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GEOLOGICAL WORK IN ANTARCTICA - 1976

by

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SUMMARY

Thirty-three localities in Enderby Land, and Rippon Depot in Kemp Land were visited during the 1975/76 summer field season by two Bureau of Mineral Resources (BMR) geologists, seconded to the Australian National Antarctic Research Expedition (ANARE). Most of the rocks exposed in the area are granulite facies metamorphic rocks, comprising garnet-quartz-feldspar gneiss and pyroxene-quartz-feldspar gneiss with subordinate pelitic, siliceous, and ferruginous metasediments, and mafic and ultramafic rocks. The origin of many of these rocks is uncertain. Widespread, massive, brown-weathering orthopyroxene-quartz-feldspar gneiss may have been derived from either greywacke-type sediments or acid volcanics, but most of the strongly layered garnet-quartz-feldspar gneiss is probably of sedimentary origin. Massive granitic gneiss, which occurs at a number of localities (e.g. Proclamation and Sheelagh Islands and Point Widdows), is probably of intrusive igneous origin, and some slightly discordant mafic and ultramafic rocks appear to be metamorphosed dykes.

Metamorphism under medium and, locally, high-pressure granulite facies conditions accompanied the formation of the present main foliation, and was followed by major asymmetric folding, with associated localised retrogression. A suite of crosscutting dolerite dykes appears to be confined to central Enderby Land (the Raggatt, Scott, Tula, and Napier Mountains). Elsewhere, particularly to the west of the Rayner Glacier, the rocks have been metamorphosed at upper amphibolite to lower granulite facies. This metamorphism is thought to post-date the dolerites - although the evidence is not conclusive - and may have been contemporaneous with a post-dolerite granulite-facies event in the Rippon Depot area. It may also be represented by localised high-pressure metamorphism in shear zones (e.g. Fyfe Hills and Mount Pardoe), and by amphibolite-facies retrogression elsewhere in central Enderby Land. Late-stage, low-grade retrogression accompanied the formation of mylonite zones and pseudotachylite veins. Granite and pegmatite, mostly confined to the area west of the Rayner Glacier, were intruded about 500 m.y. ago.

(b)

No mineral deposits of economic significance were found during the 1975-76 field season. Layers of quartz-garnet-orthopyroxene rock with up to 25 percent of magnetite by volume were found at Mounts Stadler and Jewell, Fyfe Hills, Latham Peak, and McLeod Nunataks, but none was thicker than a few metres. Green, copper-rich encrustations are quite widespread, but do not appear to indicate significant concentrations of copper minerals in the host rocks.

INTRODUCTION

Two BMR geologists from the Bureau of Mineral Resources (BMR) were seconded to the Australian National Antarctic Research Expedition (ANARE) for the 1975/76 summer field operations in Enderby Land. The major objectives were essentially the same as the previous year, when, owing to bad weather at the Knuckey Peaks base camp and problems with aircraft, few of the planned objectives were achieved (Pieters & Wyborn, 1977). Priority in field operations during the 1975/76 season was assigned to surveying, and geological mapping was therefore restricted by the requirements of that program. Nevertheless, there was some opportunity for independent geological work.

In all, 34 localities were visited, 17 with the survey parties. This was sufficient to enable a general appraisal of the geology of the area to be made in preparation for a major geological effort during the 1976/77 summer season. Most of the important outcrops within a 25 km radius of the Mount King base camp were examined using a helicopter not involved in moving survey parties. Mount King and Seavers Ridge were visited by snowcruiser. A high geological priority was a visit to the small nunatak 8 km east-northeast of Pythagoras Peak in the Tula Mountains. This was examined in 1958 by McLeod (McLeod, 1959), who collected a rock containing coexisting sapphirine and quartz, an indication of very high temperatures of metamorphism (Dallwitz, 1968). A large amount of material was collected from this locality, and is now the subject of detailed petrographic, petrological, and geochemical studies. Both geologists visited the Soviet base at Molodezhnaya; unfortunately there were no Russian geologists in residence at the time.

The most extensive exposures are the Tula, Scott, Raggatt, and Nye Mountains in the central part of Enderby Land. Elsewhere - in the Enderby Land Peninsula and west of the Rayner Glacier - outcrops are mostly small and isolated. Mounts Norvegia, Christensen, and Nils, immediately to the west of the Rayner Glacier, are largely snow-covered, and areas of exposed rock are small. Most of the nunataks consist of jagged peaks and ridges, although the relatively flat, low-lying, glaciated outcrops of the Howard Hills and elsewhere between the Auster and Beaver glaciers are exceptions. Large, flat-topped mountains similar to those in the southern Prince Charles Mountains are notably absent.

The rocks of Enderby Land, which form part of the Precambrian East Antarctic Shield, consist almost entirely of high-grade (granulite facies) metamorphics, although they commonly show the effects of retrogression. Igneous rocks include dolerite dykes, granitic veins, and pegmatites. Brief visits have been made by Australian geologists to a few localities in Enderby Land, and descriptions are given by Crohn (1959), McLeod (1959, 1964), McLeod et al. (1966), and Ruker (1963). Rocks collected from Proclamation Island by the B.A.N.Z. Antarctic Research Expedition were described by Tilley (1937). Details of geological observations made during the 1974/75 season, mostly in eastern Enderby Land and western Kemp Land, are given by Pieters & Wyborn (1977). More extensive mapping was carried out by Soviet geologists during the 1960s, and results are summarised in Kamenev (1972, 1975). Detailed geological studies of the area around Molodezhnaya station are described in Grew (1975) and Grew & others (personal communication, 1977). Soviet geologists recognised two metamorphic zones in Enderby Land - an older Napier zone or complex, extending from the Napier to the Raggatt Mountains and composed of high-temperature granulite-facies rocks, and the Rayner zone, consisting of at least partly reworked, upper-amphibolite to lower-granulite facies metamorphics, which more or less surrounds the Napier zone. Rocks from the Napier zone have been dated by Pb-Th-U methods at 3900 $\pm$ 300 m.y. (Ravich & others, 1974).

In the first part of this Record the geology of each locality visited is described to provide an information base for future workers, although this has inevitably resulted in a somewhat disjointed account. Localities are grouped roughly according to 1:250,000 Sheet areas, from north to south, although some variations to this have been made to allow geologically similar areas to be described together. More general accounts, of the metamorphism, geological history, and economic geology are given in the final part of the Record.

Nomenclature

The problems of the nomenclature of granulite-facies rocks have been discussed by Pieters & Wyborn, (1977). and we follow these authors in using the general term 'gneiss', with appropriate mineral qualifiers in order of increasing abundance. Unfoliated metamorphic rocks, in hand specimen or outcrop, are referred to as 'granulite', following the usage of Joplin (1968 - 'a relatively coarse, granular rock occurring in the granulite facies, typically with a granuloblastic texture'), rather than 'granofels' (Goldsmith, 1959), which does not seem to have found widespread acceptance. The terms 'charnockite' and 'enderbite' are not used, hypersthene granite and hypersthene tonalite being preferred for intrusive, hypersthene-bearing rocks (Streckeisen, 1974).

Textural terms are taken from Joplin (1968). Granoblastic refers to a rock composed of a 'mosaic or irregular grains or xenoblasts normally with well sutured boundaries', whereas a granuloblastic texture indicates a 'mosaic of xenoblasts with smooth intergranular boundaries or straight edges approximating to a polygonal arrangement'. The usual igneous grainsize classification is used - i.e., a medium-grained rock has a grain size of 1 - 5 mm.

GEOLOGY OF AREAS VISITED

Rippon Depot

Rippon Depot (193 m), an ANARE fuel dump for the past two summer field seasons, is situated on a spur between the Rippon and Seaton Glaciers at the head of Edward VIII Gulf. Isolated outcrops on the spur are partly smoothed and striated from ice abrasion, and consist of greyish green, fine to medium-grained, massive pyroxene-quartz-feldspar gneiss containing xenoliths and thin layers of mafic rock (Figs. 1, 3).

The gneiss characteristically consists of mesoperthite, quartz, orthopyroxene, and minor zircon and apatite, although locally it contains layers ranging in width from 5 to 50 mm, composed of feldspar, quartz, pyroxene, biotite, and garnet.

Mafic rocks range from non-layered granuloblastic to gneissic, and include xenoliths from several centimetres to tens of metres long, and layers up to 3 cm thick. They are fine to medium-grained, and consist of orthopyroxene, colourless to pale green clinopyroxene, brown hornblende, plagioclase, reddish-brown biotite, and opaque grains. One sample (76283106) also contains a pale green amphibole. Some of the mafic rocks contain aggregates of medium to coarse-grained pyroxenite, and one (76283108) contains secondary orthopyroxene at the boundaries of hornblende crystals and between hornblende and plagioclase grains, indicating a prograde reaction.

Many of the mafic bodies are intruded by granitic veins derived by anatexis of the pyroxene-quartz-feldspar gneiss (Fig. 2), and both are intersected by mafic dykes up to 50 cm wide. The dykes have a recrystallised granular texture, and consist of pale green clinopyroxene, orthopyroxene, plagioclase, opaque grains, and minor green hornblende and ?quartz.

Most of the pyroxene-quartz-feldspar gneiss is poorly foliated, although there is a slight compositional layering parallel to the mafic xenoliths and layers. The foliation generally trends about 295°, and dips vertically. In places tight to isoclinal, mesoscopic folds have axes that plunge 80° to 280° (Figs. 3,4,5). A later deformation buckled these earlier folds (Figs. 5,6), but apparently did not affect the metamorphosed

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Fig. 1. Rippon Depot. Mafic xenoliths and thin, disrupted mafic layers within pyroxene-quartz-feldspar gneiss. (Neg. GB 1028). The sledge hammer handle is about 90 cm long.

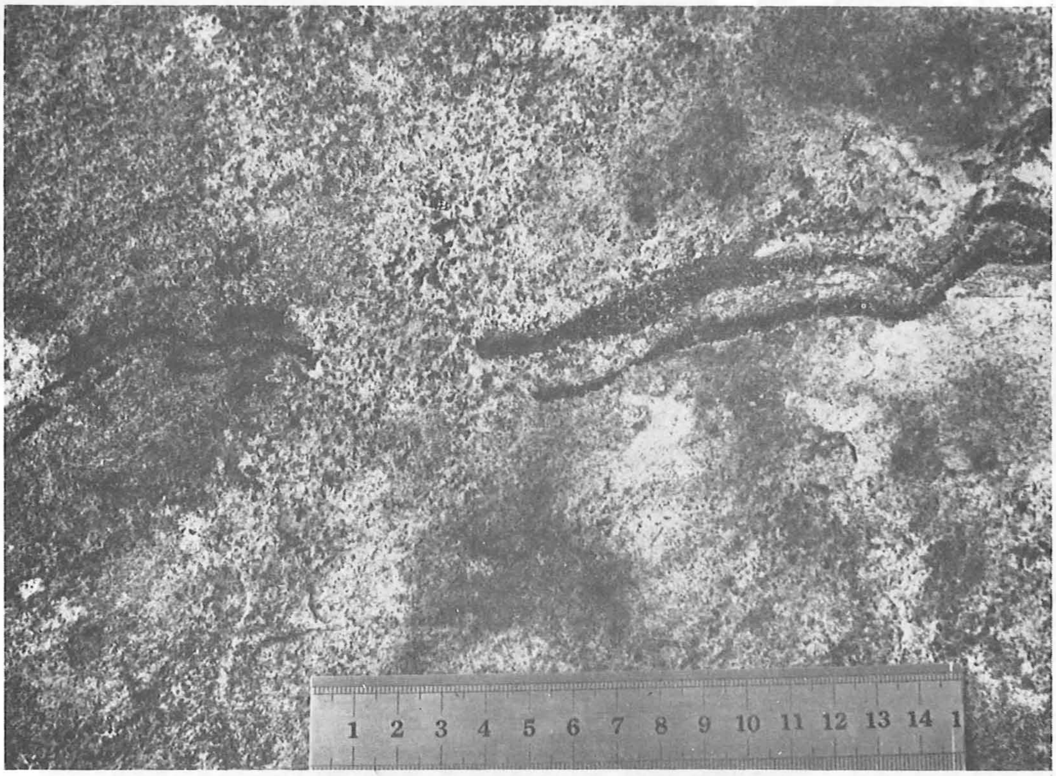

Fig. 2. Rippon Depot. Moblisate generated from pyroxene-quartz-feldspar gneiss cutting thin mafic layers. Scale in cm. (Neg. GB 1029).

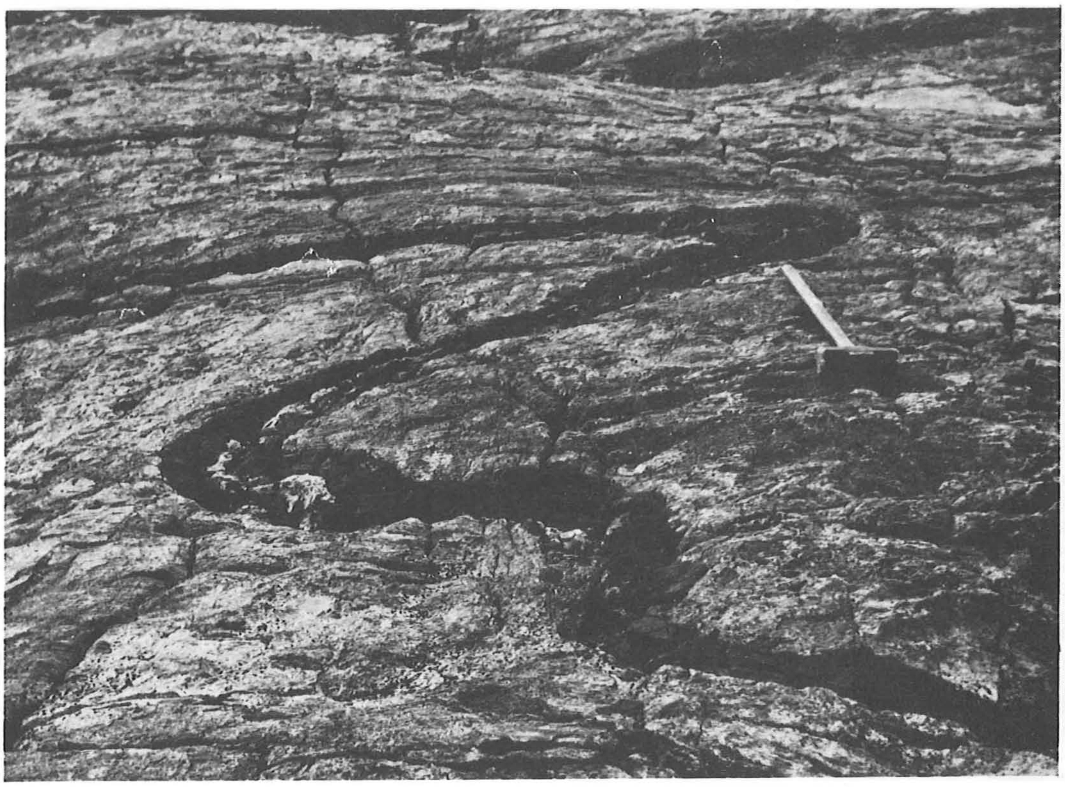

Fig. 3. Rippon Depot. Folded mafic layer. Sledge hammer handle is 90cm long. (Neg. GB 1030).

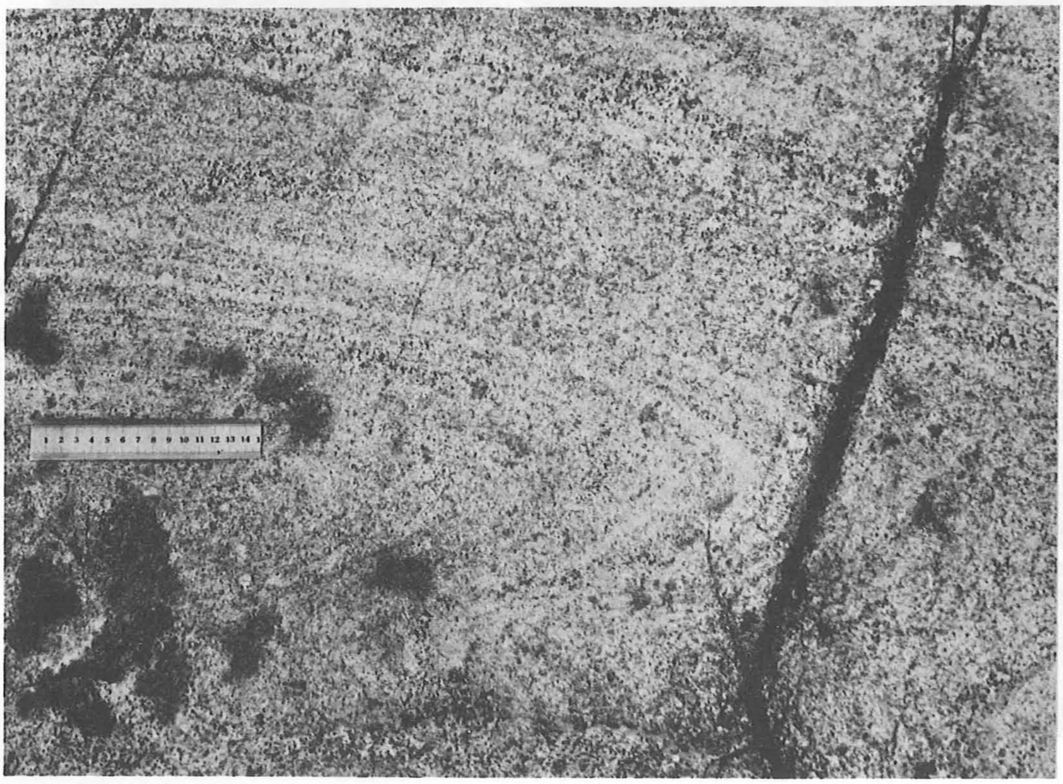

Fig. 4. Rippon Depot. Tight fold in weakly foliated pyroxene-quartz-feldspar gneiss, Scale in cm. (Neg. GB 1023).

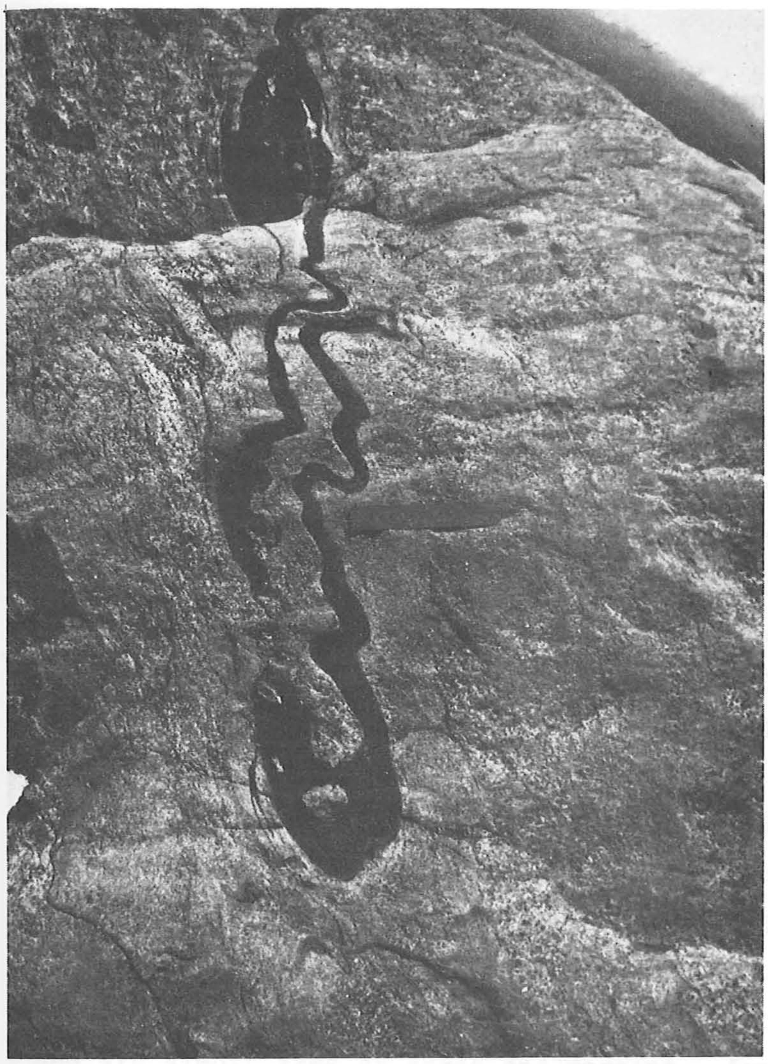

Fig. 5. Rippon Depot. tightly folded and refolded mafic layer. Scale is 15 cm long. (Neg. GB 1162).

