain amount of epidote is associated. The hornblende is a green variety with X = deep brownish green, Y = deep yellow brown, Z = deep green to almost opaque. Amongst the accessories pale brown sphene, in large crystals and grains, is very common and zircon and apatite are enclosed in the dark minerals. There are a few fairly large grains of magnetite, one or two crystals or orthite, a certain amount of interstitial calcite and a small quantity of fluorspar. The mode of this rock is :—

Quartz	29·2
Potash Felspar	39·5
Plagioclase	22·0
Biotite	4·9
Hornblende	1·4
Accessories	3·0

No. 1124, taken from berg in Helen Glacier Bay, is a coarse grained rock with large phenocrysts of pale pink potash felspar, subordinate white plagioclase and grey quartz. The dark minerals are segregated into clots. The phenocrysts are of microperthite which is accompanied by smaller hypidiomorphic crystals of oligoclase (about $Ab_{84}An_{16}$) which are often rendered turbid with minute dusty inclusions and intensely sericitised with the development of calcite. In the immediate vicinity of the microperthite this plagioclase is somewhat zoned so that the outer margin has a composition $Ab_{92}An_{8}$. In addition, there is a certain amount of quartz. The dark minerals are represented by biotite and hornblende, the latter being the more abundant of the two. Accessory sphene and apatite are associated with these. The mode is given below :—

Quartz	6·8
Microperthite	70·1
Plagioclase	13·1
Biotite	3·1
Hornblende	6·5
Accessories	0·4

This mode is really too low in quartz and too high in microperthite, the reason being that the section had been cut across portions of two microperthite phenocrysts so that these bulked more largely in the mode than would normally have been the case.

No. 1130 was collected from a berg in Helen Glacier Bay. In hand specimen a rather coarse grained granite showing abundant pink potash felspar with subordinate white plagioclase, grey quartz and a small amount of dark minerals. Under the microscope the potash felspar is seen to be a rather turbid microperthite in irregular plates whilst quartz is abundant in irregular grains. The subordinate plagioclase is greatly sericitised and epidotised but appears to have a composition about $Ab_{76}An_{24}$, often mantled with plagioclase of more acid nature. Of the dark minerals, which only occur in small quantity, hornblende is the more abundant in hypidiomorphic crystals with X = pale yellow brown, Y = medium greenish brown, Z = medium brownish green and $Z \wedge c = 20°$. Magnetite and apatite occur as accessories.

No. 1133, a loose rock taken from berg in Helen Glacier Bay, is a medium grained rock showing abundant flesh pink felspar, a good deal of quartz, subordinate white plagioclase and a certain amount of hornblende and biotite. In thin section the pink felspar is found to be microperthite and grains of quartz are abundant. The latter are badly strained in parts and may show incipient crushing. Subordinate plagioclase is present of composition about $Ab_{77}An_{23}$ sometimes rimmed with $Ab_{85}An_{15}$. A little brown biotite pleochroic from pale to almost opaque brown, and green hornblende with X = medium straw, Y = deep brownish green, Z = deep green or blue and $Z \wedge c = 19°$ are present. There is a little accessory sphene, magnetite, apatite and orthite.

No. 1134, taken from berg in Helen Glacier Bay, is a white rock of medium grain with abundant greyish quartz, white felspars and very subordinate hornblende and biotite. In thin section the rock has abundant quartz which is much strained and partly crushed in places. It occurs in large areas composed of an interlocking sutured mosaic of grains. There is a fair amount of microcline-microperthite and a little plagioclase ($Ab_{72}An_{28}$) which may show undulose extinction. Some myrmekite is present where the plagioclase comes into contact with the microperthite. A little green hornblende and brown biotite (partly altered to chlorite) and a little accessory zircon, apatite, orthite and fluorspar complete the section.

The modes of the three specimens just described are as follows :—

	No. 1130.	No. 1133.	No. 1134.
Quartz	42·1	36·9	61·1
Potash Felspar	41·1	50·6	27·7
Plagioclase	14·2	8·5	8·6
Biotite	0·8	2·0	1·2
Hornblende	1·7	1·8	1·3
Accessories	0·1	0·2	0·1

Finally, there are a few specimens which have not been sectioned :—

No. 1057, is an erratic from Gaussberg. This is similar to No. 1133 in hand specimen but contains less dark minerals.

No. 1044, is another erratic from Gaussberg. This is similar to No. 1134 but contains large irregular phenocrysts of potash felspar. No. 1106, a loose rock from berg at ice foot near Haswell Island and No. 1110, from the same locality, are both similar in hand specimen to No. 1134.

B. Granodiorites.

(a) *Biotite Granodiorites.*

Only one specimen comes here, namely No. 1090, is an erratic from Haswell Island. In hand specimen this is a grey fine grained rock with white felspar and rich in biotite. Amongst the light minerals, plagioclase is the most abundant in thin section (Fig. 17). It encloses small flakes of biotite and some contains rather abundant needles of apatite. Most of the plagioclase is zoned. The cores vary somewhat in composition from $Ab_{59}An_{41}$ to $Ab_{72}An_{28}$ but the outer zones are of constant composition at $Ab_{75}An_{25}$. Quartz is the next most abundant light mineral (often showing slight signs of strain), followed by microcline-microperthite and microcline. Both the quartz and the potash felspar enclose a few needles of apatite and the potash felspar also encloses small grains of quartz, flakes of biotite and small crystals of plagioclase. The biotite, which is abundant, occurs in medium sized flakes pleochroic from medium straw to dark muddy

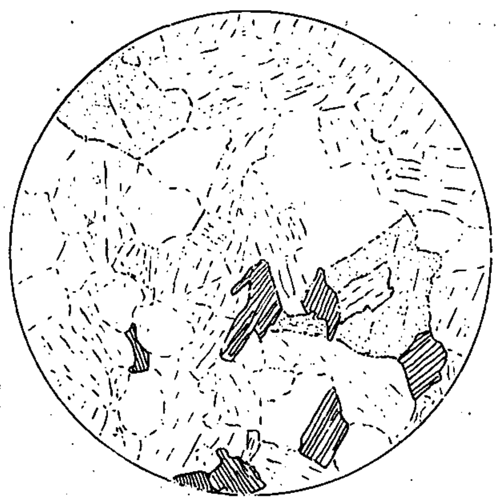

Fig. 17.

Biotite granodiorite (1090) with biotite, plagioclase, quartz and some potash felspar (light stippling).

brown. Some myrmekite is developed at the junction of plagioclase and microcline, a little zircon is enclosed in the biotite and there is a small amount of accessory orthite. The mode is :—

Quartz	24·1
Potash Felspar	21·2
Plagioclase	41·1
Biotite	11·8
Accessories	1·8

(b) *Hornblende Granodiorites.*

Two specimens come into this group, namely Nos. 1118 and 1126; the first of these is from pinnacle berg in Helen Glacier Bay, the second from another berg in the same bay.

No. 1118: The hand specimen for this seems to be missing but in thin section the rock is composed of abundant quartz and plagioclase with subordinate microcline. The plagioclase is somewhat sericitised and approximately of composition $Ab_{72}An_{28}$. Brown biotite is abundant in small flakes and is in excess of the green hornblende which occurs in irregular grains and crystals with X = medium straw, Y = deep brownish green, Z = deep green or blue and $Z \wedge c = 21°$. Amongst the accessories apatite and sphene are both present, the latter often forming rims round ilmenite, and there is some zircon. All these are chiefly associated with the dark minerals.

No. 1126 is a coarse rock made up of dull pink felspar, rather abundant grey quartz and a fair amount of hornblende and biotite. In thin section dusty plagioclase, much sericitised and epidotised, and now of composition about $Ab_{95}An_5$, is the most common light constituent. Turbid microperthite follows in large irregular plates and finally comes quartz in large irregular grains. There is a good deal of both biotite and hornblende. The biotite which occurs in flakes (often partly chloritised), is either closely associated with the hornblende or occurs as aggregates without any of the latter accompanying it. The hornblende is present in hypidiomorphic crystals with X = pale yellow brown, Y = medium greenish brown, Z = medium brownish green and $Z \wedge c = 20°$. There is a good deal of apatite and magnetite associated mainly with the dark minerals. Myrmekite is often present where plagioclase and microperthite come into contact and sometimes, also, biotite forms a symplektite with quartz.