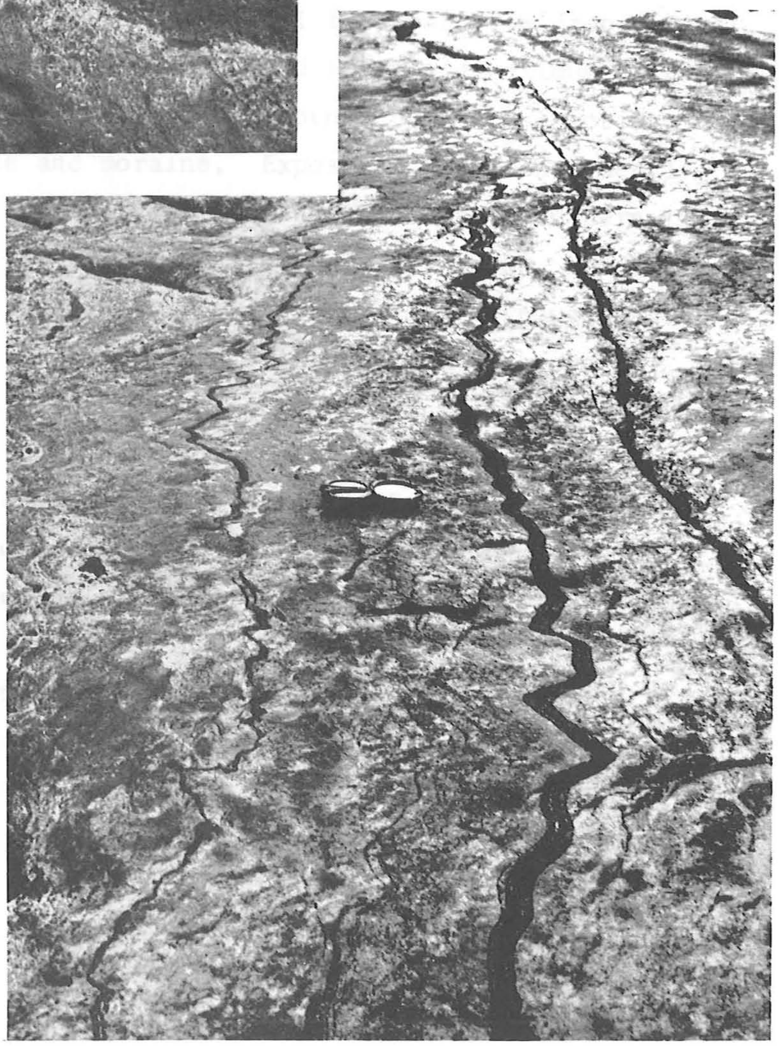

Fig. 6. Rippon Dept.Kink folded mafic layers. Compass is 15 cms across. (Neg. GB 1026).

mafic dykes, which are not folded. Late granite veins follow small displacements in the mafic and pyroxene-quartz-feldspar layers.

In summer Rippon Depot has a very mild climate and consequently parts of the outcrop show honeycomb weathering.

Proclamation Island

Proclamation Island, at the northern tip of the Enderby Land peninsula, was visited by the B.A.N.Z. Antarctic Research Expendition led by Sir Douglas Mawson in January, 1930. A varied suite of rocks, including pyroxenites, mafic granulites, orthopyroxene-quartz-feldspar gneiss (charnockite and enderbite) and various garnet-bearing gneisses, was collected and later described by Tilley (1937). The discovery of orthopyroxene-quartz-plagioclase rocks led Tilley (1937, p. 8) to suggest the name enderbite for 'an acid member of the charnockite series characterized by rhombic pyroxene and preponderating plagioclase among the feldspar constituents. Oligoclase or andesine is the essential feldspar, whereas in charnockite the essential feldspar is microperthite'.

The island is about 1.5 km long, and reaches a maximum height of 268 metres. The steep sides have been smoothed by glacial action, and are almost free of scree and moraine. Exposures are, consequently, excellent. Time permitted only a brief examination of the southern tip and western side. Most of the island consists of dark brown, massive and poorly banded orthopyroxene-quartz-feldspar gneiss, although underlying this on the southeast side are more distinctly banded garnet-quartz-feldspar gneiss, semi-pelitic gneiss, and rare mafic gneiss. Dips range from about $15^{o}/315^{o}$ in the northwest to $65^{o}/345^{o}$ near the southern tip of the island. The more steeply dipping rocks show evidence of deformation, and development of biotite along small shear zones. Dolerite erratics were also found, but no such rocks were seen in situ.

The massive orthopyroxene-quartz-feldspar gneiss (charnockite of Tilley, 1937) contains roughly equal amounts of perthite and antiperthite (An_{30-35}). Orthopyroxene commonly shows slight marginal alteration to biotite. A few samples contain garnet, and small amounts of clinopyroxene, primary reddish-brown biotite, dark greenish-brown hornblende, apatite, zircon, and opaque minerals may also be present. Unfortunately, no potash feldspar - free 'enderbites' were obtained from this, the type locality! Whether the massive gneiss is of intrusive origin, as thought by Tilley (1937), is uncertain, although the lack of very distinct banding tends to support this. No intrusive contacts were seen. Ultramafic layers and lenses in the massive orthopyroxene-quartz-feldspar gneiss contain roughly equal proportions of orthopyroxene, clinopyroxene and dark reddish-brown biotite, and a few thin pegmatites and bluish quartz veins are also present.

In the underlying more garnet-rich gneisses, orthoclase perthite is the predominant feldspar. One sample (76283086) contains orthoclase, quartz, garnet, biotite, and small amounts of orthopyroxene, cordierite, sillimanite, and spinel. A strongly deformed garnet gneiss from a shear zone (76283089) consists of very fine-grained quartz, feldspar, biotite, and numerous post-kinematic garnet grains, 0.01-0.2 mm in diameter. The biotite is concentrated in bands that have been plastically folded on a scale of a few millimetres.

Sheelagh Island

Sheelagh Island (21 m), the largest of a group of islands just off Cape Kolosov on the western coast of the Enderby Land peninsula, is an Adelie penguin rookery. It consists of homogeneous dark grey medium-grained felsic gneiss composed of perthitic orthoclase, plagioclase (minor antiperthite) blue quartz, orthopyroxene, opaque grains, apatite, and zircon. Secondary opaque and reddish-brown minerals are common along cleavage traces and fractures in the orthopyroxene. Subconformable mafic layers, up to 3 m wide, which consist of antiperthite, orthopyroxene, brown hornblende, reddish-brown biotite, and opaque grains are probably metamorphosed dyke remnants. Some orthopyroxene and most plagioclase grains show strain lamellae. Contacts between the mafic and felsic rocks are commonly marked by concentrations of orthopyroxene in the mafic layers and blue quartz in the felsic.

A northwest-trending, black, fine-grained mylonite zone, about 3 cm in width, cuts both felsic gneiss and a macic layer within it. Horizontal displacement of the mafic layer is less than a metre. The foliation dips 33° to 160°, and is intersected by steeply dipping joints

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trending 195° and 255°. A fine-grained layer in the gneiss appears to be tightly folded on a mesoscopic scale.

Mount Hurley

Mount Hurley (560 m) has a relatively flat top that is mostly covered with frost-wedged rubble, but exposures are quite good in the surrounding cliffs.

The predominant rock type is massive, reddish orthopyroxene-quartz-feldspar gneiss, with interbanded white garnet-quartz-feldspar gneiss. Dips are variable but mostly steep ($>40^{\circ}$) to the southeast. Coarse-grained layers are common, and some with abundant feldspar augen are probably deformed pegmatites. Undeformed, cross-cutting pegmatites with rather diffuse contacts also occur. Mesoperthite is the usual feldspar in the gneiss, although in some samples, particularly the garnetiferous varieties, orthoclase perthite is common. The more strongly deformed gneisses, which are intersected by small shears, 1-2 cm across, and by mylonite zones, are commonly retrogressed, with extensively granulated quartz and mesoperthite, recrystallised microcline and plagioclase, and partial replacement of garnet by biotite. One particularly strongly sheared gneiss (76283073) contains aggregates of pale green actinolitic amphibole and chlorite (after pyroxene?), sphene (as rims around ilmenite), and epidote; at least part of the amphibole is post-deformational.

Latham Peak

Latham Peak (1000 m) is about 50 km west of Mount Codrington in the Napier Mountains. Its southwestern side is mainly covered by snow and ice slopes, but elsewhere garnet-orthopyroxene-quartz-feldspar gneiss and mafic to ultramafic pods are exposed, and are intersected by basic dykes.

Much of the gneiss is fine to medium-grained, and contains mesoperthite, greyish-blue quartz, orthopyroxene, opaque grains, and locally garnet, plagioclase, microcline, reddish-brown biotite, and zircon. In sample 76283167, orthopyroxene is surrounded by garnet-quartz intergrowths that suggest the reaction

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2 Orthopyroxene + Anorthite $\longrightarrow$ Garnet + Quartz.

Mottled grey and white garnetiferous gneiss is composed of mesoperthite, quartz, zircon, and locally, light brown biotite, plagioclase, microcline, and opaque grains, together with garnet which forms red porphyroblasts up to 8 mm across.

The mafic to ultramafic pods are medium to coarse-grained, up to 4 m long, and have a range of composition. For example, boulders at the northwestern end of the outcrop consist of pale green clinopyroxene, orthopyroxene, talc, serpentine, olivine, pale green amphibole, green spinel, opaque grains, and chlorite, and a nearby amphibolite pod contains tremolite, plagioclase, chlorite, opaque grains, actinolite and zircon. Another sample (76283162) from the same area consists of medium to coarse-grained anthophyllite, olivine, colourless pyroxene, phlogopite, humite, opaque and dark brown grains, and calcite. Some ultramafic pods consist almost entirely of coarse-grained orthopyroxene and clinopyroxene.

Sapphirine-bearing rocks are contained in a body of mafic rock about 4 m across that is exposed on the northeastern side of the peak, just below the survey point (Fig. 7). The body consists mainly of medium-grained pale green clinopyroxene, orthopyroxene, plagioclase, opaque grains, and minor quartz and apatite, and within it one, or possibly two, metre-long lenses are composed of fine to medium-grained perthitic to mesoperthitic orthoclase, plagioclase, reddish-brown phlogopite, orthopyroxene, dark green spinel (commonly rimmed by sapphirine), sapphirine, cordierite, and minor zircon. In one relatively coarse-grained patch, about 15 cm across, black subidioblastic sapphirine forms grains up to 8 mm in diameter (Fig. 8). Some of the cordierite has unusual pleochroism from colourless to yellow with anomalous interference tints, and in one sample (76283175) it occurs as thin layers between spinel and orthoclase, spinel and orthopyroxene, and between sapphirine and orthoclase.

Basic dykes, ranging from 1.5 to almost 7 m in width, trend northwest and northeast. They consist of colourless pyroxene, plagioclase, and opaque grains, and have a subophitic texture. The plagioclase is partly altered to epidote and muscovite, and pyroxene is commonly altered to green hornblende and biotite. Sample 76283164 is porphyritic with subhedral lath-shaped phenocrysts of andesine, and colourless clinopyroxene, up

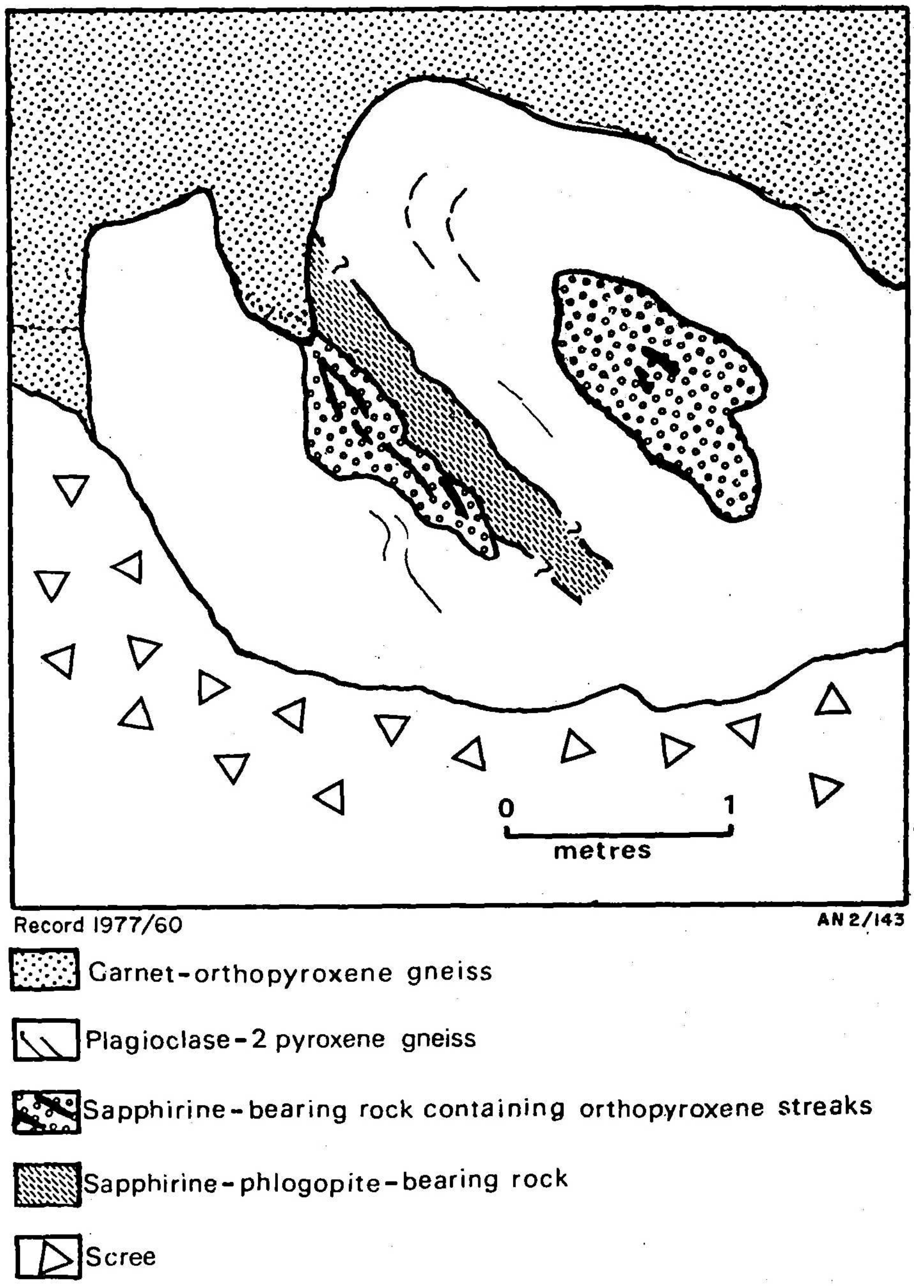

Fig. 7. Latham Peak. Sketch of outcrop showing occurrence of sapphirine-bearing rocks.

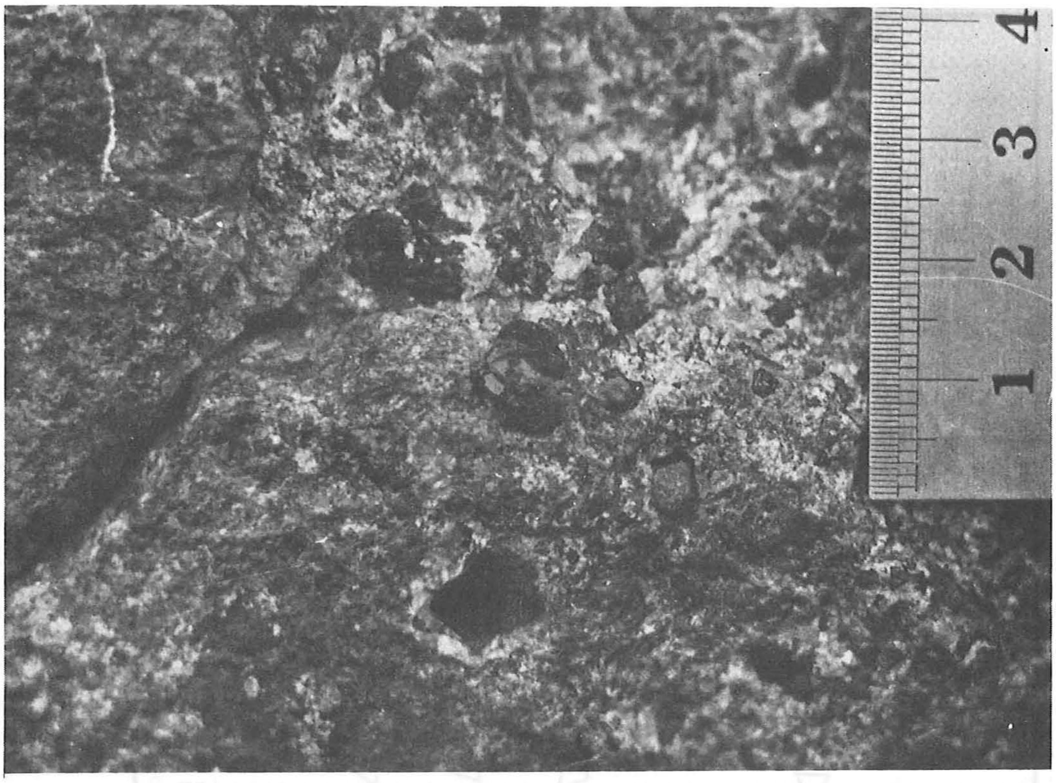

Fig. 8. Latham Peak. Black, idioblastic sapphirine in cordierite-Sapphirine-spinel-orthopyroxene-phlogopite-feldspar rock. Scale in cm. (Neg. M2037).

to 1.5 mm long, in an aphanitic groundmass of plagioclase, pyroxene, and opaque grains. Adjacent to the dykes, the country rocks are commonly deformed, and plagioclase grains are partly altered to epidote.

The rocks at Latham Peak are poorly foliated, strike about 200°, and dip vertically. They are cut by a 6 m-wide fault zone trending 225° that is filled with mylonite composed of fine-grained quartz, extensively saussuritised plagioclase, biotite, hornblende, opaque grains, and minor apatite and zircon.

Mount Codrington

Mount Codrington consists of two steep-sided ridges, trending roughly NW and NE. Only the area to the northeast of the summit, including the saddle and the northeastern peak (1222 m), was examined. There, the foliation strikes about 170°, and dips are near vertical, indicating the presence of a major fold structure, probably similar to those in the Mount King area.

Orthopyroxene-quartz-feldspar gneiss is the most abundant rock, although garnetiferous varieties are common, and some bands of mafic gneiss are also present. The gneiss is migmatitic, with thin, discontinuous pegmatitic layers and lenses. Minor flow folds and isoclinal folds are common, the latter sometimes having an axial plane foliation due to a preferred orientation of biotite grains. Both orthoclase perthite and plagioclase occur in the felsic gneiss, but andesine is the predominant, and often the only, feldspar in the more mafic bands. Reddish-brown biotite is a common minor constituent, and may mantle orthopyroxene. White to grey augen gneiss that contains lenses of more mafic gneiss is quite abundant and consists of feldspar (orthoclase perthite and microcline, and subordinate oligoclase) augen, up to 10 cm across, quartz, fine-grained, streaked-out biotite aggregates, and rarely garnet. Locally preserved cross-cutting relations demonstrate that the augen gneisses are deformed pegmatites. In the more strongly retrogressed gneiss of the saddle area, perthitic orthoclase is largely inverted to microcline, and pyroxene is replaced by fine-grained aggregates of biotite and quartz. Thin mylonite and shear zones, and epidote veins are also common here. Deformation and retrogression may have been synchronous with the major folding.

Conformable, even-grained mafic granulites, with andesine, orthopyroxene, clinopyroxene, and minor dark brown hornblende and reddish-brown biotite, may represent metamorphosed basic intrusions, although there is no direct evidence for this. A few thin, discontinuous layers and lenses of garnet-quartz gneiss, with minor orthopyroxene, potash feldspar, and an opaque mineral, occur near the northeastern peak. Garnet forms up to 50 percent of these layers, but its distribution is very irregular. Small, cross-cutting pegmatites, with diffuse margins, have similar mineralogy to that of the host gneiss. Larger pegmatites, exposed in the cliffs near the summit, were not examined.

Mount Breckinridge

Mount Breckinridge (1840 m), in the Napier Mountains, was reported by Pieters and Wyborn (1977) to consist of pyroxene-quartz-perthite gneiss, plagioclase-pyroxene rock, and locally augite-magnetite-hornblende-plagioclase rock. Gneiss collected during the 1976 survey consists of mesoperthite, quartz, pale green clinopyroxene, opaque grains and minor apatite.

Grey, medium-grained gneiss, consisting of mesoperthite and subordinate plagioclase, quartz, orthopyroxene, opaque grains, and minor zircon, is exposed on a small, mostly snow and ice-covered ridge about 1 km southeast of Mount Breckinridge. The orthopyroxene is largely altered to brownish-green biotite; several opaque grains are rimmed by chlorite, and some K-Feldspar has inverted to microcline. A 1-cm wide dolerite vein that cuts the gneiss consists of orientated plagioclase laths (up to 0.7 mm long) and fractured pyroxene grains in a fine-grained chlorite-magnetite groundmass. Crush zones marginal to the vein contain plagioclase partly altered to epidote, and orthpyroxene partly altered to hornblende. The foliation dips 30° to 280°.

Mount Selwood

Mount Selwood, in the Tula Mountains, consists of massive, poorly-banded, reddish-brown-weathering garnet-orthopyroxene-quartz-feldspar gneiss, which is particularly well exposed in the vertical cliffs near the summit at the south end of the mountain (Fig. 9). The foliation dips

a1

at a few degrees to the northwest, or is sub-horizontal. Relatively coarse-grained, leucocratic layers with conspicuous bluish quartz and pink feldspar are quite abundant. Mesoperthite is the main feldspar in most samples, although slight cataclastic deformation has resulted in recrystallisation along grain boundaries, and development of fine-grained K-feldspar and plagioclase. Orthopyroxene is ubiquitous, and garnet occurs in most samples, some layers being particularly garnet-rich. In the more mafic layers with 20 percent or more orthopyroxene, antiperthite is the only feldspar and reddish-brown biotite is a minor constituent. Similar orthopyroxene-quartz-mesoperthite gneiss occurs at Mount Pardoe and at many localities around Mount King, although in the latter area garnet is much less abundant.

Light grey to white pegmatites, with rare biotite and garnet, discordantly intrude the gneiss, and were probably formed from it by local mobilisation (Fig. 9).

Sapphirine Nunatak (proposed name)

This small nunatak (astrofix A58/15), about 8 km east-northeast of Pythagoras Peak in the Tula Mountains, was visited by McLeod during a sledging trip in 1958. McLeod (1959) described the occurrence of blue quartzite, garnet gneiss, and pyroxenite. Microscopic examination of a sample of the quartzite showed the presence of coexisting sapphirine and quartz - the first recorded occurrence of this as an equilibrium assemblage (Dallwitz, 1968). Because of the particular interest of this unusual and petrologically important rock type, a visit to this locality was a high geological priority during the 1976 season.

Sapphirine Nunatak consists largely of gently dipping, spectacularly banded rocks of varied composition, which pass upwards into massive, brown-weathering garnet-orthopyroxene-quartz-feldspar gneiss. The strongly banded rocks, mostly of probable sedimentary origin, include inter-layered massive impure quartzite, garnet-rich gneiss, garnet-quartz-feldspar gneiss, and minor pyroxene-rich mafic granulite. All these rocks are cut by a fresh dolerite dyke, about 15 metres thick, which trends north-northeast. The foliation dips about $20^{\circ}/330^{\circ}$ at the western end of the nunatak and $20^{\circ}/010^{\circ}$ at the eastern end of the ridge, where a typical section was examined. A lineation dips at about 15° to 030°, and small-scale tight to isoclinal folds are common. Minor shear zones are also present.

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Garnet-quartz-feldspar gneiss has locally discordant relationships with the quartzites (discussed below) near the eastern end of the nunatak, and probably represents a deformed anatectic melt. A slightly discordant, but deformed and partly boudinaged mafic granulite, 3 to 4 metres thick, is probably a metamorphosed dyke. It consists of orthopyroxene and clinopyroxene, and only about 12 percent of plagioclase. Similar pyroxene-rich, slightly discordant bands, with even less plagioclase, occur in the Mount King area. Farther up the ridge, garnet-rich pelitic and aluminous gneisses, leucocratic garnet-quartz-feldspar gneiss, and mafic gneiss predominate. Garnet-quartz layers contain up to 60 percent of garnet, along with small amounts of sillimanite, mesoperthite, cordierite-rich symplectite, and green spinel. One sample contains about 30 percent of spinel. The mafic gneiss consists of roughly equal proportions of plagioclase, orthopyroxene, and clinopyroxene, and minor olive-brown hornblende and reddish-brown biotite. Overlying these rocks, massive brown-weathering gneiss, containing perthite, quartz, and small amounts of garnet and altered orthopyroxene, is similar to that found at many other localities in Enderby Land, including nearby Mount Selwood.

The quartzite is generally cream or pale bluish, commonly with a milky, almost opalescent appearance. Near more mafic, usually garnet-rich, layers the rock has a very intense blue colour, possibly due to the presence of greater amounts of Ti in the quartz (Jayaraman, 1939) - minute rutile needles are ubiquitous and abundant, but are commonly absent from the outer parts of quartz grains which then have a pale brown tinge. In addition to quartz, the rocks contain various amounts of garnet, orthopyroxene, sillimanite, perthite, green and greenish-brown spinel, rutile, and very fine-grained symplectites of cordierite, with any or all of K-feldspar, quartz, or orthopyroxene. Garnet + sillimanite, and garnet + orthopyroxene commonly occur in association, but garnet + sillimanite + orthopyroxene do not. The assemblage garnet + sillimanite + orthopyroxene + quartz + feldspars is believed to be metastable (Hensen & Green, 1971).

Thin, discontinuous and commonly folded layers, mostly 1 to 5 cm in thickness, contain abundant, very dark blue grains of sapphirine, up to 5 mm in diameter (Fig. 10). They commonly have thin garnet- or, rarely, orthopyroxene-rich selvages. Sapphirine, garnet, sillimanite, orthopyroxene, quartz, greenish-brown spinel, rutile and rare monazite and zircon, all appear to be primary phases, although many also appear as

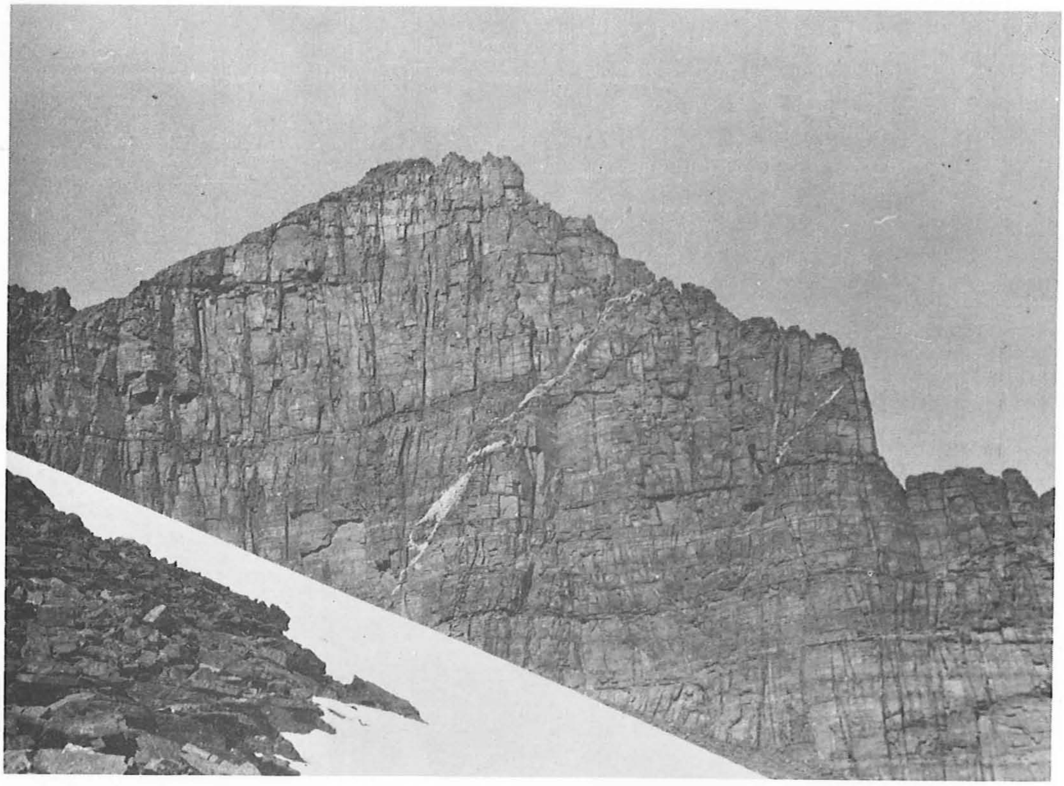

Fig. 9. Mount Selwood. Massive, brown-weathering garnet-orthopyroxene-quartz-feldspar gneiss with cross-cutting pegmatites. The cliff is about 150 metres high. (Neg. M 2041).

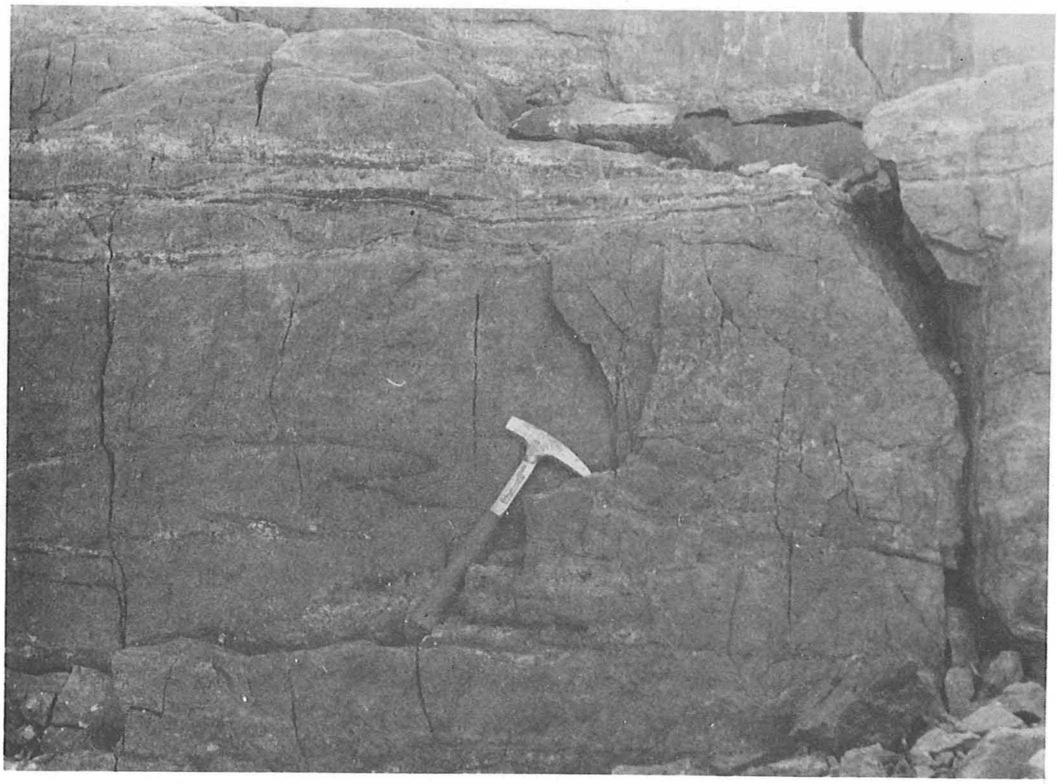

Fig. 10. Sapphirine Nunatak. Massive, bluish quartzite with thin, dark, sapphirine-rich layers. (Neg. M 2039).

breakdown products of sapphirine and other minerals. Relict osumilite (a complex K, Mg, Fe aluminosilicate) is present in a few samples, together with a phase which can either be represented as a molecular combination of a magnesian analogue of anorthite and orthoclase, with up to 30 percent substitution of Mg for K, or may be an extremely fine-grained intergrowth of cordierite and potassium feldspar. Secondary reddish-brown biotite is a minor constituent. Sapphirine is in contact with quartz in several samples, and in some cases occurs as relatively fine-grained (0.1 mm) intergrowths with quartz. But most grains have rims of one or more of the secondary minerals garnet, sillimanite, cordierite, and possibly orthopyroxene, although the last is more probably an original constituent. Probable breakdown reactions of sapphirine include:

3 Sapphirine + 7 Quartz $\longrightarrow$ 2 garnet + 4 sillimanite

Sapphirine + 4 Quartz $\longrightarrow$ Cordierite

PT conditions do not appear to have favoured the reaction

Sapphirine + 3 Quartz $\longrightarrow$ 2 Sillimanite + 2 Orthopyroxene

Spinel commonly has rims of sillimanite or garnet, or both, and has probably reacted with quartz:

3 Spinel + 5 Quartz $\longrightarrow$ Garnet + 2 Sillimanite,

but the reaction

Spinel + 2 Quartz $\longrightarrow$ Orthopyroxene + Sillimanite

does not seem to have taken place to any extent. Most, if not all, the cordierite in these rocks appears to be of secondary (retrograde) origin, although certain well-crystallised grains may be primary. Much of the cordierite occurs in fine-grained symplecites with any or all of K-feldspar, quartz, or orthopyroxene. These symplectites are particularly abundant, and, as well as being formed by reaction of intergrowths of sapphirine

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and quartz, probably resulted from breakdown of osumilite (Berg & Wheeler, 1976):

8 Osumilite → 7 Cordierite + 8 K-feldspar + 6 Orthopyroxene + 15 Quartz

A further possibility is breakdown of 'magnesian orthoclase'.

According to Hensen & Green (1973), sapphirine is stable in the presence of quartz only at temperatures in excess of about 1030°C (at a pressure of about 9 kb), although experimental work by Newton (1972) suggests that the stability field of sapphirine-quartz may extend to about 800°C under anhydrous conditions. In any case, extremely high temperatures are indicated by this assemblage. Osumilite has normally been found in a low-pressure environment, although an occurrence in association with plagioclase, hypersthene, cordierite, quartz, orthoclase, graphite, and pyrrhotite in a granulite from the contact aureole of the anorthositic Nain complex was described by Berg & Wheeler (1976), who estimated a pressure of about 5 kbar and temperature of 700-900°C. A pressure of at least 7-8 kbar is indicated for the Antarctic occurrence, however (Newton, 1972; Hensen & Green, 1973). It is uncertain whether the sapphirine breakdown reactions took place during cooling or during a separate metamorphic event (local retrograde metamorphism is common in the area), but the formation of abundant cordierite indicates that they occurred under significantly lower pressures than in sapphirine-quartz granulites from Wilson Lake, Labrador, in which sillimanite and hypersthene, but not cordierite, were formed by reaction of sapphirine and quartz (Morse and Talley, 1971). According to Hensen & Green (1973), the reaction

4 Sapphirine + 11 Quartz → Cordierite + 4 Sillimanite + 2 Garnet

proceeds at about 8-9 kbar and 1030°C.
Detailed petrographic, mineralogical, and geochemical studies of these unique rocks are now being carried out, with a view to elucidating the conditions under which sapphirine and osumilite were formed, and subsequently partly broken down.

Mount Sones

Only a brief visit was made to the northern end of Mount Sones in the hope of finding further exposures of sapphire-bearing quartzites. Most of the mountain is composed of strongly-banded, light-coloured rocks similar in appearance to those at Sapphirine Nunatak. Near the northern end, the foliation dips southeast at about 30°, but farther south, 50° to the southwest. Large-scale folding, with north or north-northeast-trending steep limbs, is common, and a major synform is exposed in the cliffs on the western side of Mount Reed. Undeformed mafic dykes crop out on both Mount Sones and Mount Reed, and near the northern end of the former, a slightly discordant layer is probably similar to the metamorphosed pyroxene-rich dykes seen at Sapphirine Nunatak and elsewhere (Fig. 11).

Near the northern end of Mount Sones, well-banded, garnet and quartz-rich gneisses, with subordinate mafic gneiss, crop out. The few thin layers of bluish quartzite present apparently do not contain sapphirine. Garnet-quartz-feldspar gneiss, with relatively abundant quartz (40-50%) and minor sillimanite, is probably of sedimentary origin. Some layers contain mesoperthite, whereas the dominant feldspar in others is plagioclase. Garnet-quartz rock, with up to 50 percent garnet, is interbanded with this gneiss. The unusual mineralogy of the mafic gneiss (garnet, orthopyroxene, quartz, plagioclase, and minor opaque minerals) indicates a sedimentary, rather than a basic igneous origin.

Although no sapphirine-bearing rocks were found at this locality, the lithology is similar to that at Sapphirine Nunatak, and more extensive investigations may reveal the presence of sapphirine. Other localities worthy of examination for sapphirine-bearing rocks are Mount Reed, parts of Pythagoras Peak (although much of this mountain is composed of massive, brown pyroxene gneiss), and the small nunatak 3 km east-northeast of Sapphirine Nunatak.

Mount King Area

Most of the larger outcrops within 30 km of the Mount King base camp were visited, landings being made at Mounts Ryder, Denham, Renouard, Smethurst, Paish, McGhee, Cordwell, Stadler, Jewell, and King, and at Seavers Ridge, Burch Peaks, and the unnamed nunatak 2 km south-southwest of Mount Torckler. Mount King had previously been visited by McLeod (McLeod, 1959). Most of the outcrops are rather small, and consist mainly of ridges and isolated peaks. The best exposures are in cliff faces - lower slopes are covered by moraine, and the flatter, upper surfaces by frost-heaved rubble and patterned ground. The geology of the various nunataks is very similar, and they will therefore be described together.

Two rock types predominate - massive, brown-weathering orthopyroxene-quartz-feldspar gneiss with minor interbanded mafic gneiss, and strongly banded, white or grey garnet-quartz-feldspar gneiss with subordinate siliceous, aluminous and ferruginous metasediments. At least two generations of dyke are present - an early suite of metamorphosed, but slightly discordant pyroxenites and a group of relatively fresh dolerites. Thin, cross-cutting quartz-feldspar pegmatites occur at Burch Peaks and Mount Jewell, but are not abundant. They were probably formed by localised, small-scale mobilisation of the enclosing gneiss.

The regional strike ranges, with local exceptions, from 025^{o} in the northeast, near Mount Cordwell, to 045^{o} at Mount Ryder. Dips are mostly moderate to steep, and are near-vertical over large areas, e.g. at Mounts Ryder, McGhee, Cordwell, Jewell, and King. The dominant structures are large-scale northeast-trending folds with near-vertical steep limbs. Smaller folds with amplitudes of tens of metres and possibly of the same generation, are well exposed at Mounts Ryder, Denham, Renouard, and McGhee. Most of the small folds are of the 'similar' type of Ramsay (1967), and range from relatively open to almost isoclinal (Fig. 12). Axial planes, where measured, dip at steep angles (45^{o}-80^{o}) to 290^{o}-310^{o}, and are roughly parallel to those of the major folds. At Mount Denham the fold axes plunge at 10^{o} to 025^{o}, and at Mount King and Seavers Ridge, a probably associated lineation plunges at low angles (5^{o}-30^{o}) to 030^{o}. Medium-scale folds seem to be more common in the garnet gneisses, although this may be only an apparent effect due to the more obvious

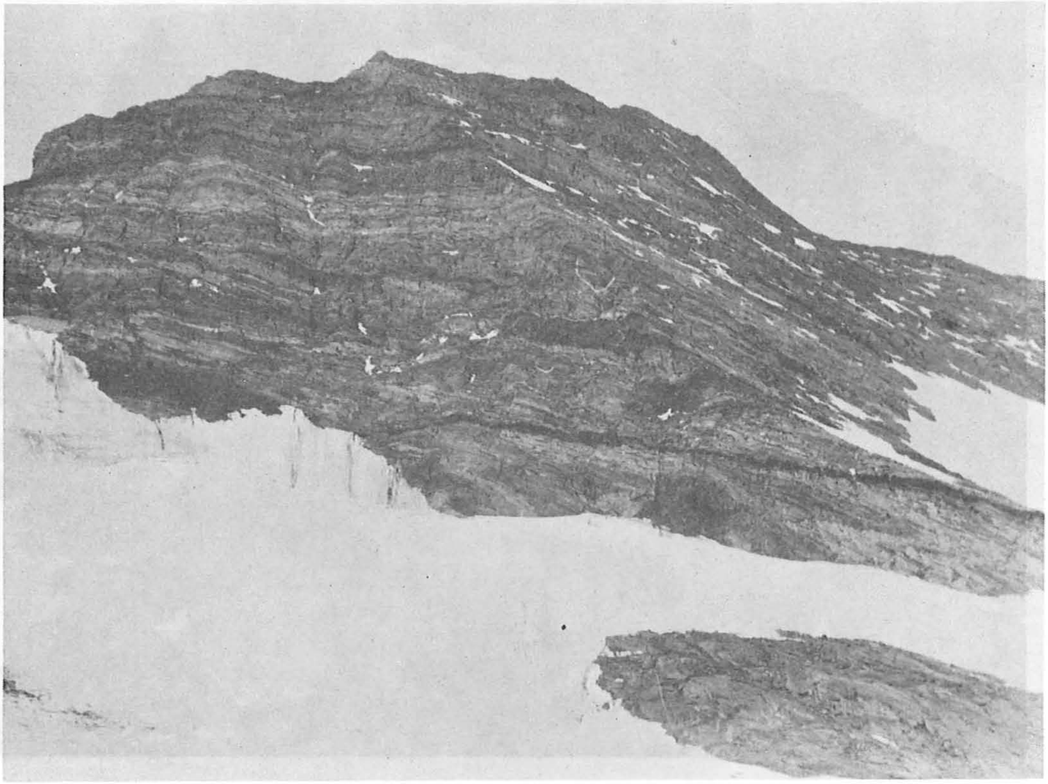

Fig. 11. Mount Sones. Slightly discordant pyroxenite dyke cutting strongly layered garnet-quartz-feldspar gneiss, garnet-rich metasediments and mafic gneiss. (Neg. M 2039).