The modes of the two specimens just described are:—

	No. 1118.	No. 1126.
Quartz	20·4	10·2
Potash Felspar	2·3	19·5
Plagioclase	47·8	45·9
Biotite	20·6	13·0
Hornblende	8·9	8·0
Accessories	...	3·4

C. Tonalites.

Three specimens of tonalite have been found. The first of these, No. 1079B, an erratic from Haswell Island, is a speckled black and white rock of rather fine grain. White plagioclase and dark minerals are abundant and there is subordinate quartz. In addition there are irregular brown and white areas where hornblende and biotite are missing and these are composed of plagioclase and sphene. In thin section (Fig. 18)

Fig. 18.

Tonalite (1079B) showing abundant biotite, some hornblende, a little sphene, plagioclase, some quartz and a little interstitial calcite seen almost at the centre of the figure. In other parts sphene occurs to the exclusion of biotite and hornblende.

the hypidiomorphic plagioclase is found to have a composition $Ab_{70}An_{30}$. Biotite and hornblende are both common, the former being the more abundant. Both occur in comparatively large crystals tending to partially enclose the other constituents. The biotite is pleochroic from medium straw to dark chocolate brown and is replaced to a small extent by penninite and secondary sphene. The hornblende has $X =$ medium straw, $Y =$ deep brownish green, $Z =$ deep green or blue and $Z \wedge c = 19°$. There is a certain amount of quartz and rather less orthoclase occasionally in micrographic intergrowth with the quartz. Some interstitial calcite is present which appears to be associated more particularly with the hornblende. Apatite and zircon in fairly large crystals accompany the dark minerals. Pale brown sphene is common in crystals comparable in size to those of hornblende and biotite, and occurs to the exclusion of these in certain areas as mentioned above. It sometimes shows lamellar twinning. Finally, a little orthite is present. The mode is :—

Quartz	13·0
Orthoclase	7·2
Plagioclase	48·1
Biotite	18·1
Hornblende	9·4
Accessories	4·2

The two other specimens, No. 1056, an erratic from Gaussberg, and No. 1073, an erratic from Haswell Island, have not been sliced. They are both black and white rocks of medium to rather coarse grain composed of white felspar (apparently plagioclase), some quartz and a good deal of both biotite and hornblende.

D. The Trondhjemitic Type.

One specimen which seems to have trondhjemitic affinities has been found. This is No. 1125, a loose rock taken from a berg in Helen Glacier Bay. In hand specimen it is a white rock of medium grain showing white felspar, grey quartz and a small amount of dark mineral. Under the microscope the rock is seen to be largely composed of large and smaller hypidiomorphic plagioclase crystals slightly altered in places with the development of secondary muscovite and calcite and, in parts, veined with more acid plagioclase so as to resemble microperthite somewhat. This plagioclase is of composition $Ab_{72}An_{28}$. Abundant quartz is also present but there is no potash felspar. There is a little biotite pleochroic from pale straw to deep fox brown and partly chloritised. A little muscovite is also present and seems to be mainly associated with the chlorite and biotite. This muscovite is distinct from that occurring as an alteration product of the felspar but, like that, may be secondary. The mode of this rock is as follows :—

Quartz	31·3
Plagioclase	63·9
Muscovite	1·0
Biotite	3·6
Accessories	0·2

E. The Charnockite Series.

Several of the specimens examined belong to the Charnockite Series, and these will now be briefly described.

Nos. 1095A, 1095B and 1095C are specimens from the rock forming Haswell Island, taken *in situ*. These three specimens are all alike and are acid members of the series. They are dark brown in hand specimen, of rather coarse grain, and composed of brown felspar, brown quartz and a fair amount of dark minerals. In thin section (Fig. 19) this rock type shows large and abundant crystals of microperthite, often enclosing many small grains of quartz; large and common grains of quartz and subordinate plagioclase of somewhat smaller dimensions and more variable grain size. The plagioclase has a composition $Ab_{70}An_{30}$ and the larger grains may sometimes show antiperthitic

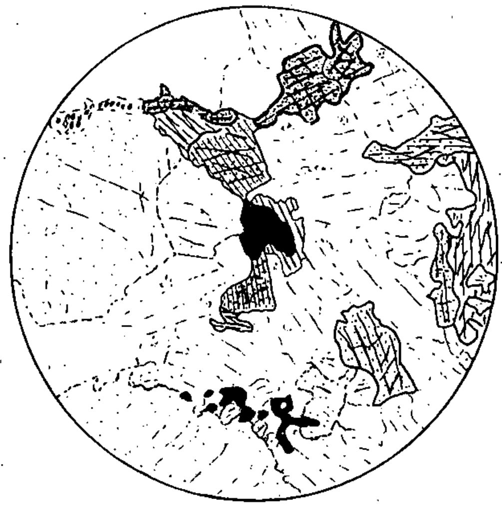

Fig. 19.

Coarse acid charnockite (1095B) with enstatite, diopsidic pyroxene, some hornblende, magnetite, quartz, plagioclase, microperthite (light stippling) and myrmekite.

structure. Myrmekite is developed where the plagioclase comes into contact with microperthite. The smaller grains of plagioclase seem to be more particularly concentrated in areas where the dark minerals occur. These latter are diopsidic pyroxene, brown hornblende and enstatite. The diopsidic pyroxene is pale green and often shows a very fine schiller structure. Brown hornblende with X = pale brown, Y = deep brown, Z = very deep brown and $Z \wedge c = 24°$ is the commonest dark mineral and often occurs as a rim round the monoclinic pyroxene. It may also rim magnetite. Enstatite is not abundant and, for the most part, its place is taken by a brown chloritic mineral in which small cores of unaltered orthorhombic pyroxene may be seen. A good deal of magnetite is present in rounded and irregular grains and apatite is not uncommon. All the light constituents are seamed with green chlorite.

No. 1100, a specimen from vein in the rock at Haswell Island, is a pale brown rock of rather fine grain, composed of brown felspar, brown quartz and a certain amount of dark minerals. In thin section (Fig. 20) this rock is seen to be an acid member of the series carrying abundant microcline-microperthite, microperthite and quartz with subordinate plagioclase ($Ab_{73}An_{27}$). A certain amount of brown biotite in small flakes

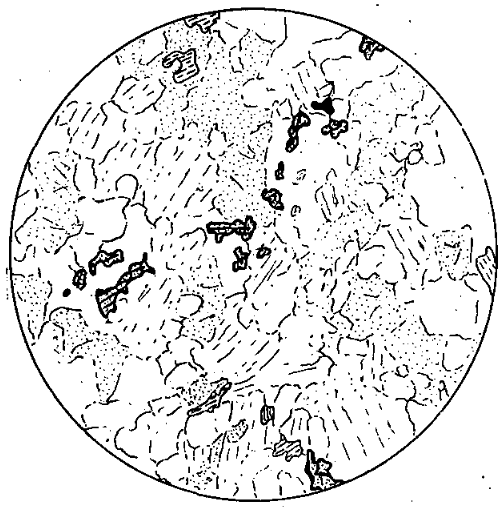

Fig. 20.

Fine grained acid charnockite (1100) with enstatite, biotite, magnetite, plagioclase, quartz and potash felspar (light stippling).

together with some enstatite (altering to delessite in parts) and a little diopsidic pyroxene complete the section. Apatite, magnetite, zircon and orthite are present as accessories and myrmekite is not uncommon. The modes of these two rock types are given below :—

	No. 1095.	No. 1100.
Quartz	22·3	25·7
Potash Felspar	43·3	44·0
Plagioclase	25·5	24·6
Biotite	...	2·3
Hornblende and Pyroxene	7·5	2·8
Accessories	1·4	0·6

The next two specimens are down at the basic end of the series.

No. 1075, an erratic from Haswell Island, is a dark, rather fine grained, compact rock which seems to be composed almost entirely of dark minerals. The thin section shows it to be a hornblende-diopside-hypersthene-plagioclase rock, with an essentially granular texture (Fig. 21). Hornblende is the most abundant constituent and is a greenish brown variety with X = pale straw, Y = deep greenish brown, Z = medium brownish green and $Z \wedge c = 24°$. Pale green diopsidic pyroxene is the next most abundant mineral and is beginning to alter in places to the greenish brown hornblende. The hypersthene is strongly pleochroic and is partly replaced by delessite accompanied by magnetite. Plagioclase is strictly subordinate and of composition $Ab_{45}An_{55}$.