Fig. 12. Mount Denham. Folded strongly layered garnet-quartz-feldspar gneiss and orthopyroxene-quartz-feldspar gneiss. Cliff in foreground is about 50 metres high. (Neg. M 2039).

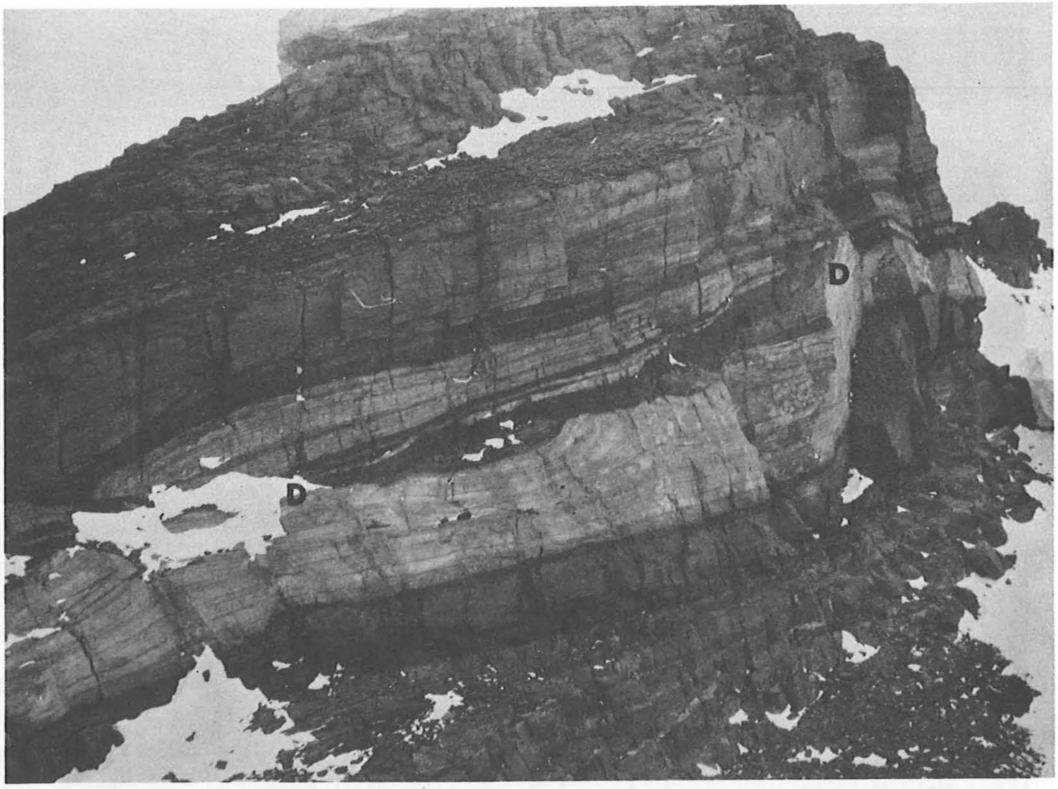

Fig. 13. Mount Stadler. Interbanded garnet-quartz-feldspar gneiss, orthopyroxene-quartz-feldspar gneiss and quartz-orthopyroxene-magnetite rock with thin, slightly discordant dolerite dyke (D-D). Cliff is about 20m high. (Neg. M2039).

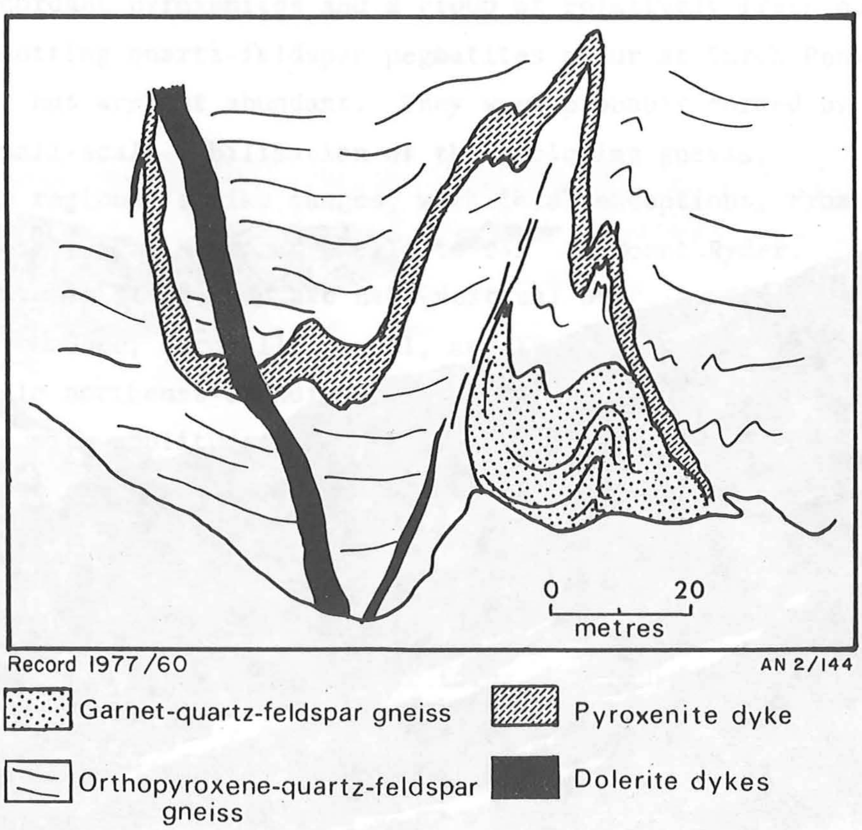

Fig. 14. Mount McGhee. Folded, massive orthopyroxene-quartz-feldspar gneiss and light coloured garnet-quartz-feldspar gneiss cut by slightly disocrdant, folded metamorphosed pyroxenite dyke and two undeformed dolerite dykes. Cliff is about 150 metres high. (Drawn from photograph).

banding in these rocks. Earlier, small-scale intrafolial folds, and isoclinal folds with amplitudes of a few metres, were deformed during the major folding (e.g. at Mount Cordwell), and many were probably formed contemporaneously with the gneissic foliation (i.e. presumably during the granulite-facies metamorphism). Retrogressive effects, including granulation of feldspars and quartz, and alteration of pyroxene, may have been associated with the large-scale folding - at Mount Cordwell the steeply dipping gneiss is rather fissile, and biotite is conspicuously developed. The pyroxenite dykes were affected by the folding (and by the high-grade metamorphism), whereas the dolerites are generally undeformed. Late-stage, low-grade metamorphism, associated with the development of mylonite zones, thin epidote veins, and locally, pseudotachylite, post-dates at least some of the dolerite dykes (e.g. at Seavers Ridge). Mylonite zones with pseudotachylite are particularly abundant at the southwestern end of Mount King, and mylonites also occur at Mount Paish.

Massive reddish-brown orthopyroxene-quartz-feldspar gneiss is common at most of the outcrops visited, and makes up most of Mounts Smethurst, Paish, McGhee, Cordwell, Jewell, and King, and Seavers Ridge, Church Nunataks, and Burch Peaks. The main constituents are feldspar (55-65%), quartz (30-35% in most samples), and pleochroic orthopyroxene (up to 8% in most samples). The feldspar is typically mesoperthite, commonly with slightly more alkali feldspar than plagioclase, although antiperthite or perthite is present in a few samples. Relatively mafic layers contain less quartz and more pyroxene (up to 25%), and plagioclase (andesine) is the usual feldspar. Clinopyroxene, garnet, zircon, apatite, and opaque minerals are minor constituents. Most of the samples examined are fine to medium-grained, and have a granoblastic texture, but a few are quite strongly foliated, with the lenticular aggregates of quartz grains typical of high-grade, leucocratic gneisses. Marginal alteration of pyroxene to biotite and, less commonly, amphibole is widespread, and in extreme cases the pyroxene is entirely replaced by fine-grained aggregates of greenish-brown or reddish-brown biotite, quartz, opaque minerals, and, more rarely, carbonate and epidote. Locally, pyroxene is replaced by yellow-brown iddingsite-like material - probably a mixture of such minerals as smectite, chlorite, and goethite (Wiltshire, 1958). K-feldspar shows incipient development of microcline twinning in some rocks. The more strongly retrogressed gneisses typically form the steep limbs of the major folds described above. The relative homogeneity of, and lack of a well-developed banding in, much of the orthopyroxene-quartz-feldspar gneiss, as well as the overall roughly 'granitic' composition, suggest an origin from either a monotonous pile of greywacke-type sediments or an acid igneous rock series (acid volcanics or, possibly, in the case of more massive gneiss, granitic intrusives). A few mostly garnet-bearing rocks, which are comparatively rich in either quartz of K-feldspar, do not appear to be of typical igneous composition, and are most probably metamorphosed sediments.

Interlayered with the orthopyroxene-quartz-feldspar gneiss, but much less abundant, is mafic pyroxene gneiss, possibly of igneous origin. It is typically massive and medium-grained (1-2 mm), and has a granulo-blastic texture. Andesine/labradorite (40-60%), orthopyroxene (18-50%), and clinopyroxene (7-22%) are the major constituents, with up to 5 percent of quartz and minor reddish-brown biotite, K-feldspar, apatite, and opaque minerals. An altered sample from Mount King (76283003) contains fine-grained aggregates of green hornblende and only minor relict pyroxene.

Discontinuous layers, lenses, and pods of coarse-grained (0.5-10 cm) pyroxenite are common, but make up only a very small proportion of the orthopyroxene-quartz-feldspar gneiss. They range in size from a few centimetres to several metres across; larger masses are rare. Most consist of clinopyroxene ($>$80%) and subordinate orthopyroxene, but a few contain 60 to 90 percent of orthopyroxene. Minor components are phlogopite or biotite, pale brownish hornblende, perthite, plagioclase, quartz, spinel, and opaque minerals. The origin of these pyroxenites is uncertain. The widespread thin layers and lenses may be metamorphic segregations, but larger masses, at least, are possibly deformed and boudinaged ultramafic igneous bodies.

White to grey, strongly banded, fine to medium-grained garnet-quartz-feldspar gneiss is conspicuous at Mounts Ryder, Denham, Keyser, Renouard, Paish, McGhee, Stadler, and Jewell, and at the unnamed nunatak 2 km south-southeast of Mount Torckler (Fig. 12). The light colour compared with the brown orthopyroxene-quartz-feldspar gneiss may be a function of lower ferric iron contents in the feldspars (Burns, 1966; Bridgwater, 1966). Mesoperthite (60-70%) is almost invariably the only feldspar; quartz (30-35% in most samples) and garnet (up to 5% in most samples) are the other common components. Some samples from Mount Stadler are relatively rich in quartz (40-50%) and garnet (up to 15%). Much of the gneiss is relatively potash-rich, K-feldspar being the predominant phase (60-70%) in the mesoperthite; orthoclase perthite is present in one sample from Mount Stadler. Quartz is commonly crowded with minute needles of rutile, and garnet, which forms crystals up to 1 cm across, shows marginal alteration to brown biotite in some samples. Zircon, apatite, and opaque minerals are minor constituents. The texture is granoblastic, with lenticular quartz aggregates in the more strongly foliated rocks. Most of these garnet-bearing gneisses are rather richer in K thay typical igneous rocks, and are considered to be of metasedimentary (probably metagreywacke) origin. Similar gneisses from MacRobertson Land are relatively high in normative corundum, also suggesting a sedimentary origin.

Associated with the garnet-quartz-feldspar gneiss are massive, medium to coarse-grained layers, usually less than 5 metres thick, of quartz ± garnet ± orthopyroxene ± magnetite gneiss. Quartz-garnet-orthopyroxene gneiss occurs at Mounts Denham and Jewell, quartz-garnet gneiss at Mounts Renouard and Jewell, quartz-orthopyroxene-magnetite gneiss at Mount Stadler and quartz-garnet-orthopyroxene-magnetite gneiss at Mount Jewell. The maximum magnetite content is about 25 percent, although the proportions of the different phases are highly variable. Minor constituents include K-feldspar, plagioclase, and, in one sample (76283238), cordierite.

Aluminous metasediments, with garnet (20-30%), quartz (full of acicular rutile inclusions) (10-50%), sillimanite (10-25%), feldspar (mesoperthite or antiperthite, up to 40%), and smaller amounts of biotite, greenish-brown spinel, and opaque minerals, occur at the nunatak 2 km south-southwest of Mount Torckler. One sample (76283255) also contains sapphirine and cordierite. Sapphirine and spinel occur both as inclusions in garnet and as separate grains with rims of sillimanite.

Massive, medium-grained, slightly discordant pyroxenite layers, up to 5 metres thick, occur at Mounts McGhee and Jewell, and possibly Burch Peaks (Fig. 14). They are granoblastic, and contain roughly equal proportions of orthopyroxene and clinopyroxene, with minor reddish-brown biotite, feldspar, and opaque minerals. If they are indeed metamorphosed basic dykes, they are of rather unusual composition: chemical analyses, now in progress, may give some indication of their origin.

Dolerite dykes were noted at Mounts McGhee, Stadler, and Jewell, and at Seavers Ridge (Figs. 13, 14). Zoned plagioclase (labradorite), commonly with a reddish-brown or grey clouding, occurs both as microphenocrysts and in the groundmass. Colourless clinopyroxene is the common pyroxene, although orthopyroxene may also be present. Quartz (up to 3% in granophyric intergrowths), apatite, and up to 10 percent of opaque minerals are minor constituents, and the texture is subophitic. Some well-crystallised, brownish-green hornblende may be a primary mineral, although alteration of pyroxene to green hornblende at grain margins, and to pale, almost colourless amphibole within grains, is common, and secondary, reddish-brown biotite mostly occurs adjacent to opaque grains. Dykes at Mounts Stadler (76283258) and Jewell (76283277) contain strongly clouded, prismatic orthopyroxene phenocrysts, in the latter case with clinopyroxene rims. That at Mount Stadler has a foliation (probably a flow foliation), with the pyroxene phenocrysts showing a strong preferred orientation. The groundmass appears to have been partly recrystallised, with granulation of pyroxene and plagioclase, although a relict igneous texture is recognizable. This dyke was probably slightly deformed and recrystallised during, or immediately after, intrusion, when the rock was still hot, which may also explain the relative lack of secondary alteration products (amphibole, etc.) Similar granulation of pyroxene was noted in orthopyroxene-quartz-feldspar gneiss (76283014) immediately adjacent to a dolerite dyke at Seavers Ridge.

Fyfe Hills

The most prominent of these hills are two sharp northwest-trending ridges on the south-eastern shore of Khmara Bay. The survey point is located at the southeastern end of the more southerly ridge where the ridge flattens out to an area of ice-wedged boulders and blocks about 500 m above sea level, and geological observations were confined to this less rugged area.

The outcrop consists of laryered garnet-quartz-feldspar gneiss, sillimanite-garnet-quartz-feldspar gneiss, pyroxene-quartz-feldspar gneiss, garnet-pyroxene-hornblende-quartz-feldspar gneiss, and magnetite-orthopyroxene-garnet-quartz gneiss. Conformable pyroxenite pods up to 3 m long may represent boudinaged ultramafic layers (Fig. 15). Layering

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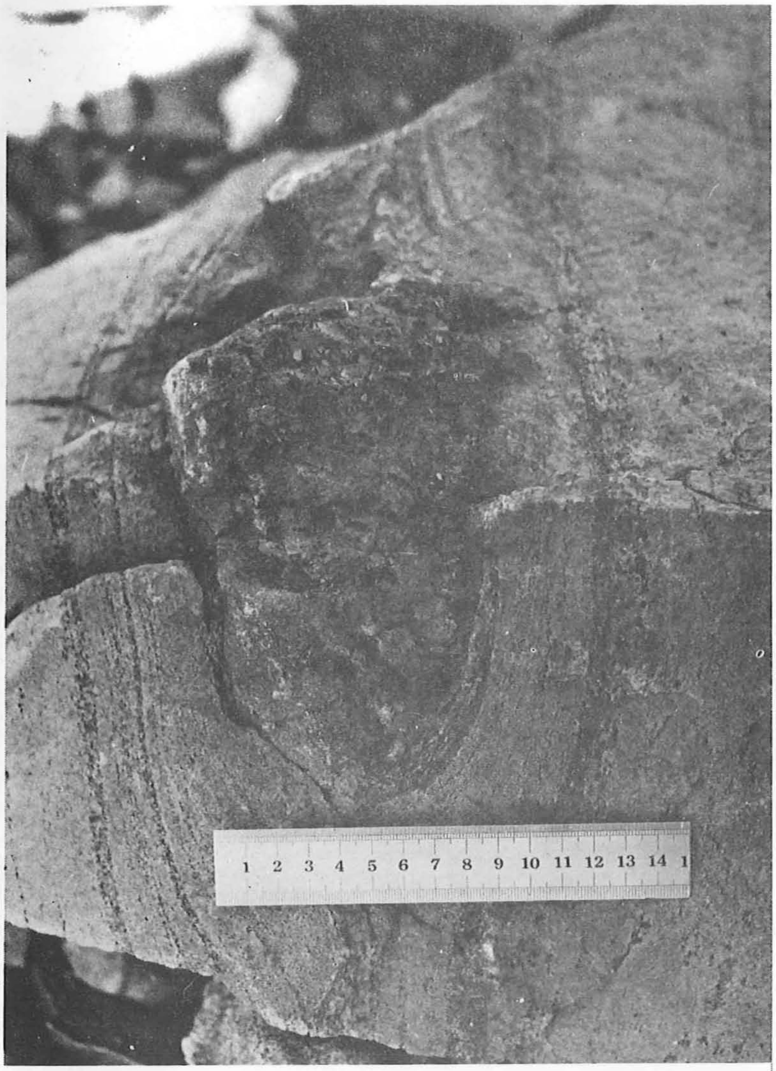

Fig. 15. Fyfe Hills. Coarse-grained pyroxenite pod within thinly layered garnet and pyroxene-quartz-feldspar gneiss. Scale in cm. (Neg. M 2036).

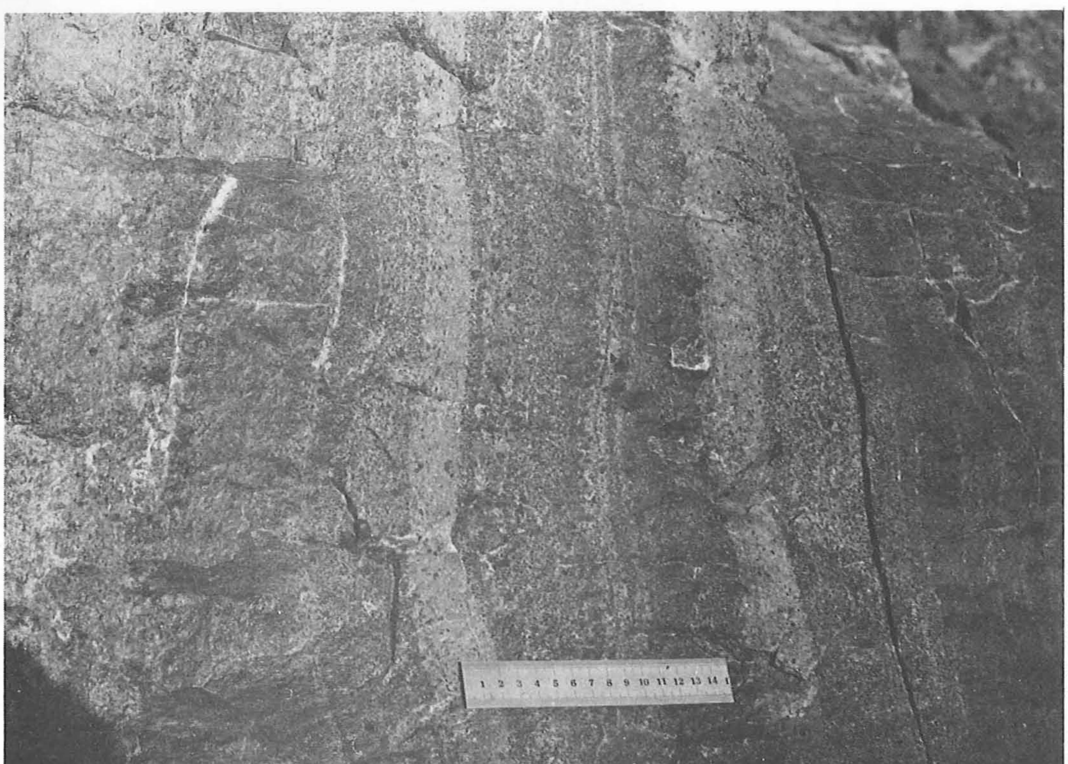

Fig. 16. Fyfe Hills. Layered garnet and pyroxene-quartz-feldspar gneiss. Scale in cm. (Neg. M 2036).

ranges from mafic streaks only a few millimetres thick to lithological units about 1 m thick (Fig. 16).

White, fine to medium-grained gneiss, with scattered pink garnet, consists of mesoperthite, quartz, plagioclase, and minor opaque grains, biotite, and zircon. Sillimanite-bearing varieties are light yellow or pink with darker streaks of garnet and biotite. Sample 76283125 is fine to medium-grained, and contains quartz, plagioclase, possible microcline, aggregates of brown biotite, sillimanite, and garnet, opaque grains, zircon, and sphene, whereas sample 76283133 is medium-grained, and contains mesoperthite and brown spinel, but lacks plagioclase and microcline.

Fine to medium-grained pyroxene-quartz-feldspar gneiss has a brown-dark green-cream speckled appearance and locally contains mafic layers a few millimetres thick. It consists of plagioclase (some antiperthite), quartz, orthopyroxene (partly altered to hornblende and biotite), opaque grains, green hornblende, and locally reddish-brown biotite, apatite, and zircon. Sample 76283138 consists of mafic layers of orthopyroxene, clinopyroxene, plagioclase, brown hornblende, reddish-brown biotite, sphene, and opaque grains, and felsic layers that contain quartz and perthitic orthoclase but lack hornblende and biotite. Fine to medium-grained, light grey gneiss, with mafic streaks and clots, consists of mesoperthite, quartz, plagioclase, dark green hornblende, pale green pyroxene, garnet, opaque grains, zircon, and apatite. Both hornblende and pyroxene are partly altered to iron-stained ?biotite. The magnetite-bearing gneiss is dark and medium-grained, and contains quartz, garnet, orthopyroxene, between 5 and 10 percent of anhedral magnetite, and minor green hornblende.

Medium to coarse-grained pyroxenite pods can be seen in hand specimen to contain both pale green clinopyroxene and black orthopyroxene. Northwest of the survey point a pyroxenite body, at least 20 m long, is composed of medium to coarse-grained orthopyroxene, pale green clinopyroxene, brown hornblende, opaque grains, and green spinel, but less massive samples also have biotite and locally serpentinised olivine.

At the extreme southeastern end of the area examined strongly deformed and foliated, fine-grained pelitic and semi-pelitic gneiss, muscovite-biotite augen pegmatite, and black mylonite crop out. In these rocks the feldspars are microcline and sericitised plagioclase. The presence of the assemblage quartz + kyanite + gedrite + garnet + biotite + cordierite in a pelitic gneiss (76283127) possibly indicates the hydration reaction

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5 Cordierite + 2 Water $\longrightarrow$ 6 Kyanite + 2 Gedrite + 7 Quartz

(Green and Vernon, 1974). Sample 76283123 is relatively undeformed, and consists of quartz, garnet (partly altered to sillimanite and cordierite), sillimanite (including fibrolite), cordierite, zircon, opaque grains, and ?leucoxene. In a slightly deformed fine to medium-grained mafic gneiss (76283126) that contains actinolite, tremolite, orthopyroxene, plagioclase, garnet, clinopyroxene, opaque grains, and minor biotite and quartz, garnet is localised along the amphibole-plagioclase boundaries, and was probably formed by the reaction

Hornblende + Plagioclase $\longrightarrow$ Garnet + Quartz

The pegmatite consists of white and pink feldspar augen in a fine-grained biotite-muscovite-quartz-feldspar matrix, and in places the muscovite flakes are up to 7 cm across. Malachite obcurs locally along fractures, and light yellow or green limonite coats some foliation surfaces.

Layering and foliation coincide over most of the outcrop examined, and dip 85^{o} to the southeast. The southwest end of the pyroxenite body northwest of the survey point appears to be the nose of a fold with its axis and associated lineation plunging 56^{o} to 050^{o}. At the southeastern end of the outcrop, however, tight mesoscopic folds have axes plunging 64^{o} to 130^{o}. Both cross-cutting and concordant mylonite zones occur within the gneiss. Sample 76283141 from a mylonite zone is dull black, and consists of medium-sized fractured grains of pyroxene and olivine. Phlogopite flakes are partly altered to green biotite, and fractures are filled by yellow-green serpentine, opaque grains, and minor calcite.

Fyfe Hills thus consist of metamorphosed, locally deformed and faulted semi-pelitic and quartzo-feldspathic rocks containing boudinaged basic igneous layers. Partial retrogression is probably related to the deformation.

Mount Pardoe

Mount Pardoe (843 m) is an 8-km long north-northwest-trending ridge on the southern side of Amundsen Bay. In this area the regional strike is roughly easterly, although the gneisses are complexly folded. At Priestley

Peak, nearly isoclinal folds with amplitudes of perhaps 100 metres are conspicuous, and at Mount Trail more open folds have axial planes inclined at large angles to the foliation. Some of the latter structures may be equivalent to the major folds in the Mount Douglas area. Mafic dykes occur at Priestley Peak (possibly two generations) and Tonagh Island.

On the eastern summit of Mount Pardoe itself, very massive, poorly banded brownish quartz-feldspar gneiss dips at 35° to 225°, and exhibits particularly well-developed honeycomb weathering. The main constituents are mesoperthite, quartz, orthopyroxene (1-3%) and, in some specimens, garnet (up to 3%). Most samples show signs of retrogression and cataclastic deformation. Orthopyroxene is rimmed by pale brown, fine-grained biotite, and some is replaced by a reddish-brown iddingsite-like mineral. Quartz, feldspar and garnet are extensively granulated, particularly along original grain boundaries, where they form aggregates of very small grains (< 0.05 mm). The feldspar is partly recrystallised to plagioclase and microcline, and relict mesoperthite occurs as large porphyroclasts, 1-2 mm across. In zones of even more intense retrogression, the gneiss has lost its distinctive brown colour, and is pale grey, possibly owing to exsolution of iron from the feldspars (Burns, 1966; Bridgwater, 1966) or to alteration of the feldspars. Orthopyroxene is entirely replaced by fine-grained, partly recrystallised, aggregates of biotite, ferrohastingsite, and quartz. These retrograde zones trend E-W, and there is a suggestion of a new, steeply dipping foliation associated with them.

In the saddle west of the summit, more distinctly layered felsic gneiss with subordinate mafic layers is present. Shear zones are common, and a lineation plunges at 15° to 270°. Light grey garnetiferous gneiss and leucocratic gneiss with a typical 'acid granulite' texture (lenticular quartz grains) are common, and the even-grained mafic layers are typically composed of plagioclase, orthopyroxene, clinopyroxene, and minor greenish-brown primary hornblende, garnet, and an opaque mineral. Several samples of mafic gneiss are extensively retrogressed and strongly foliated, with granulation of plagiocalse and pyroxene, and alteration of pyroxene to green amphibole and biotite; the latter mostly occurs near garnet and opaque grains. Primary brown hornblende is absent from the most altered samples. Most, or all, of the garnet appears to be of late crystallisation, being far more abundant in the more altered rocks. It occurs around secondary amphibole rims which, in turn, surround pyroxene; it is particularly abundant in small shear zones, and probably crystallised during relatively high-pressure retrogression by a reaction such as

Plagioclase + Orthopyroxene + Water → Hornblende + Garnet + Quartz

Apparently secondary garnet is likewise present in some retrogressed leucocratic gneisses, where it occurs as rims in association with quartz, around orthopyroxene -

Plagioclase + Orthopyroxene → Garnet + Quartz.

One ultramafic layer consists of orthopyroxene, clinopyroxene, very pale hornblende, olivine, phlogopite, and an opaque mineral.

Thin, cross-cutting, pink biotite-bearing pegmatites are present in the felsic gneisses, but are not abundant. White, coarser-grained quartz-feldspar pegmatites, with minor muscovite, biotite and garnet, occur in the rubble, but were not found in situ.

Mount Douglas

Mount Douglas, in the southern Scott Mountains, consists of a northwest-trending ridge, about 6 km long, separated from the northeastern summit (1564 m) by a low saddle. Exposures are best in the steeper cliff faces, flatter areas being covered by frost-heaved rubble and scree. The rocks consist mainly of reddish-brown-weathering, rather massive and poorly banded quartz-feldspar gneiss intruded by west-northwest-trending dolerite dykes up to about 50 metres wide. Similar gneiss appears to be the main rock type in this part of the Scott Mountains, although more distinctly banded rocks, with a higher proportion of mafic layers, occur locally. Dolerite dykes are particularly abundant at Mounts George, Henry, Arthur, and Douglas and at Simpson Peak. On the main peak of the Gromov Nunataks, the dykes appear to be cut by pink pegmatite or granite veins.

The regional strike is roughly east, parallel to the axes of major folds with near-vertical limbs and north-dipping axial planes. The northeastern summit of Mount Douglas is situated on the steep limb of one such fold, the foliation dipping vertically or at steep angles ($>70^\circ$) to the south. At the northeastern tip of the mountain the dip is about 25^{o} to the north, whereas at Simpson Peak and Mount Henry, dips are generally to the south at moderate angles (20-50^{o}).

Near the northeastern summit, the only area examined in detail, the main rock type is migmatitic garnet-pyroxene-quartz-feldspar gneiss, with the reddish-brown colour typical of 'charnockitic' gneisses. One of the most common varieties consists of plagioclase, quartz, and orthopyroxene with minor reddish-brown biotite, and, in one case, clinopyroxene. Discrete grains of orthoclase perthite occur in only one sample, although potash feldspar occurs in antiperthite in the others. The foliation in one rock (76283022), defined by a strong preferred orientation of biotite (8%), was probably imposed during the major folding. Minor mafic bands contain plagioclase, about equal amounts of orthopyroxene and clinopyroxene, and biotite. Orthoclase is more abundant in the garnetiferous gneisses, but plagioclase still predominatessin most samples. In one sample (76283021) there are aggregates of small, subhedral to euhedral garnet crystals, a texture that may be due either to a reaction involving the breakdown of an initial grossular-rich garnet to give grossular-poor garnet, anorthite, and hypersthene or may be merely the result of recrystallisation associated with deformation. The latter may also be the reason for the lack, in rocks of suitable composition, of mesoperthite, a very common mineral at other localities, although most of the steeply dipping gneiss does not appear to be particularly deformed. Most of the gneiss is medium-grained, with the garnetiferous layers generally being coarser-grained (1-5 mm) than those in which pyroxene is the main mafic mineral (1-2 mm). More quartz-rich layers (e.g. 76283036), as well as rare layers of quartz-garnet-orthopyroxene rock, are almost certainly of sedimentary origin. Abundant pegmatitic layers and segregations have a similar mineralogy to that of the host gneiss and typically contain bluish quartz. One of the few undeformed cross-cutting pegmatites contains large grains of magnetite.

The dolerite dykes are fairly fresh, and contain plagioclase with a greyish clouding, clinopyroxene, and minor orthopyroxene, quartz, apatite, and an opaque mineral. The pyroxene shows some marginal alteration to brownish-green hornblende. The dykes have chilled margins and, being undeflected, are younger than the major folds, but are older than thin mylonite zones which affect both gneisses and dykes. The gneisses in these zones are thoroughly granulated and cut by thin pseudotachylite veins.

Oblachnaya Nunatak

Oblachnaya Nunatak (1600 m), about 45 km east of the Scott Mountains, consists of a variety of garnet-bearing gneisses.

Massive, fine to medium-grained leucocratic gneiss forms layers up to several metres thick, and consists of mesoperthite, quartz, partly sericitised plagioclase, irregularly distributed pink garnet, biotite, and opaque grains. The very poorly developed foliation is defined by lenticular aggregates of feldspar and mosaic quartz, and the rock contains conformable, coarse feldspathic veins. In a fine to medium-grained, speckled gneiss, feldspar comprises perthitic orthoclase and locally antiperthitic plagioclase, and both brown and green biotite are present. Quartz and feldspar are finely granulated along grain boundaries. A grey variety is characterised by the presence of orthopyroxene, as well as mesoperthite, quartz and various amounts of pink and red garnet, plagioclase, biotite, and accessory opaque grains, apatite, zircon, and sphene. Biotite is commonly located at the margins of the garnet grains.

At the central part of the nunatak the layering dips about 35° to 065°, and a lineation, defined by mineral elongation, plunges 25° to 065°. Leucocratic layers locally crosscut the regional foliation, and towards the southeast end of the nunatak are displaced a few metres vertically by two southeast-trending fault zones up to 1 m wide, and filled with mylonitised biotite-garnet-quartz-feldspar gneiss. Here the foliation dips 51° to 330°.

McLeod Nunataks

A high ridge on the eastern side of McLeod Nunataks was visited. A wind-scour on the east side of the ridge provides a good cliff-face exposure of medium-grained leucocratic gneiss, mafic gneiss, and plagioclase-pyroxene granulite.

The leucocratic gneiss consists of antiperthite, pink garnet, quartz, sillimanite, dark green spinel (commonly enclosed by garnet or rimmed by sillimanite), reddish-brown biotite, opaque grains, and zircon. Subordinate, discontinuous mafic layers, up to a metre wide, with at least 60 percent pyroxene are common. One medium-grained mafic gneiss (76283192) contains pale pink and colourless orthopyroxene, anthophyllite, greenish-brown spinel, plagioclase, biotite, and opaque grains, and another (76283195) consists of partly granuloblastic orthopyroxene, garnet, plagioclase, reddish-brown biotite, opaque grains, and dark green spinel. Locally the mafic gneiss is associated with fine to medium-grained quartz-orthopyroxene-magnetite-garnet rock, with up to 25 percent of magnetite by volume. Ultramafic layers a few metres wide consist entirely of coarse-grained black pyroxene (probably orthopyroxene).

The ridge top is composed mainly of grey fine to medium-grained granulite consisting of orthopyroxene, colourless clinopyroxene, plagioclase and accessory reddish-brown biotite and opaque grains. Locally quartz segregations define a weak foliation.

Calcite veins cut pale green clinopyroxene-plagioclase rock in the central part of the ridge. The veins generally consist of a core of calcite with a margin about 2 cm thick composed of grey bladed wollastonite and accessory scapolite, pale green clinopyroxene, calcite, sphene, quartz, and apatite. The wollastonite is altered along fractures to calcite. A horizontal quartz vein, 2 cm wide, cuts the gneiss in the cliff face.

Light green masses of hydrated aluminium sulphate (alunogene) occur in fractures in the mafic rock, and yellow jarosite and natrojarosite coat some rock surfaces (G.W.R. Barnes, BMR, personal communication, 1976). White powder coating rocks near the calcite veins may be secondary carbonate.

Near the central part of the ridge the foliation and layering are roughly horizontal, and a near-horizontal lineation defined by quartz elongation and fracture cleavage trends 106°. In the cliff face the layering is folded about horizontal axes parallel to the lineation. The outcrop pattern is partly controlled by jointing, which dips at 81° to 110°.

Point Widdows

Point Widdows, about 18 km west-southwest of the Thala Hills, is a small coastal outcrop that consists of medium-grained biotite-hornblende-orthopyroxene-quartz-plagioclase gneiss with xenoliths of fine-grained biotite-quartz-feldspar rock, cross-cut by pegmatite and quartz veins up to several centimetres in width.

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The gneiss consists of about 65 to 70 percent plagioclase (?oligoclase), partly altered orthopyroxene, green hornblende, dark brown biotite, quartz, opaque grains, and minor apatite. Its apparent compositional homogeneity and the presence of xenoliths suggest that the gneiss may be of intrusive origin.

The foliation strikes 290° but the dip is indeterminate. Some of the seaward facing rock exposures have a honeycomb surface (Fig. 17) probably caused by a combination of repeated wetting and drying, frost-wedging, and abrasion from wind-borne rock or ice particles. Moraine scattered over the outcrop consists of calc-silicate rock, garnet gneiss, and biotite gneiss, and contains pyrite and malachite.

Molodezhnaya

The Soviet Antarctic Expedition Molodezhnaya base is situated at the western end of the Thala Hills. Bedrock exposures in the station area consist mainly of a series of low-lying, glaciated, west-northwest trending ridges, partly separated by snowfields and several freshwater lakes. The geology has been described in detail by Grew & others (Grew, 1975; Grew & others, personal Communication, 1977).

Migmatitic quartz-feldspar gneiss makes up most of the exposures examined, although mafic gneiss is also quite abundant, and thin, subconcordant quartzo-feldspathic veins are common. On a large scale, the gneisses are well banded, although many individual layers are massive and have a poorly defined foliation. Flow and isoclinal folds are common, and both mafic and pegmatitic layers are commonly boudinaged (Fig. 18). Over most of the area the foliation strikes west-northwest, but dips are extremely variable; on the western side of the station, dips are about 20° to the south. Elsewhere, folds with amplitudes of tens of metres are common, and have near-vertical, relatively strongly deformed steep limbs and steeply dipping axial planes (the only axial plane measured dips south-southeast). Fold axes mostly plunge east-southeast at low angles, and are parallel to a lineation which, at one locality, dips at 10° to 105°. Small, cross-cutting shear folds were noted at several localities, and, in one place, an undeformed pegmatite follows the north-trending steep limb of such a fold (Fig. 19).

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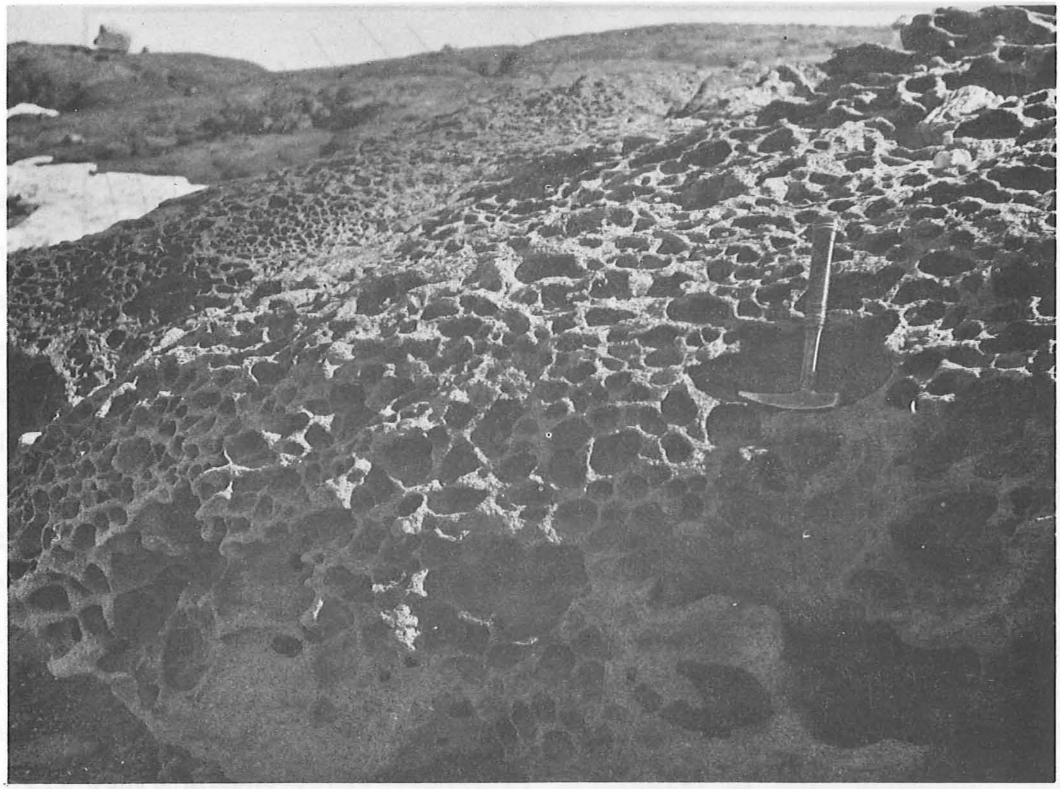

Fig. 17. Point Widdows. Honeycomb weathering of massive biotite-hornblende-orthopyroxene-quartz-plagioclase gneiss.