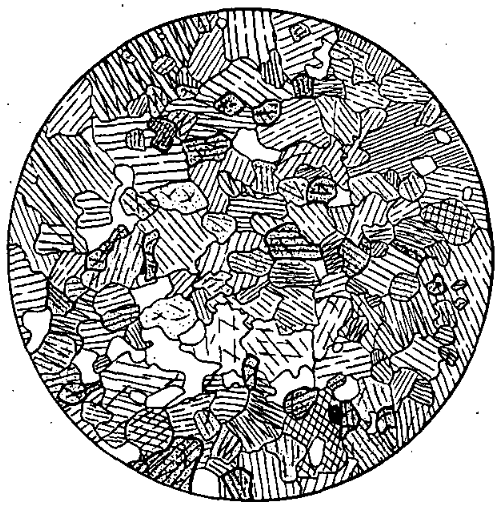

Fig. 21.

Basic charnockite (1075) showing abundant hornblende, diopsidic pyroxene, a fair amount of hypersthene and a little plagioclase.

No. 1091, another erratic from Haswell Island, is, again, a dark, rather fine grained, compact rock rich in dark minerals and showing a fair amount of brown plagioclase. Under the microscope, the rock shows obvious relationships to No. 1075 (figure 22). Hornblende is still abundant and shows the same characters. Pale green diopsidic pyroxene is again prominent and plagioclase has become more common.

Fig. 22.

Basic charnockite (1091) with hornblende, plagioclase, diopsidic pyroxene, a little hypersthene and irregular patches of olivine.

Hypersthene, however, is a good deal less abundant and a new mineral, olivine, makes its appearance. This olivine is present in rounded grains and as irregular straggling patches, usually surrounded by hornblende, occasionally by hypersthene. This olivine is altered occasionally, along cracks, to a deep brown chloritic substance. The texture of the rock is again granular.

The modes of these two rocks are as follows :—

	No. 1075.	No. 1091.
Plagioclase	10·9	25·4
Hornblende	39·4	46·2
Diopside	27·0	20·4
Hypersthene	22·1	1·0
Olivine	...	7·0
Accessories	0·6	...

F. The Leucite Basalt of Gaussberg.

Three specimens in the collection are of the leucite basalt of Gaussberg. Two of these, Nos. 1050A and 1060B, have phenocrysts of leucite and augite in a fine textured groundmass, the other (No. 1060A) has phenocrysts of leucite and augite set in a pale yellow brown glass carrying numerous small crystals of brown mica and black elongated rods (probably ilmenite). This leucite basalt has been fully described elsewhere (Reinisch : Deutsche Südpolar-Expedition 1901–1903, Bd. 2, p. 75) so that further mention of it is unnecessary.

III. METAMORPHOSED IGNEOUS ROCKS.

A. Acid Gneisses.

The first group of these to be described comprises a series of gneissose rocks which are all rather similar in hand specimen and of a grey colour. They are all either biotite or biotite-muscovite gneisses.

No. 1005, a rock taken from a capsized berg to north-east of Hut, is a medium grained grey gneiss showing abundant quartz, white plagioclase and a fair amount of biotite, in small flakes, marking out the foliation. In thin section there is a good deal of biotite which is pleochroic from pale straw to muddy brown and partly chloritised in places. The remainder of the rock is composed of about equal quantities of plagioclase and quartz. The quartz is a little strained and the plagioclase which is of composition $Ab_{61}An_{39}$, is much sericitised. The biotite seems to be mainly associated with the plagioclase and bands rich in these two minerals alternate with others composed mainly of quartz with subordinate plagioclase and biotite. Amongst the accessories sphene is common in crystals and grains, associated with the biotite and sometimes having a core of ilmenite. Apatite is also common and there is some orthite.

No. 1086 is an erratic from Haswell Island. In hand specimen a dark apparently fine grained gneiss with rather ill developed foliation brought out by the biotite. In thin section the foliation does not show up so well but is marked by the sub-parallel arrangement of the biotite flakes. Microcline-microperthite is abundant in both large and small grains enclosing plagioclase and quartz either partially or wholly. Quartz is also abundant in large and small grains and is unstrained. Plagioclase is subordinate and of composition $Ab_{73}An_{27}$. It is zoned to a certain extent and in the vicinity of microperthite may be as acid as $Ab_{90}An_{10}$. There is a good deal of myrmekite, typically developed at the junctions between plagioclase and microperthite. Biotite is common in small flakes pleochroic from medium straw to dark muddy brown. It sometimes forms symplektitic intergrowths with plagioclase or quartz. Amongst the accessories small crystals of apatite are common, there is a certain amount of magnetite and, finally, a little zircon occurs.

No. 1081 is another erratic from Haswell Island. A grey, rather fine grained gneiss in hand specimen with abundant white plagioclase (some of it occurring in distinct lenses), a good deal of muscovite and biotite, giving rise to a marked foliation and a little visible quartz. Under the microscope (Fig. 23), however, quartz is conspicuous, partly in large grains much strained and cracked, partly in smaller grains less or unstrained.

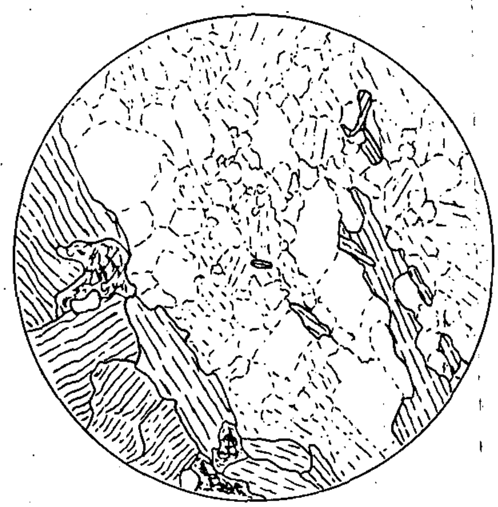

Fig. 23.

Acid igneous gneiss (1081) showing abundant muscovite in a matrix composed mainly of quartz and plagioclase. Other parts of the section contain biotite as well.

Plagioclase ($Ab_{69}An_{31}$) is also abundant again in both large and smaller grains, the former showing secondary twinning. A certain amount of microcline is present (but not very much) and there are also one or two large grains of this. Both muscovite and biotite are very common marking out the foliation planes. The flakes of these minerals are often bent and those of muscovite form an intergrowth with quartz at their margins. Small crystals of zircon are commonly enclosed in both the muscovite and biotite, and there is some sphene in small grains. The rock is one of acid nature which has suffered crushing and a good deal of recrystallisation under regional conditions.

No. 1135, which is a loose rock taken from berg in Helen Glacier Bay, is a similar rock to No. 1081 but on the whole of finer grain. The texture is now mainly granular, the constituents show little sign of strain and microcline (perthitic here) is rather more abundant. A few large crystals of plagioclase or of plagioclase and microperthite together still remain and these appear as augen in hand specimen. The rock is of the same type as No. 1081 but has suffered more advanced recrystallisation.

No. 1132 is another loose rock taken from berg in Helen Glacier Bay. Macroscopically the specimen is a grey fine grained gneiss with fairly good foliation cut by a white fine grained aplite vein which follows the direction of foliation. Under the microscope the gneiss itself is composed of medium sized grains of plagioclase ($Ab_{77}An_{23}$) and much strained quartz set in a finer grained matrix of the same components together with some interstitial microcline and rather abundant flakes of biotite which have a sub-parallel arrangement. A very little muscovite in minute flakes is associated with some of the biotite. Apatite, in comparatively large grains, and some magnetite are accessory and a certain amount of myrmekite is developed. The aplitic vein contains one or two large grains of microperthite, microcline, plagioclase ($Ab_{80}An_{20}$) and quartz set in a very fine grained ground mass of the same constituents. Quartz is abundant in the groundmass and much of it shows signs of strain. Some of it is somewhat elongated in the direction of the foliation of the surrounding gneiss. A good deal of very fine myrmekite is developed in this groundmass. In addition there is a little muscovite and a few flakes of biotite.

There are several other specimens of grey gneiss in the material collected but these have not been sliced.