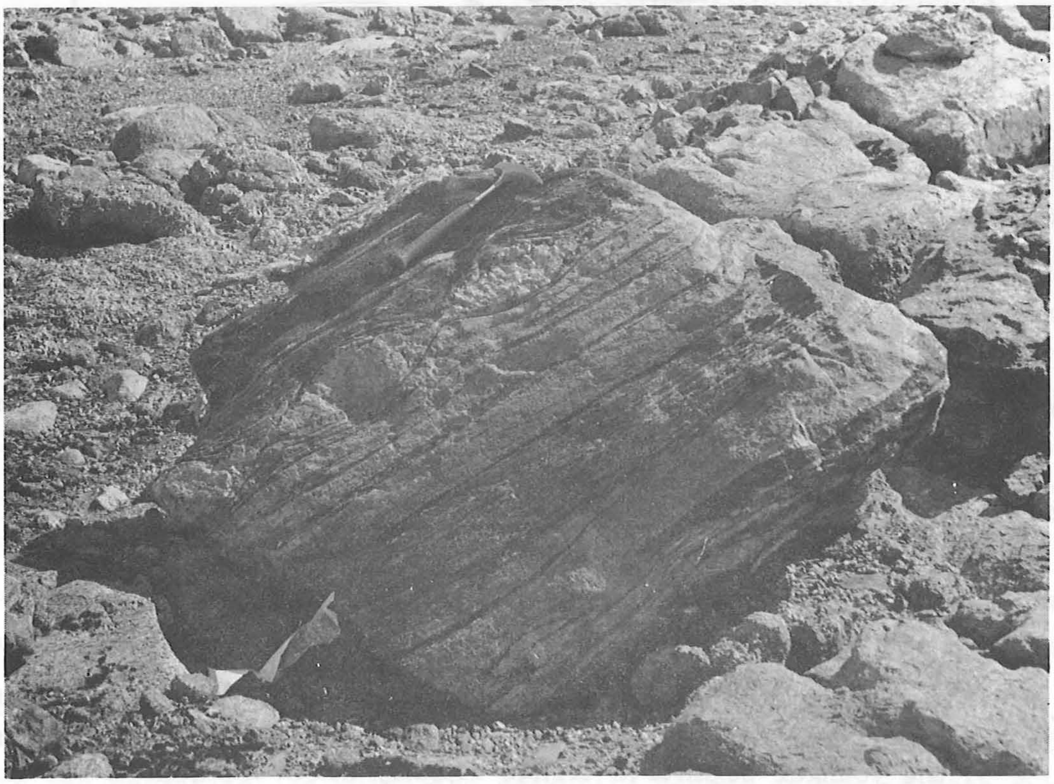

Fig. 18. Molodezhnaya. Migmatitic hornblende-biotite-quartz-feldspar gneiss, with boudinaged pegmatite layer. (Neg. M 2040).

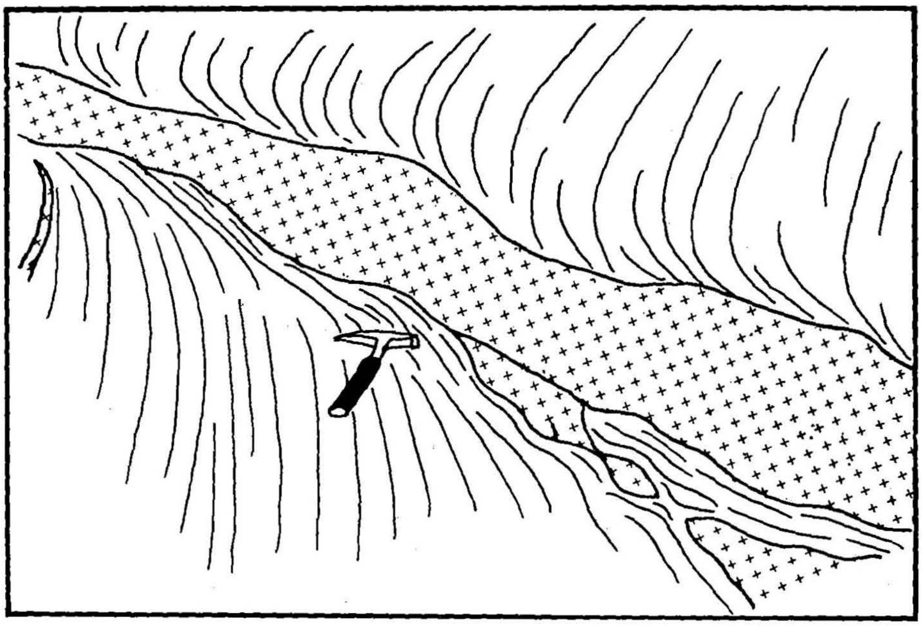

Fig. 19. Mologozhnaya. Pegmatite intruding north-trending steep limb of shear fold. Note boudinaged pegmatite layer.

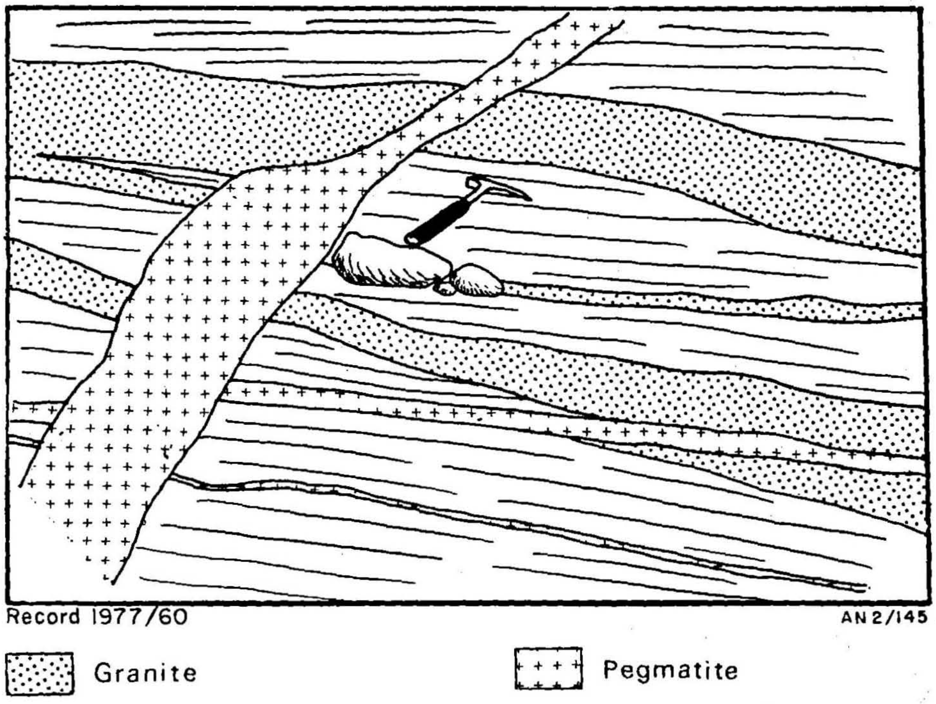

Fig. 20. Molodezhnaya. Two generations of pegmatite dyke cutting granite dyke. The foliation in the gneiss strikes east-southeast, and the younger pegmatite trends roughly north-northeast.

The quartz-feldspar gneisses have a wide range of composition; the most common mafic minerals are olive-green hornblende and dark brown biotite. A hornblende and biotite-bearing gneiss (76283043) contains large, sieve-like crystals of hornblende with abundant quartz inclusions, suggesting replacement of pyroxene (the formation of hornblende from pyroxene involves production of excess silica). Garnet is quite abundant locally, particularly on the north side of the station; minor constituents include apatite, zircon and opaque minerals. Orthopyroxene and clinopyroxene are present in only one sample (76283038), although, according to Grew (1975), pyroxene is of widespread occurrence in the area, particularly in non-migmatitic gneisses. In the more hornblende-rich gneiss, plagioclase (oligoclase-andesine) is normally the predominant feldspar, whereas in the more siliceous biotite ± hornblende gneiss, perthite, often showing incipient microcline twinning, is equally or more abundant. Much of the massive hornblende-biotite gneiss which crops out to the north of the station is of granodioritic composition and is considered by Grew & others (personal communication, 1977) to be of plutonic igneous origin. The deformed remnants of possibly related pegmatites are represented by concordant layers of augen gneiss, consisting of oligoclase and smaller amounts of perthite, quartz, and biotite. Amphibolites are composed of andesine/labradorite, green hornblende, quartz (up to 15%), and minor biotite. The relative abundance of quartz and, in one sample, epidote, suggests a sedimentary, rather than a mafic igneous, origin for at least some of them. Mafic calc-silicate rocks, with abundant epidote, actinolite, and, locally, garnet, are widespread, but make up only a small proportion of the complex. A few calcite-rich bands crop out near the coast to the north of the station. Retrograde effects are relatively minor in most of the gneisses examined - most look quite fresh in thin section, but locally biotite shows alteration to chlorite and feldspars are sericitised.

Cross-cutting pink granite and pegmatite dykes, up to 5 metres wide, are very common. Most of the granites appear to pre-date the pegmatites, although there are several generations of each. About 1 km east of the station, slightly discordant granitic veins are cut by thin southeast-trending pegmatites, which are cut in turn by a much thicker (0.5 - 2 m) north-northeast-trending set (Fig. 20). Composite dykes of pink granite and pegmatite, in which the pegmatite occurs at one or both dyke margins, suggest near-contemporaneous intrusion of granite and pegmatite. Contacts between pegmatite and granite are fairly sharp, and in one place inclusions of pegmatite within the granite indicate that the latter is younger. The granitic veins range from granite (sensu stricto) to adamellite, and consist of perthite (commonly microcline), oligoclase, quartz, and biotite. The pegmatites are more variable in composition (Grew & others, personal communication, 1977), but most are biotite-quartz-feldspar pegmatites, the feldspar being either K-feldspar or sodic plagioclase or, in most cases, both.

Compared with most localities visited in the Tula and Scott Mountains, the gneisses of the Molodezhnaya area are of significantly lower grade - mesoperthite is absent, and hydrous phases (green hornblende and dark brown biotite) are much more common than pyroxene. The abundance of hydrous minerals indicates that the highest grade of metamorphism attained was probably only just within the granulite facies. According to Grew (1975), the widespread folding was probably contemporaneous with this high-grade metamorphism. Pegmatites, both concordant and cross-cutting, are particularly abundant, and there is possibly less widespread evidence of alteration, although local amphibolite-facies retrogression was apparently associated with emplacement of the acid dykes (Grew, 1975). A Rb-Sr isochron age of 987 ± 60 m.y. (initial ratio 0.7109 ± 0.0015) was obtained by Grew(1975) on nine samples of charnockitic gneiss. This age is similar to those given by granulite-facies gneisses from the northern Prince Charles Mountains and Mawson Coast. Seven granitic dykes from the Molodezhnaya area gave an isochron age of 512 ± 155 m.y., and biotite concentrates from two pyroxene and hornblende gneisses were dated at 460 and 465 m.y. (Grew and others, personal communication, 1977). Pegmatites and granitic rocks from a wide area of MacRobertson Land have given similar ages, thought to be related to the Pan-African orogeny that has been widely identified in basement igneous and metamorphic rocks from Africa (Clifford, 1974).

Pinn Island

Pinn Island (116 m) is a low rubbly ridge on the southern side of Casey Bay. Samples of medium-grained biotite-quartz-feldspar granulite, fine to medium-grained mafic gneiss, and dolerite from locally derived

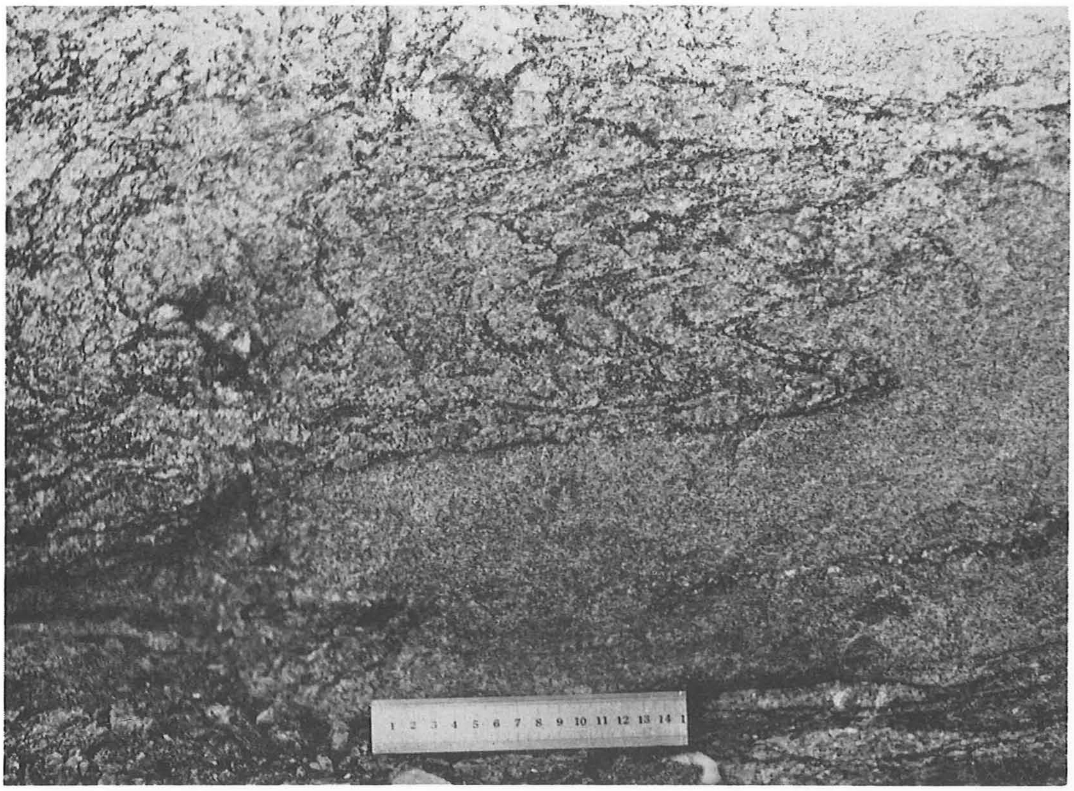

Fig. 21. Mount Christensen. Folded biotite-hornblende-quartz-feldspar gneiss and granite. Scale in cm. (Neg. M 2036).

moraine were collected by the surveyor and geophysicist who visited the island in January 1976.

The biotite-quartz-feldspar granulite consists of perthitic microcline, partly sericitised plagioclase, quartz, opaque grains, orange-brown biotite partly altered to chlorite, and apatite. Orthopyroxene, pale green clinopyroxene, green hornblende or light green amphibole, and biotite make up about 80 percent by volume of the mafic gneiss. The dolerite consists of partly altered clinopyroxene and plagioclase, opaque grains, and some secondary green amphibole.

The presence of chlorite and microcline and the alteration of pyroxene and plagioclase indicate that the rocks have been affected by low-grade, retrogressive metamorphism.

Mount Christensen

Mount Christensen (1523 m), on the west side of the Rayner Glacier, is almost completely covered by snow and ice. The small discontinuous exposures that were examined consist of medium-grained biotite-hornblende-quartz-feldspar gneiss intruded by locally concordant, fine to medium-grained biotite granite with tourmaline. The gneiss contains perthitic orthoclase, antiperthite, quartz, green hornblende, biotite, and accessory epidote, apatite, opaque grains, and ?allanite. A foliation that dips about 35^{o} to the southeast is defined by quartz-feldspar lenses and layers up to 1 cm wide interbanded with segregations of hornblende and biotite. Both granite and gneiss have been folded on a mesoscopic scale.

Late-stage pegmatites, up to several centimetres wide, cut the folded gneiss and granite. They are medium-grained at their margins, and composed of feldspar, quartz, biotite, tourmaline, and, in places, euhedral magnetite.

Krasin Nunataks

Krasin Nunataks are on the southeast edge of the Nye Mountains, and consist of layered mafic and quartz-feldspar gneiss. The mafic gneiss forms rubbly layers with subdued relief between massive, more prominent felsic layers.

The mafic gneiss commonly consists of plagioclase, orthopyroxene, pale green clinopyroxene, green hornblende, biotite, opaque grains, and minor quartz. Sample 76283181 contains secondary clinopyroxene at orthopyroxene-plagioclase and hornblende-plagioclase grain boundaries. An ultramafic layer within the mafic gneiss is composed of orthopyroxene, pale green to colourless clinopyroxene, olivine (partly altered to yellow serpentine), light green amphibole, opaque grains, and phlogopite.

Poorly foliated, medium to coarse-grained quartz-feldspar gneiss forms layers up to 30 m thick which are locally discordant to the foliation in the mafic gneiss, and contain elongated and rarely folded mafic xenoliths intersected by granitic veins. The gneiss contains orthoclase, plagioclase, quartz, and rare pyroxene, biotite, zircon, and opaque grains. Perthite and antiperthite are common, and in places are partly altered to calcite and ?chlorite. The massive felsic layers have gradational margins with minor mafic selvages, and were probably intruded after metamorphism and minor folding of the mafic gneiss. Development of secondary clinopyroxene in some of the mafic gneiss indicates a second high-grade metamorphism which may be related to the intrusion of the felsic rocks.

The layering generally strikes 255°, and dips 85 to 90° south. A lineation defined by mineral elongation in the mafic gneiss plunges 43° towards 090°. Pegmatite veins mostly parallel the foliation, but some late-stage biotite-quartz-feldspar pegmatites with minor magnetite cut both mafic and felsic layers. Locally, malachite fills fractures in the mafic gneiss, and in places the quartz-feldspar gneiss is covered by a yellow limonite crust.

Sandercock Nunataks

Sandercock Nunataks are some of the most southerly rock exposures in Enderby Land. The central main nunatak is a rubbly flat-topped hill with moderate ice slopes on all sides except the north tip where a deep scour exposes near-vertical rock faces.

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This hill consists of horizontally foliated, generally medium-grained felsic gneiss composed of perthitic orthoclase, plagioclase, quartz, biotite, scattered orthopyroxene and opaque grains, red poikilitic garnet, and minor apatite and zircon. Locally the gneiss contains ovoid K-feldspar megacrysts up to 6 cm long. Reddish-brown and opaque minerals at the margins of, and along fractures in, orthopyroxene may have been formed by exsolution of iron from the orthopyroxene. The foliation is defined by patches and streaks of garnet and biotite flakes. Elongated biotite and feldspar define a lineation trending east, and rare elongated fine-grained bodies several centimetres long and of a similar composition to the enclosing gneiss are also present. The compositional homogeneity of the gneiss and the presence of these 'xenoliths' suggest an intrusive igneous origin.

The gneiss is cut by veins of garnet-biotite granite and tourmaline-bearing granite.

METAMORPHISM

The highest grade of metamorphism reached in much of central Enderby Land (the area from the Napier to the Raggatt Mountains, corresponding to the Napier zone of Soviet geologists (Kamenev, 1972)), is intermediate-pressure granulite facies. The assemblage orthopyroxene + clinopyroxene + plagioclase is widespread in mafic rocks, whereas the corresponding high-pressure assemblage garnet + clinopyroxene + quartz (de Waard, 1967; Green & Ringwood, 1967) was not found, although it is present in the Robert Glacier area of western Kemp Land (Pieters & Wyborn, 1977). Cordierite occurs in a few localities (e.g. Fyfe Hills and Latham Peak), and sillimanite is fairly widespread, but rocks of pelitic composition are relatively uncommon in the areas visited. Hydrous minerals are notably rare, but include reddish-brown biotite and, in mafic rocks, brown hornblende. Mesoperthite is the characteristic feldspar in rocks of suitable composition, and is compatible with crystallisation under high temperatures and low water pressures (Tuttle & Bowen, 1958; Turner & Verhoogen, 1960). Relatively rapid cooling appears to be necessary to prevent recrystallisation of two feldspars (Smith, 1974). Coexisting sapphirine and quartz (Dallwitz, 1968) indicate temperatures of at least 800°C (Newton, 1972), and possibly as high as 1050°C (Hensen & Green, 1973), and pressures in excess of 7 kb. Breakdown of sapphirine to cordierite + sillimanite + garnet, possibly during the waning stages of the high-grade metamorphism, proceeds at about 8-9 kb and 1030°C according to Hensen & Green (1973).

West of the Rayner Glacier and at Krasin Nunataks, the metamorphic grade is rather lower. Green hornblende and brown biotite are much more abundant, pyroxenes are less common, and some of the rocks have a strongly migmatitic appearance indicating higher P_{H_2O}. Mesoperthite is apparently absent, and most leucocratic rocks contain two feldspars. Granitic and pegmatitic veins are common, and some of the granitic gneisses may be of intrusive igneous origin (e.g. Krasin Nunataks). Nevertheless, the presence of orthopyroxene, with or without clinopyroxene, in felsic gneisses indicates that granulite-facies conditions had just been reached. Evidence for a possible earlier high-grade metamorphism is the presence of hornblende with abundant quartz inclusions in a gneiss from Molodezhnaya. This suggests breakdown of original pyroxene:

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Orthopyroxene + Clinopyroxene + Plagioclase + Water $\rightarrow$ Hornblende + Quartz.

A rather deformed, possibly retrograde mafic gneiss from Molodezhnaya contains the amphibolite facies assemblage hornblende + plagioclase + quartz + biotite + epidote. Calc-silicate rocks rich in epidote, hornblende, and garnet are common in moraine at Molodezhnaya and Point Widdows, suggesting that amphibolite facies rocks may be widespread in that area.

Apart from the above example, evidence for polymetamorphism is confined mainly to more deformed rocks, some of which may be associated with the major folding described below, although there is evidence for crystallisation of secondary pyroxene at Rippon Depot and Krasin Nunataks. At Mount Pardoe and Latham Peak, orthopyroxene in felsic gneiss is surrounded by a rim of garnet + quartz intergrowths, probably as a result of a reaction such as

2 Orthopyroxene + Anorthite $\rightarrow$ Garnet + Quartz,

which suggests increasing pressure at constant temperature or decreasing temperature at constant pressure, similar to the reaction

3 Orthopyroxene + 2 Anorthite $\rightarrow$ Clinopyroxene + 2 Garnet + Quartz,

which is favoured by high pressure (de Waard, 1967; Green & Ringwood, 1967). In mafic two pyroxene-plagioclase gneiss at Mount Pardoe and Fyfe Hills, formation of secondary hornblende and garnet has occurred by a combination of the reactions

Pyroxene + Plagioclase $\rightarrow$ Hornblende + Quartz and
Hornblende/Pyroxene + Plagioclase $\rightarrow$ Garnet + Quartz.

A possible overall reaction is

Plagioclase + Orthopyroxene + Water $\rightarrow$ Hornblende + Garnet + Quartz.

This also suggests reaction under relatively high-pressure conditions (Green & Ringwood, 1967) - in most retrograde rocks pyroxene is replaced only by amphibole or biotite. However, bulk composition is also important in determining the appearance of garnet in mafic rocks (de Waard, 1967); lower values of Mg/Fe cause garnet to appear at lower pressures (Green & Ringwood, 1967). A similar reaction has been described in high-grade metamorphic rocks from New Zealand, where replacement of hornblende by garnet in hypersthene-bearing hornblende metadiorites was accompanied by an increase in Al and decrease in Na in the rock (Blattner, 1976), and from Uganda (de Waard, 1967).

At Fyfe Hills, sheared pelitic gneiss contains the metastable assemblage quartz + gedrite + kyanite + garnet + biotite + cordierite. There are no obvious reaction relationships, but one possibility is the breakdown of cordierite to kyanite + gedrite under the influence of stress and with addition of water -

5 Cordierite + 2 Water $\rightarrow$ 6 Kyanite + 2 Gedrite + 7 Quartz.

Green & Vernon (1974) describe such a reaction in high-grade metamorphic rocks of the Arunta Block, and suggest it resulted from an increase of water fugacity at constant total pressure (8-9.5 kb) and temperature (750-820^{o}C).

All these reactions suggest relatively high pressures and temperatures corresponding to at least the upper amphibolite facies, and most involve addition of water. The formation of near-vertical shear zones may have permitted access of water into otherwise almost anhydrous rocks, and shearing stress may well have been an important factor. Both Mount Pardoe and Fyfe Hills lie on the boundary between the Napier metamorphic zone and the younger Rayner zone of Kamenev (1972).

Lower-grade (greenschist to amphibolite facies) retrogression is widespread in both dolerite dykes and country rocks, and is particularly common in association with shear zones and mylonites. Mesoperthite is recrystallised to two feldspars, and pyroxene is wholly or partly replaced by fine-grained aggregates of actinolitic amphibole or biotite, with quartz and, in some cases, minor carbonate and opaque minerals -

Orthopyroxene + Clinopyroxene + Plagioclase + Water→Hornblende + Quartz;
Orthopyroxene + Anorthite + Water→Hornblende + Quartz;
Orthopyroxene + K feldspar + Water→Biotite + Quartz.

In felsic gneisses, orthopyroxene is commonly altered to biotite, although a thin rim of cummingtonite is present in a few samples. Actinolite or hornblende are the main alteration products in mafic rocks, although biotite is common around opaque grains, probably because the Mg/Fe ratio of biotite is lower than that of the original pyroxene, and excess Fe is provided by the ore minerals. Other retrograde effects include alteration of orthopyroxene to yellowish-brown iddingsite-like material, chloritisation of biotite, and sericitisation and saussuritisation of feldspar.

GEOLOGICAL HISTORY & DISCUSSION

The pre-metamorphic nature of many of the rocks of central Enderby Land is uncertain. The relative homogeneity and lack of a well-defined banding in much of the brown-weathering orthopyroxene-quartz-feldspar gneiss of the Scott, Tula, and Napier Mountains, together with its roughly 'granitic' composition, suggest an origin from either greywacke-type sediments or acid igneous rocks (acid volcanics or, in the case of some particularly massive gneiss, such as that at Proclamation and Sheelagh Islands, and Point Widdows, granitic intrusives). Some garnetiferous varieties with relatively abundant quartz or K-feldspar do not appear to be of typical igneous composition, and are probably metamorphosed sediments. Interlayered mafic pyroxene-plagioclase granulites and gneisses are probably mostly of igneous origin, although some may be metasediments (derived from calcareous sediments or mafic tuffs). Some pyroxenite pods and lenses are presumably the result of extreme fragmentation and boudinage of ultramafic igneous bodies, although others may represent metamorphic segregations.

The spectacular banding of the white to grey garnet-quartz-feldspar gneisses, which are particularly abundant in the Tula Mountains, probably represents original, although partly transposed, sedimentary layering. These gneisses are generally rather more K-rich than typical igneous rocks, and some have a relatively high quartz content. Similar rocks from MacRobertson Land are significantly corundum-normative, which also suggests a sedimentary origin. Associated with the garnet-quartz-feldspar gneisses are a variety of rocks of undoubted sedimentary origin, including siliceous, aluminous, and ferruginous types. Pelitic meta-sediments occur at Fyfe Hills, Latham Peak, and a number of localities in the Tula Mountains, and rocks with up to 25 percent magnetite occur at Mounts Jewell and Stadler, Fyfe Hills, Latham Peak, and McLeod Nunataks. Calc-silicate gneiss is abundant in moraine at Molodezhnaya and Point Widdows.

The compositions of many of these rocks may have been modified by partial melting and separation of a granitic component during metamorphism. Thus, the more aluminous layers, such as the sapphirine-quartz bearing rocks of Sapphirine Nunatak, could be the refractory residues of originally less highly aluminous sediments.

In the Scott, Tula, and Napier Mountains, the rocks have been metamorphosed under medium-pressure granulite-facies conditions. It was during this metamorphism that the present foliation, largely defined by compositional layering, was formed. Preferred orientation of minerals such as biotite is not common, except in the more deformed rocks, although lenticular quartz aggregates occur in some leucogneisses. Minor intrafolial and irregular, plastic folds were probably formed by transposition of an earlier sedimentary or metamorphic layering. Mesoscopic isoclinal folds, with amplitudes of a few metres and, in some cases, with an axial plane foliation, may be of the same age.

There is evidence for at least two types of dyke which antedate this metamorphism. Two pyroxene-plagioclase granulites of probable basaltic composition occur at Rippon Depot, Sapphirine Nunatak and possibly Sheelagh Island, and pyroxenite dykes, which retain slightly discordant contacts, were found at Mounts Sones, McGhee, and Jewell.

Structures formed after the granulite-facies event mostly have axial planes inclined at a large angle to the foliation, whereas earlier folds have axial planes sub-parallel to the foliation. A major folding episode throughout much of Enderby Land resulted in the formation of asymmetric folds with near-vertical limbs. The regional strike ranges from north or north-northeast in the Napier Mountains to east or east-northeast in the Scott Mountains, although locally the folding is complex. Smaller, similar-type folds with amplitudes of tens of metres may belong to the same generation. They range from relatively open to almost isoclinal, and have axial planes roughly parallel to those of the major folds, dipping at steep angles (45°-80°) to 300° in the Mount King area. At Mount Denham, the fold axes plunge 10° to 025°, and a probably associated lineation at Mount King and Seavers Ridge plunges at low angles (5°-30°) to 030°. Some retrogression effects, including cataclastic deformation and alteration of pyroxene, may have been associated with the major folding. At some localities (e.g. Mounts Cordwell and Douglas), the steeply dipping gneiss is rather fissile, with conspicuous development of sub-parallel biotite flakes.

Evidence for a second phase of high-grade metamorphism (upper-amphibolite to lower-granulite facies) was found at Fyfe Hills, Mount Pardoe, and Latham Peak, where reactions took place under relatively high-stress conditions in association with shearing, in some cases involving introduction of water. Both Fyfe Hills and Mount Pardoe lie on the boundary between the two metamorphic zones of Kamenev (1972). Development of secondary pyroxene in mafic gneiss at Rippon Depot and Krasin Nunataks also suggests possible overprinting by a later metamorphism which post-dates a period of mafic dyke intrusion at Rippon Depot. Elsewhere, the only evidence of polymetamorphism is provided by retrograde reactions such as alteration of pyroxene to hornblende and biotite, and garnet to biotite, associated with recrystallisation of feldspar and other minerals. The relationship of the second high-grade metamorphism to this retrogression is uncertain, but they may have been , at least in part, contemporaneous.

The dolerite dykes post-date the major folding at Mount Douglas and in the Mount King area. They show some retrogressive effects, such as alteration of pyroxene to pale green amphibole, but this may be largely a deuteric effect. However, late-stage, low-grade metamorphism, with the development of mylonite zones, thin epidote veins, and pseudotachylite, post-dates at least some of the dolerite dykes (e.g. at Seavers Ridge). A lineation was developed in the mylonite zones, which at Mount King plunges steeply towards 320°.

West of the Rayner Glacier and at Krasin Nunataks, the highest metamorphic grade is upper-amphibolite to lower-granulite facies, although there is some evidence for an earlier high-grade metamorphism. The gneisses at Molodezhnaya are highly migmatitic, and metamorphism occurred under much higher water pressures than in central Enderby Land. Foliated, but locally discordant granitic rocks occur at Krasin Nunatak and Mount Christensen. East-southeast-trending, asymmetric folds with amplitudes of tens of metres and subhorizontal axes are common at Molodezhnaya, and have an associated axial lineation. Small, cross-cutting shear folds are apparently younger. Cross-cutting granitic and pegmatitic veins, up to 5 metres wide, are common. In general, the granites antedate the pegmatites, but there are several generations of each. Tourmaline-bearing pegmatites occur at Mount Christensen.

No dolerite dykes were found in this area or anywhere else in the Rayner zone of Kamenev (1972), although metamorphosed basic dykes occur at Rippon Depot and possibly Sheelagh Island. The only dolerite dykes shown within the Rayner zone on the Soviet geological map of Enderby Land are very close to the boundary with the Napier zone on the eastern side of Casey Bay near Fyfe Hills (Kamenev, 1975). The absence of unmetamorphosed dolerite dykes in much of the area west of the Rayner Glacier supports the Soviet conclusion that the gneisses are younger than those of the Napier zone, and consist, at least in part, of reworked older metamorphic rocks, The very limited age data support this view. Very old ages (3900 $\pm$ 300 m.y.) were obtained on rocks from the Napier zone by Pb-Th-U methods (Ravich & others, 1974), whereas a Rb-Sr isochron age of 987 $\pm$ 60 m.y., with an initial Sr^{87}/Sr^{86} ratio of 0.7109, was obtained on charnockitic gneiss from the Molodezhnaya area (Grew, 1975;). Granitic dykes from Molodezhnaya have given ages of about 500 m.y. (Grew & others, personal communication, 1977). Comparisons may be made with the granulite-facies rocks of the northern Prince Charles Mountains and MacRobertson Land and Kemp Land Coast, where Rb-Sr ages of 900 to 1100 m.y. have been obtained (Tingey & others, 1976; Arriens, 1975). According to Trail (1970), an early lower granulite-facies metamorphism was separated from a late amphibolite-facies metamorphism by the intrusion of dolerite dykes. The only relatively fresh, undeformed basic dykes examined from this area have alkaline affinities and have given a range of Phanerozoic ages (BMR, 1975). Undeformed quartz tholeiite dykes have been found only in the older, mostly Archaean, metamorphic rocks of the southern Prince Charles Mountains (Tingey & others, 1976). Similar dykes from the Vestfold Hills, Princess Elizabeth Land, have given Rb-Sr ages of about 1400 m.y. (Arriens, 1975; BMR, 1975).

ECONOMIC GEOLOGY

No mineral deposits of economic significance were found during the 1975-76 field season. Layers of quartz-garnet-orthopyroxene rock with up to 25 percent of magnetite by volume were found at Mounts Stadler and Jewell, Fyfe Hills, Latham Peak, and McLeod Nunataks, but none was thicker than a few metres. Green, copper-rich encrustations are quite widespread, but do not appear to indicate significant concentrations of copper minerals in the host rocks.

CONCLUSIONS

A tentative summary of the geological history of Enderby Land is given below.

1) Deposition of sediments, including pelitic, siliceous, and ferruginous types, and probable extrusion of mainly acid volcanics.
2) Emplacement of mafic and ultramafic dykes and possibly granitic intrusions.
3) Medium-pressure (locally high-pressure) granulite-facies metamorphism; formation of present foliation and isoclinal folds. ?Archaean
4) Major asymmetric folding, with localised retrogression.
5) Intrusion of dolerite dykes.
6) Upper-amphibolite to lower-granulite facies metamorphism with associated asymmetric folding in the area to the west of Rayner Glacier and at Krasin Nunatak, probably contemporaneous with a post-dyke ?900-1100 m.y.

granulite-facies metamorphism in the Seaton Glacier area (e.g. Rippon Depot), and with localised high-pressure metamorphism in shear zones elsewhere (e.g. Fyfe Hills, Mount Pardoe).

7) Low-grade retrogression, mylonite zones, epidote veins, and pseudotachylite.

8) Granite and pegmatite intrusion (west of Rayner Glacier). 500 m.y.

It must be emphasised that this outline is only tentative, and much further work remains to be done before a more definitive statement on geological history can be made. In particular, the relationship between the upper amphibolite to lower granulite facies metamorphism in the area to the west of the Rayner Glacier and the localised second metamorphism in central Enderby Land is uncertain, although they have been tentatively correlated. Much of the late, low-grade retrogression and brittle deformation in central Enderby Land may be of the same age. There is no definite evidence that the second high-grade event post-dates the dolerite dykes, although this seems probable. More detailed field work and, more specifically, isotopic dating, will be necessary to elucidate these problems.

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APPENDIX
PETROGRAPHIC DATA

In the following tables samples are arranged according to locality, in the same order in which the localities are described in the text. Visual estimates of the percentages of each mineral in each sample are given in brackets. Only abbreviated rock names are given in the column 'Comments'.

Sample	Assemblage	Comments
RIPPON DEPOT (SQ 40-41/9)		
76283105	Pale green clinopyroxene and orthopyroxene (together 57), plagioclase (40), opaque grains (3), and accessory green hornblende, biotite, and ?quartz.	Metamorphosed mafic dyke. Recrystallised; granular texture.
76283106	Orthopyroxene and colourless clinopyroxene (together 55), pale green amphibole (25), plagioclase (20), and accessory light brown phlogopite and opaque grains.	Fine to medium-grained mafic pyroxene granulite (xenolith). Interlocking grains of Intexene, amphibole, and plagioclase.
76283107	Mesoperthite (68), quartz (30), orthopyroxene altered to opaque mineral and yellow-brown mineral (2), and accessory zircon and apatite.	Fine to medium-grained felsic orthopyroxene gneiss.
76283108	Greenish-brown hornblende (43), orthopyroxene (40), plagioclase (15), orange-brown phlogopite (2), and accessory opaque grains.	Fine to medium-grained mafic pyroxene gneiss. Secondary growth of orthopyroxene at boundary between hornblende grains and between hornblende and plagioclase grains.
76283109	Clusters of medium-grained orthopyroxene, with brownish-green hornblende and reddish-brown biotite along fractures and grain boundaries, and brown alteration along some fractures. The surrounding rock consists of perthitic orthoclase, antiperthite, quartz, opaque grains, and accessory biotite.	Felsic orthopyroxene gneiss.
76283110	Orthopyroxene partly altered to red iron oxide and brown mineral (50), plagioclase with deformed twin lamellae and numerous opaque inclusions (20), brown hornblende (10), reddish brown biotite (10), quartz (10), and accessory opaque grains and zircon.	Fine to medium-grained, layered mafic pyroxene gneiss. Segregation of pyroxene-plagioclase and quartz-plagioclase.

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Sample	Assemblage	Comments
76283111	Pale green clinopyroxene and orthopyroxene (together 53), plagioclase with deformed twin lamellae (45), reddish-brown biotite (1), opaque grains (1), and accessory brown hornblende.	Fine to medium-grained mafic pyroxene granulite.
76283112	Layered. 1. Reddish-brown biotite, ?orthoclase, and plagioclase. 2. Plagioclase, quartz, orthopyroxene, and mesoperthite. 3. Predominantly quartz. Accessory opaque grains, zircon, and apatite.	Fine to medium-grained felsic orthopyroxene-biotite gneiss.
76283113	Medium to coarse-grained aggregate of pale green and colourless clinopyroxene (90), partly altered to brown hornblende. Interstitial colourless orthopyroxene, plagioclase, quartz, and accessory opaque grains.	Clinopyroxenite. Exsolution lamellae in the clinopyroxene.

PROCLAMATION ISLAND (SQ 38-39/8)

Sample	Assemblage	Comments
76283082	Quartz (35), perthite (27), antiperthite (27), garnet (5), orthopyroxene (3), reddish-brown biotite (3), and accessory opaque grains.	Medium-grained felsic orthopyroxene-garnet gneiss. Garnet and orthopyroxene show marginal alteration to biotite.
76283083	Perthite (32), sodic andesine (32), quartz (30), orthopyroxene (5), and accessory dark brown hornblende, clinopyroxene, apatite, and opaque grains.	Medium-grained felsic orthopyroxene gneiss. Primary hornblende.
76283084	Perthite (40), plagioclase - An_{30} (28), quartz (25), orthopyroxene (5), clinopyroxene (1), opaque grains (1), and accessory dark brownish-green hornblende, apatite, and zircon.	Fine to medium-grained felsic orthopyroxene gneiss.
76283085	Perthite (34), sodic andesine (30), quartz (30), orthopyroxene (5), opaque grains (1), and accessory clinopyroxene, brownish-green hornblende, and apatite.	Medium-grained felsic orthopyroxene gneiss.

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Sample	Assemblage	Comments
76283086	Orthoclase (42), quartz (40), garnet (10), reddish-brown biotite (3), orthopyroxene (2), cordierite (2), and accessory spinel, sillimanite, and opaque grains.	Medium-grained semi-pelitic gneiss. Spinel and sillimanite occur as inclusions in garnet.
76283087	Perthite (35), sodic andesine (35), quartz (25), orthopyroxene (2), garnet (2), and accessory biotite, zircon and opaque grains.	Fine to medium-grained felsic orthopyroxene-garnet gneiss. Abundant myrmekitic intergrowths.
76283088	Perthite (45), quartz (35), plagioclase (17), garnet (1), biotite (1), cordierite (1), and accessory zircon and opaque grains.	Medium to coarse-grained semi-pelitic gneiss.
76283089	Feldspar, quartz, garnet, and brown biotite.	Very fine-grained, sheared felsic garnet-biotite gneiss. Abundant post-kinematic garnet.
76283090	Orthopyroxene (33), clinopyroxene (33), reddish-brown biotite (33), and opaque grains (1).	Fine to medium-grained pyroxenite layer.
76283091	Phenocrysts: plagioclase (12) and clinopyroxene (12). Groundmass: brownish amphibole, plagioclase, and opaque grains.	Dolerite (float). Subophitic texture.
76283092	Quartz (36), perthite (29), antiperthite (29), orthopyroxene (3), brown biotite (3), and accessory opaque grains.	Fine to medium-grained felsic orthopyroxene gneiss. Biotite replaces orthopyroxene and has a preferred orientation.

SHEELAGH ISLAND (SQ 38-39/11)

Sample	Assemblage	Comments
76283149	Perthitic orthoclase (60), plagioclase (some antiperthite; 20), quartz (15), orthopyroxene (5), and accessory opaque grains, apatite, and zircon.	Medium-grained felsic orthopyroxene gneiss. Orthopyroxene partly clouded by opaque grains along cleavage and fractures.

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Sample	Assemblage	Comments
76283150	Perthitic orthoclase (some mesoperthite; 60), quartz (20), plagioclase (some antiperthite; 17), orthopyroxene (3), and accessory opaque grains and apatite.	Medium-grained felsic orthopyroxene gneiss. Orthopyroxene partly altered to opaque grains and reddish-brown mineral.
76283151	Antiperthite (55), orthopyroxene (40), brown hornblende and reddish-brown biotite (together 3), and opaque grains (2).	Metamorphosed mafic dyke (granulite). Plagioclase twin lamellae strained.
MOUNT HURLEY (SQ 38-39/12)		
76283067	Mesoperthite (plus K-feldspar and plagioclase; 65), quartz (35) and accessory orthopyroxene.	Medium-grained orthopyroxene leucogneiss. Mesoperthite is partly recrystallised.
76283068	Mesoperthite (plus K-feldspar and plagioclase; 66), quartz (32), and orthopyroxene (2).	Fine to medium-grained felsic orthopyroxene gneiss. Mesoperthite is partly recrystallised.
76283069	Mesoperthite (65), quartz (20), orthopyroxene (15), and accessory opaque grains.	Fine to medium-grained felsic orthopyroxene gneiss.
76283070	Mesoperthite (62), quartz (35), garnet (2), and accessory secondary biotite.	Medium-grained felsic garnet gneiss.
76283071	Perthite and mesoperthite (together 60), quartz (37), and garnet (3).	Medium-grained felsic garnet gneiss. Feldspars and garnet slightly altered.
76283072	Perthite and mesoperthite (together 64), quartz (32), garnet (2), secondary dark brown biotite (2), and accessory opaque grains.	Fine to medium-grained felsic garnet gneiss. Feldspar partly recrystallised. Some microcline. Garnet partly altered to biotite.
76283073	Mesoperthite and orthoclase (together 62), quartz (30), chlorite (4), pale green actinolite (2), apatite (1), opaque grains (1), and epidote and sphene.	Sheared, altered felsic gneiss. Feldspars and quartz extensively granulated. Mafic minerals replaced by chlorite and actinolite (post-kinematic). Sphene rims opaque grains.