Nos. 1008, 1009, 1010, 1011, 1014, 1021, 1023, taken from capsized berg to N.E. of Hut, and No. 1055, an erratic from Gaussberg, are all very similar in hand specimen. They are grey gneisses with more or less well developed foliation and composed of white felspar (which also forms augen in some), colourless quartz and a fair amount of biotite. No. 1015, taken from capsized berg to N.E. of Hut, is similar but coarser and with augen of pink felspar and quartz. No. 1018, from same locality, is again similar but coarser and has a good deal less biotite. No. 1033, an erratic from moraine at Junction Corner, is a medium grained grey gneiss with fairly abundant biotite and small augen of white felspar. No. 1003, taken from capsized berg to N.E. of Hut, is a grey medium grained gneiss showing abundant partly chloritised biotite, white felspar, grey quartz and augen composed of aggregates of pale flesh coloured felspar grains. No. 1002, from the same locality, is a beautiful coarse gneiss with abundant black biotite, white felspar and grey quartz. Augen of white felspar, quartz or both are present and the foliation is well developed. No. 1001, from the same locality, is a coarse gneiss in which richly biotitic folia alternate with bands composed of quartz, plagioclase and potash felspar.

In addition to these grey gneisses, there are some others which fall here :—

Nos. 1019 and 1020, both taken from capsized berg to north-east of Hut, are medium grained gneisses composed of white felspar (reddened in parts), grey quartz and some minute flakes of biotite with sub-parallel arrangement. Nos. 1030 and 1031, erratics from moraine at Junction Corner, are medium grained gneisses with rather ill developed foliation. Bands composed of a good deal of biotite, some potash felspar and quartz alternate with wider ones of felspar, quartz and only a little biotite. One, No. 1030, contains pink garnet in its light bands, the garnet now mainly altered to chlorite. No. 1046 is an erratic from Gaussberg. It is a medium grained rock composed of pale pink felspar, white felspar and quartz with a rough foliation marked out by biotite flakes. No. 1137, an erratic from Gaussberg, is a medium grained gneiss with well developed foliation. Pink lenticles composed of bright pink felspar and quartz are surrounded by dark bands which carry abundant chlorite.

Next we deal with two white gneisses, very different in appearance from those dealt with above.

No. 1053, which is an erratic from Gaussberg, is a white fine grained rock in which scattered flakes of biotite give a rough foliation and grains of brown sphene are common. Seen in thin section (Fig. 24) the rock has a granular, almost aplitic, texture. Quartz and plagioclase ($Ab_{70}An_{30}$) are about equally abundant and there are minor amounts of orthoclase and microcline. There is a little decomposed biotite, one or two

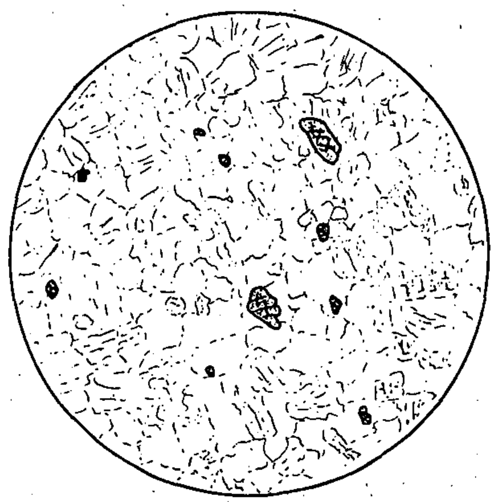

Fig. 24.

Sphene-bearing gneiss (1053). Large grains of sphene in a fine grained matrix of quartz and felspar (mainly plagioclase). Other parts of the section show scattered flakes of biotite.

flakes of greenish blue hornblende, and pale brown sphene in crystals of some size is present in fair amount. Scapolite is replacing part of the plagioclase and also occurs to some extent interstitially. Amongst the accessories zircon in large crystals is rather noticeable, magnetite is common, apatite needles are enclosed in the quartz, there are some little flakes of muscovite formed at the expense of plagioclase and, finally, a little orthite.

No. 1070, which is an erratic from Haswell Island, is a fine grained white rock showing abundant white felspar and greyish quartz. Small flakes of biotite scattered about give the rock a rough foliation and small bright pink garnets are sporadically developed. In thin section the rock shows a good deal of microcline and abundant quartz which may or may not show signs of strain. Some of the quartz is drawn out in the direction of foliation and then stands out as comparatively large grains. Plagioclase ($Ab_{75}An_{25}$) is present in fair amount and some of the grains and hypidiomorphic crystals show secondary twinning and bending of the lamellae. A few scattered flakes of biotite are to be seen and there is a little secondary muscovite developed at the expense of plagioclase. The garnet seen in hand specimen is anhedral and colourless in the section. The texture is granular but of variable grain size, with a tendency for the microcline to be interstitial and the plagioclase to be hypidiomorphic.

Finally, we have a group of hornblende bearing gneisses.

No. 1034, an erratic from moraine at Junction Corner, is a dark medium grained gneiss with rather ill developed foliation and augen of greyish felspar. Under the microscope these augen are found to be composed of microperthite partly or wholly enclosing grains of all the other constituents. The remainder of the rock is composed of a medium grained aggregate of quartz, plagioclase, microperthite, biotite and hornblende. The texture is granitic, the plagioclase ($Ab_{60}An_{40}$) is in excess of the quartz (which is unstrained) and microperthite is subordinate. Both biotite and hornblende are common, the former in small flakes pleochroic from pale straw to deep chocolate brown, the latter in small irregular plates and crystals with $X =$ yellow brown, $Y =$ deep brown, $Z =$ deep brownish green and $Z \wedge c = 26°$. Some interstitial calcite is present associated more particularly with the dark minerals as are apatite and zircon together with minor amounts of sphene. A little ilmenite occurs, some of which is rimmed with sphene. The mode of this rock is as follows :—

Quartz	9·4
Potash Felspar	29·1
Plagioclase	43·2
Biotite	6·6
Hornblende	10·4
Accessories	1·3

No. 1035, an erratic from moraine at Junction Corner, is a very similar rock to the above but with much better foliation. The augen of felspar are here hardly noticeable. In thin section the rock agrees quite closely with No. 1034 except that the augen of microperthite are no longer noticeable and that there is rather less hornblende. A good deal of myrmekite is present here and the quartz is somewhat strained. There are also two hornblende gneisses which have not been sectioned.

No. 1032, an erratic from moraine at Junction Corner, is a coarse gneiss with large augen of white felspar and composed of quartz, felspar, rather abundant hornblende and biotite. No. 1137A, an erratic from Gaussberg, is a rather coarse hornblende gneiss carrying a fair amount of pink garnet.

B. Crushed Granitic Rocks.

Under this heading we deal with a few examples of acid rocks which have suffered crushing to a greater or lesser extent. The first two are massive rocks, the last two are gneissose.

No. 1040, an erratic from Gaussberg, is a massive dull red rock showing pink felspars and white quartz. It is seamed with numerous red veins which form a reticulate network between the constituents. Under the microscope (Fig. 25) large grains and fragments of quartz (with signs of strain) and microcline are embedded in a crushed

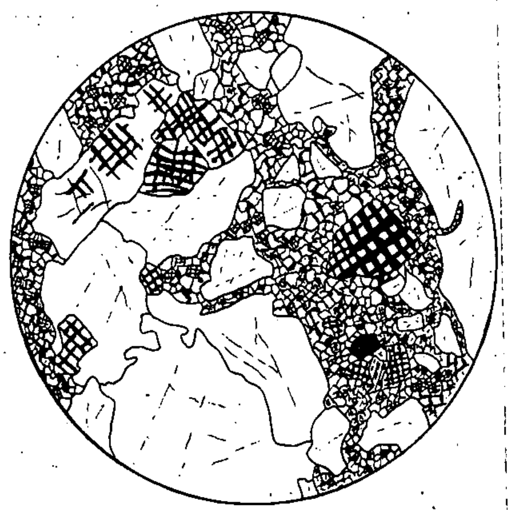

Fig. 25.

Crushed granite (1040). Large grains of quartz and smaller ones of microcline in a crushed matrix of the same constituents together with haematite and a very little decomposed biotite.

matrix of varying grain size of the same constituents together with a little decomposed biotite and rather abundant haematite which is partly in grains and partly cementing the crushed material. In addition very fine veins of crushed material traverse some of the larger quartz and microcline fragments, either going right across or else ending off abruptly in the interior of the grain.

No. 1122 is a loose rock taken from berg in Helen Glacier Bay. In hand specimen it is a rather fine grained massive pink rock with pink felspar, abundant quartz and small flakes of a dark mineral. The specimen is traversed by a number of veins, some of these being brown in colour whilst some are composed of epidote and chlorite. In thin section the rock is seen to be a crushed granite. It is composed of abundant orthoclase and strained quartz with subordinate plagioclase (albite) and a little chloritised biotite. These constituents are crushed down in places along irregular veins into angular fragments of varying size. These fragments are cemented together by a reticulate network of finely granular epidote and chlorite or of limonite.

No. 1127, another loose rock taken from berg in Helen Glacier Bay, is a coarse gneiss in hand specimen showing a fair amount of quartz with subordinate white felspar, rather abundant chlorite marking out the well-developed foliation and with large augen (up to 1½ in. x 1 in. in size) of very pale pink potash felspar. In thin section the rock contains large fragments of microcline-microperthite, one or two of microperthite and a few smaller fragments of plagioclase ($Ab_{60}An_{40}$). These are set in a granular matrix of abundant unstrained quartz, subordinate plagioclase and microperthite, flakes of chlorite (with associated secondary sphene) marking out the foliation, a little biotite, some ilmenite often with a granular sphene border and, finally, some small flakes of white mica.

No. 1129 is a loose rock taken from berg in Helen Glacier Bay. In the hand specimen it is observed to be a grey medium grained gneiss with rather abundant biotite, fairly good foliation and augen of white felspar. Under the microscope the specimen shows fragments and grains of microcline-microperthite, quartz and subordinate plagioclase, sometimes all three of these together in aggregates, set in a granular ground mass. This groundmass is composed of microcline-microperthite, quartz, plagioclase, a fair amount of biotite in small flakes and a good deal of muscovite in flakes and irregular plates. The ground mass is of varying grain size and a good deal of myrmekite is present where the plagioclase meets potash felspar. The accessories include a certain amount of magnetite and some zircon.

These last two rocks appear to be related to the grey acid gneisses from the same locality (see p. 69) and are probably less altered representatives of those rocks. Both of these rocks represent crushed granites which have suffered some recrystallisation and this has chiefly affected the ground mass. In the related grey acid gneisses recrystallisation has gone further.

No. 1012, taken from capsized berg to north-east of Hut, has not been sliced. In hand specimen it is composed of crushed fragments of pale pink potash felspar, white plagioclase (partly reddened) and grey quartz. Folia of chlorite are common and a vein of green epidote crosses the specimen.

C. Crushed Gabbro.

No. 1108, a loose rock from berg at ice foot near Haswell Island, is a coarse grained massive grey rock with large crystals of grey plagioclase and patches of some green dark mineral. In thin section (Fig. 26) the rock reveals itself as a gabbro, now somewhat altered. The chief constituent is plagioclase ($Ab_{45}An_{55}$) in large hypidiomorphic crystals. These are much cracked and faulting has sometimes taken place along the fracture. In addition there is a great development of secondary twinning and the crystals are crushed along certain lines. The interstices between the plagioclase crystals were originally occupied by diallage. This diallage is now replaced by aggregates of (*a*) actinolite and brown biotite flakes, both enclosing a good deal of apatite; or (*b*) fibrous actinolite and grains of magnetite; or (*c*) actinolite and flakes of greenish brown biotite

Fig. 26.

Crushed gabbro (1108) with large plagioclase crystals much cracked, faulted and crushed in places together with augite, now represented by a felted mass of actinolite and biotite.

D. Hornblende Schists.

The first three specimens to be described here are all related.

No. 1076 is an erratic from Haswell Island. It is a black, fine-grained, finely schistose rock in hand specimen. Under the microscope plagioclase and hornblende are the essential constituents and are about equally abundant. The plagioclase is fresh, granular and, for the most part, untwinned. It approximates in composition to $Ab_{67}An_{33}$. The hornblende is present in allotriomorphic and hypidiomorphic crystals with a sub-parallel arrangement. It is pleochroic with X = pale brown, Y = deep brownish green, Z = deep green and $Z \wedge c = 29°$. It encloses a good deal of magnetite. Amongst the accessories magnetite is common, there is a little sphene and zircon, and one or two grains of orthite are present.

No. 1085 is another erratic from Haswell Island. This is very similar in hand specimen to No. 1076 but of somewhat coarser grain. In thin section it is also very similar mineralogically except that a fair number of small sphene crystals and a little apatite are present. It differs, however, in showing crushing effects. The plagioclase has undulose extinction and much of it has been crushed down to an aggregate of small grains, sometimes showing mortar structure. The hornblende has been crushed down in the same way and to much the same extent.

No. 1074, which is another erratic from Haswell Island, is, again, similar in hand specimen to the foregoing. In thin section it is seen to occupy an intermediate position between the two just described. The plagioclase shows undulose extinction but there is no actual crushing of it or of the hornblende.

The remaining specimens which are dealt with here are not associated and do not show crushing effects.

No. 1121 is a rock taken from berg in Helen Glacier Bay. A rather fine-grained highly schistose rock with alternate bands of white plagioclase and dark hornblendic with abundant magnetite. Under the microscope (Fig. 27) the dark hornblendic bands are found to be composed of hypidiomorphic crystals of hornblende associated with abundant magnetite in shapeless plates partially or wholly enclosing the hornblende. In other parts, a good deal of sphene, in both large and small grains, is enclosed. The hornblende has X = pale yellow, Y = brownish green, Z = apple-green and $Z \wedge c = 23°$. A little biotite, pleochroic from pale orange to fox brown, accompanies the hornblende. These hornblende rich bands alternate with ones rich in plagioclase and with strictly subordinate hornblende and a little biotite. The plagioclase is granular, very fresh on the whole, and for the most part well twinned. It has a composition $Ab_{50}An_{50}$. Apatite, in small quantity is accessory. The hornblende grains are larger on the average than those of felspar.

Fig. 27.

Hornblende schist (1121). Hornblende rich folia alternating with one composed of plagioclase.

No. 1105 was collected as a loose rock from berg at ice foot near Haswell Island. In hand specimen this is a black and white schistose rock of medium grain showing abundant black crystals of hornblende and white plagioclase. The rock is somewhat coarser than the preceding one and without the tendency for the segregation of the light and dark constituents (Fig. 28). The hornblende occurs in rather coarse hypidiomorphic crystals with X = pale yellowish, Y = light brown, Z = light greenish brown and $Z \wedge c = 21°$. The colour is patchy, however, and some portions are almost colourless whilst others are of a more greenish hue than the normal type given above. This hornblende encloses a little magnetite. The plagioclase ($Ab_{56}An_{44}$) is granular, mostly well twinned, and fresh. Apatite is a not uncommon accessory.

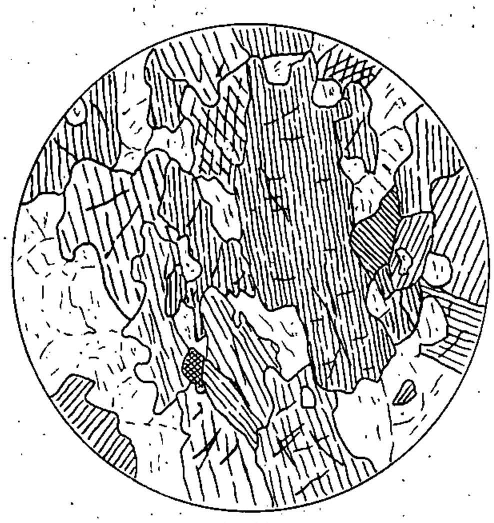

Fig. 28.

Hornblende schist (1105). The section shows well developed hornblende and smaller grains of plagioclase.

No. 1041 is an erratic from Gaussberg. In hand specimen this rock is composed of two distinct portions. One of these is white and composed almost exclusively of felspar. The other is black and mainly composed of little crystals of hornblende. In thin section (Fig. 29) this black portion is seen to be a hornblende fels with schistose structure. This grades rapidly through a portion containing about equal quantities of plagioclase and hornblende to the white portion with plagioclase and strictly subordinate hornblende.

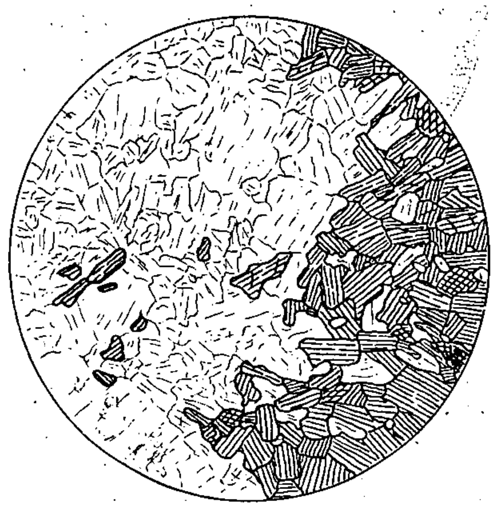

Fig. 29.

Junction of (?) injected vein with hornblende schist (1041). To the right the section is almost a hornblende-fels whilst towards the left, the big plagioclase crystals characteristic of the vein begin to appear.

The hornblende fels is composed of an interlocking mass of hypidiomorphic and allotriomorphic hornblende crystals together with a few small interstitial grains of plagioclase. The hornblende has X = pale yellow, Y = medium brownish green, Z = deep apple-green and $Z \wedge c = 16°$. The intermediate zone is composed of the same hornblende together with fresh grains of plagioclase ($Ab_{64}An_{36}$). The felspar is largely untwinned and where twinning does occur, the Pericline law is more frequent than the Albite law. A little apatite and some magnetite occur as accessories here.

The felspathic portion is composed, for the most part, of coarse hypidiomorphic crystals of plagioclase which are intensely decomposed. In small patches, where the alteration is not so intense, albite veining may be seen. Usually, however, the crystals are a mass of sericite and prehnite. In addition some smaller grains of hornblende and plagioclase are present, similar to those of the intermediate zone. The foliation of the hornblende fels makes an angle with the felspathic portion and it is very probable that the felspathic portion represents an injected vein.

No. 1016 is a rock taken from capsized berg to north-east of Hut. This has not been sectioned but is a dark fine-grained rock composed of white felspar, black hornblende and with rather feeble schistosity.

E. Thermally Metamorphosed Dolerite.

Only one specimen falls here, namely No. 1077, which is an erratic from Haswell Island. In hand specimen this is a black, massive, fine-grained rock. Under the microscope the light and dark constituents are present in roughly equal proportions. The original ferro-magnesian constituent was a monoclinic pyroxene. This is now largely represented by a pale green actinolitic amphibole with the excretion of a good deal of magnetite. A feature of the rock is the abundance of deep brown biotite which is derived from the amphibole and occurs in aggregates of small flakes which are particularly concentrated in the vicinity of iron ore. The plagioclase is hypidiomorphic in crystals of varying size. Some have innumerable small black rod-like inclusions, particularly certain rather larger crystals which are present. These also contain small inclusions of orthoclase. All the plagioclase has a composition $Ab_{68}An_{32}$ with the exception of a few zoned crystals where the composition ranges from $Ab_{48}An_{52}$ to $Ab_{68}An_{32}$. A good deal of this plagioclase carries globular inclusions of magnetite and, in addition, it encloses numerous needles of apatite. Finally, there is a very little orthoclase small in plates which has actively corroded the plagioclase wherever the two come into contact. It is apparent from the above description that we are dealing with a basic igneous rock, probably a dolerite, which has been thermally metamorphosed and affected by acid material to some extent. Most likely the specimen has come from a xenolith which was enclosed in an acid magma.

IV. METAMORPHOSED SEDIMENTARY ROCKS.

A. Calcareous.

Two specimens are to be described here. The first, No. 1088, an erratic from Haswell Island, is a white medium grained marble composed of interlocking grains of calcite.

The second, No. 1050B, an erratic from Gaussberg, represents less pure calcareous material. In hand specimen it is a green medium grained rock with abundant pale green pyroxene, some pink calcite and a certain amount of orange brown garnet. In thin section (Fig. 30) the rock is found to contain colourless monoclinic pyroxene, clinozoisite, garnet, sphene, plagioclase, a little hornblende, scapolite and calcite. The pyroxene is

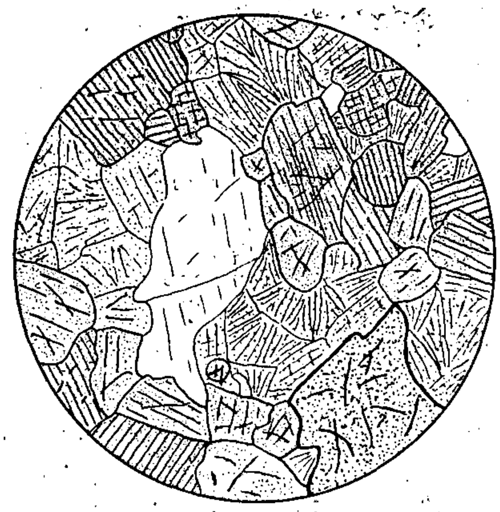

Fig. 30.

Impure metamorphosed limestone (1050B). The section shows abundant diopsidic pyroxene, some garnet, a little plagioclase and common interstitial clinozoisite.

the most abundant constituent in well-formed crystals which show good lamellar twinning parallel to (001). It is biaxial, positive with $Z \wedge c = 40°$. This pyroxene is occasionally changing over to a beautiful blue green hornblende with small extinction angle. The clinozoisite is the next most abundant mineral in fairly good crystals but aggregated so that the whole plays an interstitial role. The sphene is fairly common in small grains and crystals which are pleochroic from very pale to somewhat darker brown. The basic plagioclase is not common but occurs in fairly well formed crystals with a patchy twinning under crossed nicols. Its exact composition could not be determined. Scapolite is present in some quantity in plates with strong birefringence. The garnet is colourless or very pale brown, quite isotropic, anhedral and not abundant. In places it appears to be changing over to clinozoisite. A little interstitial calcite occurs all through the section but is chiefly in patches associated with a little pyroxene, garnet and sometimes scapolite. There seems to be a definite antipathy between the calcite and the clinozoisite. The crystalloblastic order appears to be pyroxene, sphene; garnet, plagioclase; clinozoisite, scapolite; calcite.

B. Semi-Argillaceous.

The first specimen to be described here is of rather peculiar type. It is No. 1052, an erratic from Gaussberg, and is a biotite-cummingtonite-iron ore-garnet schist. In hand specimen the rock is fine grained with rather ill-developed schistosity. Brown biotite, yellow felspar, quartz, a dark greyish mineral, black iron ore and a little pink garnet can all be made out. Under the microscope (Fig. 31) the dark greyish mineral turns out to be a colourless amphibole. This amphibole is biaxial positive with $Z \wedge c = 20°$ and medium birefringence. It is inclined to be fibrous and repeated

Fig. 31.

Biotite-cummingtonite-iron ore-garnet schist (1052), showing abundant biotite, cummingtonite and magnetite with noticeable apatite and a very little garnet together with quartz and plagioclase.

twinning parallel to (100) (?) is not uncommon. The amphibole would thus appear to belong to the cummingtonite series. The biotite is in small flakes pleochroic from medium straw to dark brown. Both these minerals are fairly abundant, the amphibole being rather more so than the biotite. The iron ore (magnetite) is very common in irregular masses and in grains of smaller size. Little anhedral grains of pale pink garnet are not uncommon but are sporadically developed. This garnet has minute vermicular inclusions giving a kind of intergrowth structure. These could not be determined with certainty but seem to be of quartz. The remainder of the rock is composed of quartz and plagioclase ($Ab_{59}An_{41}$) in about equal quantities. Both include grains of iron ore and rounded apatite which is a common accessory. Finally, there is a little zircon. The texture as a whole is granular with the exception of the biotite and amphibole which are hypidiomorphic.

The text specimen, No. 1128, from a berg in Helen Glacier Bay, is a biotite-garnet schist. In hand specimen it appears as a rather fine grained schistose rock, the schistosity marked out by abundant parallel flakes of biotite. The remainder is apparently of quartz and felspar and a coarser portion or vein of these two components runs parallel to the schistosity. In thin section (Fig. 32) there is abundant biotite in small flakes, pleochroic from pale straw to deep chocolate and with a marked parallel arrangement. In addition there are a few small grains of pale pink anhedral garnet. The remainder of the rock is composed of about equal quantities of plagioclase ($Ab_{61}An_{39}$) and quartz. Both are granular but the quartz grains tend to be somewhat elongated in the direction of schistosity. Amongst the accessories apatite is fairly abundant, magnetite is common, there is a little pyrite, some rounded crystals of zircon and one or two little flakes of muscovite are also present. The coarser band noticed in the hand specimen is composed of plagioclase, quartz, some garnet and a little biotite. It is not well marked out from the remainder of the rock in thin section.

Fig. 32.
Garnet-biotite schist (1128) with biotite, garnet, plagioclase and quartz.

The next four specimens are all gneisses of one sort or another. The first, No. 1078, an erratic from Haswell Island, is a biotite-garnet-gneiss of fairly coarse texture (Fig. 33). Biotite, pleochroic from medium straw to almost opaque muddy brown, is abundant in clots composed of aggregates of large flakes enclosing a fair amount of

Fig. 33.
Garnet-biotite gneiss (1078) with garnet, biotite clots (with a good deal of enclosed apatite), quartz, plagioclase, potash felspar and myrmekite.

apatite and zircon. These clots are elongated in the direction of foliation. Anhedral garnet, colourless and quite isotropic in thin section, is associated both with the biotite clots and the light constituents. This garnet is occasionally altering to chlorite along cracks. The remainder of the rock is composed of quartz and plagioclase ($Ab_{68}An_{32}$) with a small amount of potash felspar (both orthoclase and microcline), some small flakes of biotite and a little muscovite associated with this biotite. The quartz shows signs of strain in places, the plagioclase shows some secondary twinning and is much sericitised in parts. Myrmekite is not uncommonly developed between plagioclase and quartz and between plagioclase and potash felspar.

No. 1071, an erratic from Haswell Island, is a fine grained, beautifully banded biotite gneiss. The light bands are composed mainly of quartz and felspar whilst the dark bands have a large proportion of biotite. Under the microscope (Fig. 34) the biotite is a muddy brown variety (partly chloritised) which occurs in abundant small parallel flakes marking out the dark bands. These alternate with granular areas which contain

Fig. 34.

Fine grained biotite gneiss (1071) showing biotite, quartz and plagioclase.

subordinate biotite and are composed chiefly of quartz, orthoclase and plagioclase. The quartz is unstrained and elongated in some places in the direction of foliation. The plagioclase ($Ab_{71}An_{29}$) is more abundant than the orthoclase which only occurs in certain areas following the direction of foliation. Accessory zircon and rounded grains of apatite are associated with the biotite.

No. 1045, an erratic from Gaussberg, is a similar banded biotite gneiss but of coarser grain and with coarser, less well developed banding. It has not been sectioned.

The final specimen is No. 1114, obtained from the pinnacle berg in Helen Glacier Bay, and this is a garnet-sillimanite-cordierite-biotite-muscovite gneiss. It is a white medium grained rock in hand specimen showing quartz and felspar and some muscovite with scattered flakes of biotite and small pink grains of garnet. In thin section, quartz and microcline-microperthite are the two most noticeable minerals in large and smaller grains. Some of the microcline-microperthite is also present as large irregular plates. Plagioclase ($Ab_{72}An_{28}$), in medium sized grains, is subordinate. Some fox-red biotite is present in small flakes and there is a good deal of muscovite, partly in large irregular plates partially enclosing the other constituents, and partly in large flakes running parallel to the foliation of the rock. Sillimanite occurs as small needles and also as felted masses which are elongated parallel to the foliation. It may be abundantly enclosed in muscovite. A little cordierite occurs in small rounded grains which may show simple twinning and which may be altered to a pale green isotropic material. The main sillimanite clusters are associated with the cordierite in patches and one rather gets the impression that this rock is a mixed one. The garnet noticed in hand specimen had not been included in the thin section.

V. THE ROCKS CLASSIFIED ACCORDING TO LOCALITY.

All collected in the region between "The Grottoes" and Gaussberg.

A.—Gravel and Rocks taken from Capsized Berg to north-east of Hut.

(*a*) Grey acid igneous biotite gneisses, Nos. 1001, 1002, 1003, 1005, 1008, 1009, 1010, 1011, 1014, 1015, 1018, 1021 and 1023.
(*b*) Acid igneous biotite gneisses, Nos. 1019 and 1020.
(*c*) Crushed granite, No. 1012.
(*d*) Pink biotite granite, Nos. 1006, 1007, 1013, 1017 and 1022.
(*e*) Hornblende schist, No. 1016.

B.—Rocks from Moraine at Junction Corner.

(*a*) Acid igneous biotite-garnet gneiss, No. 1030.
(*b*) Acid igneous biotite gneiss, No. 1031.
(*c*) Acid igneous hornblende gneisses, Nos. 1032, 1034 and 1035.
(*d*) Grey acid igneous biotite gneiss, No. 1033.

C.—Erratics from Gaussberg.

(*a*) Biotite granites—
  (i) Nos. 1048, 1049 and 1054.
  (ii) No. 1047.
  (iii) No. 1042.
(*b*) Hornblende granites, Nos. 1044 and 1057.
(*c*) Tonalite, No. 1056.
(*d*) Pink acid igneous gneiss, No. 1137.
(*e*) Grey acid igneous biotite gneiss, No. 1055.
(*f*) Acid igneous garnet-hornblende gneiss, No. 1137A.
(*g*) White biotite-sphene gneiss, No. 1053.
(*h*) Crushed granite, No. 1040.
(*i*) Injected hornblende schist, No. 1041.
(*j*) Metamorphosed impure limestone, No. 1050B.
(*k*) Biotite-cummingtonite-iron ore-garnet schist, No. 1052.
(*l*) Sedimentary biotite gneiss, No. 1045.
(*m*) Quartz vein, No. 1043.

D.—Gaussberg.

(*a*) Leucite basalt, Nos. 1050A, 1060A and 1060B.

E.—Erratics from Haswell Island.

(*a*) Aplogranite, No. 1087.
(*b*) Fine-grained granite with dolerite xenolith, No. 1136.
(*c*) Coarse biotite granite, No. 1072.
(*d*) Hornblende granite, No. 1082.
(*e*) Biotite granodiorite, No. 1090.
(*f*) Tonalite, No. 1079B.
(*g*) Basic charnockites, Nos. 1075 and 1091.
(*h*) Grey acid igneous biotite gneiss, No. 1086.
(*i*) Grey acid igneous muscovite-biotite gneiss, No. 1081.
(*j*) White garnet gneiss, No. 1070.
(*k*) Hornblende schists, Nos. 1074, 1076 and 1085.
(*l*) Marble, No. 1088.
(*m*) Coarse-grained sedimentary biotite-garnet gneiss, No. 1078.
(*n*) Fine-grained sedimentary biotite gneiss, No. 1071.
(*o*) Quartz veins, Nos. 1080 and 1084.

F.—Specimens from Haswell Island, *in situ*.

(*a*) The main rock type—Coarse acid charnockite, Nos. 1095A, 1095B and 1095C.
(*b*) Specimen from vein in the above—Fine-grained acid charnockite, No. 1100.
(*c*) Specimen from vein in the acid charnockite—Massive grey-brown quartz, No. 1102.
(*d*) Specimen from vein in the acid charnockite—Granite aplite, No. 1103.

G.—Gravel and Loose Rock from Berg at Ice-foot, near Haswell Island.

(*a*) Hornblende granites, Nos. 1106 and 1110.
(*b*) Crushed gabbro, No. 1108.
(*c*) Hornblende schist, No. 1105.
(*d*) Massive grey-brown quartz, No. 1107.

H.—Rocks taken from Pinnacle Berg in Helen Glacier Bay.

(*a*) Biotite granite, No. 1115.
(*b*) Hornblende granodiorite, No. 1118.
(*c*) Garnet-sillimanite-cordierite-muscovite-biotite gneiss, No. 1114.

I.—Loose Rock taken from Two Bergs in Helen Glacier Bay.

(*a*) Biotite granites, Nos. 1120 and 1131.
(*b*) Hornblende granites, Nos. 1124, 1130, 1133 and 1134.
(*c*) Hornblende granodiorite, No. 1126.
(*d*) Trondhjemitic type, No. 1125.
(*e*) Grey acid igneous muscovite-biotite gneisses, Nos. 1132 and 1135.
(*f*) Crushed granites—
  (i) No. 1122.
  (ii) Nos. 1127 and 1129.
(*g*) Hornblende schist, No. 1121.
(*h*) Biotite-garnet schist, No. 1128.

The distribution of the various types brings out some points of interest as far as the present collection is concerned. It is noticeable that the grey acid igneous gneisses are represented amongst the erratics from most of the localities. Similar considerations apply to the hornblende schists and to biotite granite. Hornblende granites are not quite so widely distributed and in this they agree with the metamorphosed sediments. Hornblende gneisses are only found as erratics at one locality and the same applies to biotite granodiorite, whilst hornblende granodiorite is confined to erratics from Helen Glacier Bay. The charnockites are confined to Haswell Island and to erratics taken from that island. Crushed granites are of restricted distribution and crushed gabbro is confined to an erratic from the Haswell Island region. Such are the main facts which can be gathered about the distribution of the various types but these results, of course, might be severely modified by further collecting.

VI. COMPARISON WITH OTHER AREAS.

In comparing the present collection of rocks with those of other areas in the Antarctic, it is natural to turn first to Kaiser Wilhelm II Land, more particularly as some of our material is comprised of erratics from Gaussberg. Erratic material from icebergs and the moraines at Gaussberg has been described from Kaiser Wilhelm Land by Reinisch (R. Reinisch, Deutsche Südpolar-Expedition, 1901–1903, vol. 2, Part 7, pp. 631–640). Our erratics from Gaussberg, although agreeing in a general way with those described by Reinisch, do not seem to be exactly identical. He describes biotite granites with microcline-microperthite as the potash felspar but none with fluorspar or with orthite, both minerals contained in the Gaussberg biotite granites of the present collection. The hornblende granites appear to be very similar in both collections but he does not mention tonalite. The grey acid igneous biotite gneiss in our Gaussberg material can be correlated with specimens described by Reinisch, whilst he also describes a sphene-bearing gneiss rather similar to the one in the present collection but without scapolite. He mentions hornblende schists and a calc-silicate rock which is similar to but not identical with the impure metamorphosed limestone of the present collection. He further describes a number of types not represented in our collection from Gaussberg but, on the other hand, the quartz vein, the sedimentary biotite gneiss and the biotite-cummingtonite-iron ore-garnet schist, described in the present report, are not represented amongst his specimens.

When we leave the erratics from Gaussberg and consider the present collection as a whole, we also find a very general similarity of the material to that described by Reinisch. In addition to the actual material from Gaussberg with which we have already dealt, the other biotite granites, hornblende granites, hornblende schists, acid igneous biotite and biotite-muscovite gneisses and the hornblende gneisses all show a good deal of similarity, in some cases amounting to identity, with specimens mentioned by him. He also finds gabbro which would probably be much the same as the crushed gabbro of the present report were the latter in an unaltered condition. Finally, the metamorphosed sediments also offer certain points of similarity.

Secondly, we turn to Eastern Queen Mary Land, where a fair amount of material has been collected and described (S. R. Nockolds, Report on a Series of Rocks from Eastern Queen Mary Land*). Here, again, we have biotite and hornblende granites but they are not strictly comparable to anything found in the present collection. The fine-grained granite with doleritic xenoliths (from an unknown locality) is, however, exactly comparable with specimens from Eastern Queen Mary Land. In the collection from the latter area there are no granodiorites and tonalites whilst the trondhjemitic type found there is of more basic nature than the one described in the present report. Both areas contain members of the charnockite series but the acid members in Western Queen Mary Land are coarser and do not show the banding characteristic of those in Eastern Queen Mary Land. With regard to the acid igneous gneisses, the grey muscovite bearing varieties in the present collection may possibly be related to the Group II gneisses of Eastern Queen Mary Land. Apart from this the gneisses of the two areas are not very comparable. The thermally metamorphosed dolerite described here is similar to some described from Eastern Queen Mary Land and one or two of the crushed granitic rocks bear some resemblance to the least altered of the chlorite-epidote-albite rocks found in the latter area. The one metamorphosed sedimentary specimen from Eastern Queen Mary Land is not comparable to any found in this collection from Western Queen Mary Land.

On the whole it is evident that the present collection of rocks from the basal complex of Antarctica shows a much greater resemblance to material described from Kaiser Wilhelm Land than to material described from Eastern Queen Mary Land. If it is possible to draw conclusions from the limited amount of material collected, then we notice that on going westwards from Eastern Queen Mary Land, there is an increase in the amount of metamorphosed sediments, a greater abundance of hornblende schists, a decrease in the importance of the charnockite series and the incoming of such rock types as gabbro. These features are apparently continued into Kaiser Wilhelm II Land.

* Now published as Section I of Dr. Nockold's report. [Ed.]

EXPLANATION OF THE MICROPHOTOGRAPHS OF PLATE III.

Fig. 1. Acid charnockite (No. 1313) showing hypersthene, diopsidic pyroxene, quartz, orthoclase and plagioclase. Ordinary light, × 30.

2. Basic charnockite (No. 1315) with abundant hornblende, plagioclase and minor amounts of diopsidic pyroxene and hypersthene. Ordinary light, × 25.

3. Ultrabasic charnockite (No. 1376). Greenish brown hornblende, diopsidic pyroxene, hypersthene and subordinate biotite. Ordinary light, × 30.

4. Schistose basic charnockite (No. 1326). Hypersthene, monoclinic pyroxene, biotite and plagioclase. Ordinary light, × 20.

5. Metamorphosed dolerite (No. 1385), showing laths of felspar with innumerable dusty inclusions, hornblende and biotite. Ordinary light, × 40.

6. Pseudotachylyte (No. 1362) with fragments of quartz and felspar, and numerous vesicles now filled with calcite, chlorite, etc. Ordinary light, × 10.

Fig. 1.

Fig. 2.

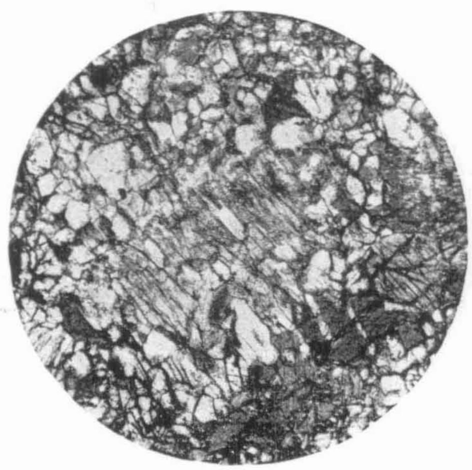

Fig. 3.

Fig. 4.

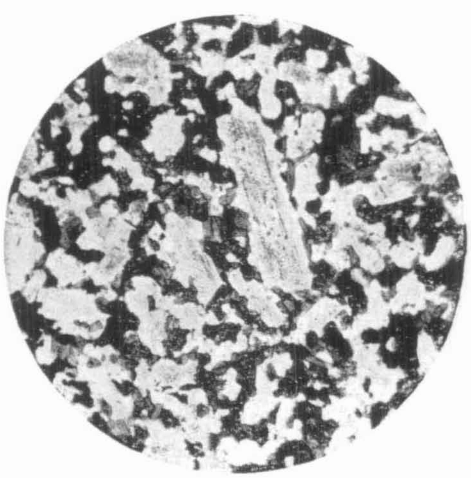

Fig. 5.

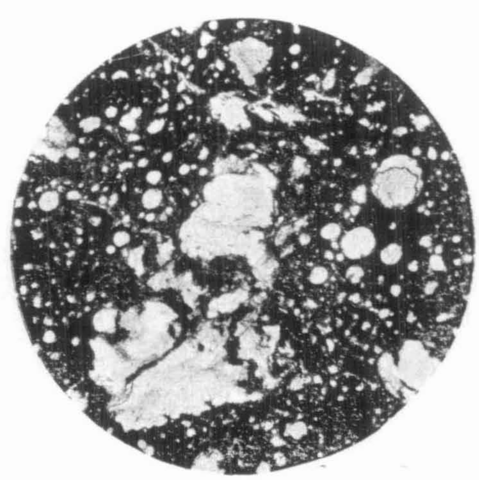

Fig. 6.

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