Sample	Assemblage	Comments
LATHAM PEAK (SQ 38-39/12)		
76283153	Colourless pyroxene extensively altered to green hornblende and biotite (60), plagioclase laths partly altered to epidote and muscovite (30), and opaque grains (10).	Partly altered dolerite dyke. Subophitic texture.
76283154	Mesoperthite-quartz rock cut by chlorite-epidote veins.	Medium grained. Feldspar contains inclusions of epidote.
76283155	Pale green clinopyroxene and orthopyroxene (together 55), talc and serpentine (together 30), olivine (5), pale green amphibole (5), green spinel and opaque grains (together 5), and accessory chlorite.	Medium-grained olivine pyroxenite. Spinel commonly rimmed by opaque mineral which in turn is rimmed by chlorite. Olivine altered along fractures to serpentine.
76283156	Tremolite and subordinate actinolite (together 40), quartz (35), magnetite (25), and accessory apatite.	Fine to medium-grained magnetite-quartz-amphibole gneiss.
76283157	Tremolite (60), plagioclase (20), chlorite (18), opaque grains (2), and accessory actinolite and zircon.	Fine to medium-grained amphibolite. Plagioclase partly altered to sericite and epidote. Chlorite commonly rims tremolite blades.
76283158	Mesoperthite and plagioclase (together 68), quartz (20), orthopyroxene (5), reddish-brown biotite (5), and opaque grains (2).	Medium-grained felsic orthopyroxene gneiss.
76283159	Pale green clinopyroxene and orthopyroxene (together 70), plagioclase (20), light brown hornblende (10), and accessory phlogopite.	Fine to medium-grained mafic pyroxene granulite. Some coarse poikilitic pyroxene grains.
76283160	Orthopyroxene (45), plagioclase (30), reddish-brown biotite (25), and accessory green spinel, apatite, and and zircon.	Fine to medium-grained mafic biotite-orthopyroxene gneiss.

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Sample	Assemblage	Comments
76283161	Layered. 1. Plagioclase (some antiperthite; 64), quartz (35), and accessory orthopyroxene, reddish-brown biotite, opaque grains, and calcite. 2. Orthopyroxene (70), colourless phlogopite (30), and accessory calcite.	Medium-grained felsic orthopyroxene gneiss and fine-grained phlogopite pyroxenite. Plagioclase partly altered.
76283162	Anthophyllite (50), olivine (40), colourless pyroxene (10), and accessory phlogopite, humite, opaque and dark brown grains, and calcite.	Medium to coarse-grained ultramafic gneiss. Humite pleochroic from colourless to yellow.
76283163	Mesoperthite and plagioclase (together 70), quartz (20), orthopyroxene (5), garnet (5), and accessory reddish-brown biotite and opaque grains.	Fine to medium-grained felsic garnet-orthopyroxene gneiss. Some garnet-quartz intergrowths. Orthopyroxene partly altered to brown mineral. Some feldspar grains full of quartz inclusions.
76283164	Subhedral laths of andesine (20) and colourless clino-pyroxene (15) in a fine-grained groundmass (65) of plagioclase laths, pyroxene, and opaque grains.	Porphyritic dolerite dyke. Phenocrysts up to 1.5 cm long. Some feldspar laths are zoned. Subophitic texture.
76283165	Orthopyroxene (80), quartz (20), and accessory opaque grains.	Medium to coarse-grained quartz-orthopyroxene gneiss.
76283166	Quartz (75), plagioclase (20), orthopyroxene partly altered to brown mineral (5), and accessory garnet and opaque minerals. Pod consisting of buff and colourless clinopyroxene (98) and minor quartz.	Medium-grained pyroxenite pod in a medium to coarse-qgrained felsic orthopyroxene gneiss.
76283167	Perthite and antiperthite (together 63), quartz (30), orthopyroxene (5), garnet (1), and opaque grains (1).	Medium-grained felsic garnet-orthopyroxene gneiss. Garnet-quartz intergrowth around an ortho-pyroxene grain. Orthopyroxene partly altered to brown mineral. Possible microcline present (hazy cross-hatching).

Sample	Assemblage	Comments
76283168	Plagioclase (40), colourless clinopyroxene (30), brown and green hornblende (20), opaque minerals (10), and accessory ?actinolite.	Altered dolerite dyke. Primary igneous texture. Plagioclase partly saussuritised and sericitised. Brown hornblende may be primary.
76283169	Perthitic K-feldspar (65), quartz (25), antiperthite partly altered to epidote and sericite (5), poikilitic garnet (5) and accessory zircon.	Medium-grained felsic garnet gneiss. Hazy cross-hatching suggests much of the feldspar may be microcline.
76283170	Quartz and extensively saussuritised plagioclase (together 55), biotite (20), green hornblende (20) opaque grains (5), and accessory apatite and zircon.	Fine-grained gneiss from fault zone. Crosscutting quartz veins.
76283171	Mesoperthite (67), quartz (25), orthopyroxene (5), garnet (2), opaque grains (1), and accessory zircon.	Medium-grained felsic garnet-orthopyroxene gneiss. Orthopyroxene partly altered to brown mineral. Myrmekite.
76283172	Mesoperthite and orthoclase (together 68), quartz (30), garnet, partly rimmed by light brown flakes of biotite and pale green isotropic mineral (2), and accessory plagioclase and opaque grains.	Medium-grained felsic garnet gneiss. Sutured grain boundaries. Myrmekite.
76283173	Pale green clinopyroxene and orthopyroxene (together 55), plagioclase (43), opaque grains (2), and accessory quartz and apatite.	Medium-grained mafic pyroxene gneiss. Clinopyroxene twinned. Exsolution blebs in the orthopyroxene. Plagioclase lamellae deformed.
76283174	Perthitic orthoclase and subordinate plagioclase (together 40), phlogopite (20), sapphirine (15), cordierite (15), orthopyroxene (7), dark green spinel (3), and accessory zircon.	Medium-grained aluminous gneiss. Cordierite pleochroic from colourless to yellow (anomalous interference tints). Spinel generally enclosed by sapphirine.

Sample	Assemblage	Comments
76283175	Perthitic orthoclase (30), dark green spinel (20), orthopyroxene (20), phlogopite (20), cordierite (5), and sapphirine (5).	Medium-grained aluminous gneiss. Cordierite pleochroic from colourless to yellow, present as thin layers between spinel and orthoclase, spinel and orthopyroxene, and between sapphirine and orthoclase. Sapphirine rims spinel.
76283176	Plagioclase (some antiperthite) and perthitic orthoclase (together 40), orthopyroxene (20), phlogopite (15), dark green spinel (12), sapphirine (5), and cordierite (3).	Fine to medium-grained aluminous gneiss. Some coarse orthopyroxene grains. Segregated into two main assemblages; 1) Orthopyroxene-spinel-phlogopite-plagioclase. 2) Orthopyroxene-spinel-phlogopite-plagioclase-sapphirine-orthoclase-cordierite.
MOUNT CODRINGTON (SQ 38-39/12)		
76283074	Calcic andesine (60), quartz (25), orthopyroxene (12), opaque grains (2), and accessory reddish-brown biotite and K-feldspar (in antiperthite).	Fine to medium-grained felsic orthopyroxene gneiss.
76283075	Mesoperthite and K-feldspar (together 55), quartz (37), orthopyroxene (6), reddish-brown biotite (2), and accessory zircon and opaque grains.	Fine to medium-grained felsic biotite-orthopyroxene gneiss. Feldspars and orthopyroxene slightly altered. Biotite shows preferred orientation.
76283076	Plagioclase (60), orthopyroxene (16), clinopyroxene (13), brown hornblende (6), reddish-brown biotite (4), opaque grains (1), and accessory apatite and K-feldspar (in antiperthite).	Fine to medium-grained mafic pyroxene gneiss. Primary hornblende and biotite.
76283077	Labradorite (60), quartz (30), orthopyroxene (7), and opaque grains (3).	Fine to medium-grained felsic orthopyroxene gneiss. Alteration of orthopyroxene to fine-grained biotite and carbonate along a vein.
76283078	K-feldspar (mostly microcline; 62), quartz (30), secondary dark brown biotite (8), and accessory zircon and opaque grains.	Altered, fine to medium-grained felsic gneiss. Fine-grained aggregates of biotite + quartz + opaque minerals replace ?pyroxene.

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Sample	Assemblage	Comments
76283079	Perthite and microcline (together 40), quartz (30), oligoclase (25), secondary biotite (5), and accessory zircon and opaque grains.	Altered, medium to coarse-grained augen gneiss.
76283080	Quartz (62), garnet (30), orthopyroxene (5), K-feldspar (3), and accessory brown biotite and opaque grains.	Medium to coarse-grained orthopyroxene-garnet-quartz gneiss.
76283081	Quartz (80), garnet (18), and opaque grains (2).	Medium-grained garnet-quartz gneiss.
MOUNT BRECKINRIDGE (SQ 38-39/12)		
76283114	Mesoperthite (69), quartz (25), pale green clinopyroxene (3), opaque grains (3), and accessory apatite.	Fine to medium-grained felsic clinopyroxene gneiss. Clinopyroxene partly iron stained and altered to brown mineral.
76283115A	Mesoperthite and subordinate plagioclase (together 68), quartz (30), highly altered orthopyroxene (2), and accessory opaque grains and zircon.	Altered, medium-grained felsic orthopyroxene gneiss. Orthopyroxene strongly altered at margins and along fractures to brownish-green biotite. Chlorite rims several opaque grains. Hazy cross-hatching suggests microcline may be present.
76283115B	Oriented plagioclase laths (up to 0.7 mm long) and fractured pyroxene grains in a fine-grained chlorite - magnetite groundmass.	Dolerite vein. Country rock similar to specimen 76283115A, but also contains perthitic microcline and minor apatite. Some crush zones marginal to the vein. Some plagioclase alteration to epidote, and pyroxene alteration to hornblende.
MOUNT SELWOOD (SQ38-39/12		
76283096	Mesoperthite (plus K-feldspar and plagioclase; 57), quartz (35), orthopyroxene (4), garnet (4), and accessory zircon and opaque grains.	Fine to medium-grained felsic orthopyroxene-garnet gneiss. Some recrystallisation of mesoperthite and quartz.

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Sample	Assemblage	Comments
76283097	Mesoperthite (62), quartz (25), orthopyroxene (8), garnet (5), and accessory biotite and opaque grains.	Fine to medium-grained felsic garnet-orthopyroxene gneiss.
76283098	Plagioclase (64), orthopyroxene (20), quartz (15), reddish-brown biotite (1), and accessory apatite, opaque grains, and K-feldspar (in antiperthite).	Fine to medium-grained felsic orthopyroxene gneiss.
76283099	Mesoperthite (plus K-feldspar and plagioclase; 62), quartz (35), orthopyroxene (3), and accessory garnet and opaque grains.	Fine to medium-grained felsic orthopyroxene gneiss. Some recrystallisation of mesoperthite and quartz.
76283100	Garnet (35), quartz (35), mesoperthite (30), and accessory orthopyroxene, reddish-brown biotite, and opaque grains.	Medium to coarse-grained felsic garnet gneiss.

SAPPHIRINE NUNATAK (SQ 38-39/12)

Sample	Assemblage	Comments
76283259	Orthopyroxene (50), clinopyroxene (36), plagioclase (12), opaque grains (2), and accessory reddish-brown biotite.	Medium-grained mafic pyroxene granulite (possibly a metamorphosed dyke).
76283260	Orthopyroxene (40), plagioclase (35), clinopyroxene (25), and accessory rutile.	Fine-grained mafic pyroxene gneiss.
76283261	Clinopyroxene (37), plagioclase (35), orthopyroxene (23), brown hornblende (3), reddish-brown biotite (1), and opaque grains (1).	Medium-grained mafic pyroxene gneiss. Primary hornblende and biotite.
76283262	Quartz (70), symplectites of cordierite and ?K-feldspar (14), garnet (8), sillimanite (5), green spinel (1), and accessory rutile and reddish-brown biotite.	Fine to medium-grained semi-pelitic gneiss. Spinel and quartz locally in contact, but most is rimmed by sillimanite.
76283263	Quartz (50), garnet (45), plagioclase (4), and opaque grains (1).	Medium-grained garnet-quartz rock.

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Sample	Assemblage	Comments
76283264	Perthite (62), quartz (35), garnet (2-3), altered orthopyroxene (1), and accessory opaque grains.	Medium-grained felsic orthopyroxene-garnet gneiss. Orthopyroxene is mostly altered to 'iddingsite'.
76283265	Garnet (60), mesoperthite and perthite (together 22), green spinel (10), sillimanite (5), plagioclase (2), opaque grains (1), and accessory quartz and rutile.	Fine to medium-grained aluminous (pelitic) gneiss. One layer contains about 30 percent of spinel.
76283266	Quartz (65), garnet (13), sillimanite (13), and symplectite of cordierite and ?K-feldspar (8).	Fine to medium-grained semi-pelitic gneiss. Quartz is crowded with rutile inclusions.
76283350-3372	Quartz, garnet, sapphirine, sillimanite, perthite, greenish-brown spinel, cordierite, and accessory rutile, zircon, monazite, osumilite, and ?magnesian orthoclase.	Various impure quartzites and interlayered aluminous metasediments. These are now the subject of an intensive study, and will not be described in detail here.

MOUNT SONES (SQ 38-39/16)

Sample	Assemblage	Comments
76283267	Quartz (50), antiperthite (30), garnet (18), opaque grains (1), and accessory zircon.	Medium-grained felsic garnet gneiss. Quartz-rich.
76283268	Mesoperthite (55), quartz (42), sillimanite (2), and garnet (1).	Fine to medium-grained felsic garnet-sillimanite gneiss.
76283269	Garnet (30), orthopyroxene (20), quartz (20), antiperthite (18), opaque grains (2), and accessory secondary biotite.	Medium to coarse-grained mafic orthopyroxene-garnet gneiss. Orthopyroxene shows slight marginal alteration.
76283270	Quartz (58), garnet (40), and opaque grains (1-2).	Medium-grained garnet-quartz rock. Quartz is full of rutile inclusions.

Sample	Assemblage	Comments
MOUNT RYDER (SQ 38-39/12)		
76283201	Mesoperthite (63), quartz (35), garnet (2), and accessory opaque grains.	Fine to medium-grained felsic garnet gneiss.
76283202	Mesoperthite and K-feldspar (together 65), quartz (32), and garnet (3).	Fine to medium-grained felsic garnet gneiss.
76283203	Antiperthite (including 13% K-feldspar; 63), quartz (35), orthopyroxene (2), and accessory zircon and opaque grains.	Fine to medium-grained felsic orthopyroxene gneiss. Orthopyroxene is slightly altered.
76283204	Mesoperthite (plus K-feldspar and plagioclase; 64), quartz (35), altered orthopyroxene (1), and accessory apatite and opaque grains.	Altered, fine to medium-grained felsic orthopyroxene gneiss. Mesoperthite partly recrystallised.
76283205	Antiperthite (including 12% K-feldspar; 60), orthopyroxene (28), clinopyroxene (7), quartz (4), and opaque grains (1).	Fine to medium-grained mafic pyroxene gneiss. Relatively rich in K-feldspar.
76283206	Plagioclase (54), orthopyroxene (30), clinopyroxene (13), opaque grains (1), quartz (1), and K-feldspar (in antiperthite; 1).	Medium-grained mafic pyroxene gneiss.
76283207	Orthopyroxene (88), clinopyroxene (5), phlogopite (5), and plagioclase (2).	Fine to medium-grained orthopyroxenite (float).
76283208	Clinopyroxene (86), plagioclase (10), perthite (2), and quartz (2).	Medium to coarse-grained clinopyroxenite layer in gneiss.
76283209	Orthopyroxene (65), clinopyroxene (27), dark reddish-brown biotite (4), plagioclase (2), opaque grains (2), and accessory spinel.	Medium to coarse-grained pyroxenite layer in gneiss.

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Sample	Assemblage	Comments
MOUNT DENHAM (SQ 38-39/12)		
76283210	Mesoperthite (65), quartz (35), and accessory garnet	Medium-grained garnet leucogneiss.
76283211	Mesoperthite (63), quartz (35), garnet (2), and accessory opaque grains and secondary brown biotite.	Medium-grained felsic garnet gneiss.
76283212	Mesoperthite (64), quartz (33), secondary biotite (3), and accessory apatite, zircon, and opaque grains.	Altered, fine to medium-grained felsic gneiss. Fine-grained aggregates of dark brown and greenish-brown biotite and quartz replace pyroxene or garnet.
76283213	Mesoperthite (65), quartz (34), altered orthopyroxene and biotite (together 1), and minor zircon and opaque grains.	Altered, fine to medium-grained felsic orthopyroxene gneiss. Orthopyroxene is largely altered to 'iddingsite' and biotite.
76283214	Andesine (54), orthopyroxene (25), clinopyroxene (15), quartz (5), and opaque grains (1).	Fine to medium-grained mafic pyroxene gneiss.
76283215	Perthite (64), quartz (35), secondary biotite, etc. (1-2).	Altered, medium-grained felsic gneiss. Fine-grained aggregates of greenish-brown biotite, with quartz, epidote, and green amphibole replace ?pyroxene.
76283216	Garnet (48), quartz (25), orthopyroxene (25), and opaque grains (2).	Medium to coarse-grained quartz-orthopyroxene-garnet gneiss.
MOUNT RENOUARD (SQ 38-39/12)		
76283217	Mesoperthite (65), quartz (35), and accessory altered orthopyroxene and opaque grains.	Altered, fine to medium-grained orthopyroxene leucogneiss. Orthopyroxene is altered to 'iddingsite'. Quartz is crowded with rutile inclusions.

Sample	Assemblage	Comments
76283218	Mesoperthite (60), quartz (35), garnet (5), and accessory opaque grains.	Strongly foliated, fine to medium-grained felsic garnet gneiss.
76283219	Quartz (72), garnet (28), and accessory sphene, zircon, and opaque grains.	Medium-grained garnet-quartz gneiss. Quartz is full of minute rutile needles.
76283220	Quartz (65), garnet (25), perthite (10), and accessory altered orthopyroxene, zircon, and opaque grains.	Coarse-grained felsic garnet gneiss. Perthite is partly sericitized. Quartz-rich.
76283221	Mesoperthite (70), quartz (28), garnet (2), and accessory secondary biotite.	Fine to medium-grained felsic garnet gneiss. Extensive granulation along shear zones. Partial alteration of garnet to biotite.
MOUNT SMETHURST (SQ 38-39/12)		
76283222	Mesoperthite (65), quartz (30), orthopyroxene (4), and accessory apatite and opaque grains.	Fine to medium-grained felsic orthopyroxene gneiss.
76283223	Mesoperthite (65), quartz (33), altered orthopyroxene (2), and accessory opaque grains.	Altered, medium-grained felsic orthopyroxene gneiss. Orthopyroxene is mostly altered to 'iddingsite'.
76283224	Plagioclase (60), orthopyroxene (29), clinopyroxene (10), opaque grains (1), and accessory reddish-brown biotite, K-feldspar, and apatite.	Medium-grained mafic pyroxene gneiss.
76283225	Clinopyroxene, with minor orthopyroxene, plagioclase, K-feldspar, quartz, and opaque grains.	Very coarse-grained (1-5 cm) clinopyroxenite segregation.
MOUNT PAISH (SQ 38-39/12)		
76283226	Andesine (53), orthopyroxene (24), quartz (15), clinopyroxene (8), and accessory K-feldspar (in antiperthite), reddish-brown biotite, and opaque grains.	Fine to medium-grained felsic two-pyroxene gneiss.

Sample	Assemblage	Comments
76283227	Mesoperthite (55), quartz (40), orthopyroxene (5), and accessory zircon and opaque grains.	Fine to medium-grained felsic orthopyroxene gneiss.
76283228	Mesoperthite (60), quartz (36), orthopyroxene (3), opaque grains (1), and accessory zircon.	Fine to medium-grained felsic orthopyroxene gneiss.
76283229	Mesoperthite (68), quartz (30), and garnet (2).	Fine to medium-grained felsic garnet gneiss.
76283230	Mesoperthite (65), quartz (33), garnet (2), and accessory biotite, zircon and opaque grains.	Fine to medium-grained felsic garnet gneiss. Garnet is partly altered to brown biotite.
76283231	Mesoperthite (57), secondary brown biotite (23), quartz (20), and accessory zircon and opaque grains.	Altered, fine to medium-grained felsic gneiss. Fine grained aggregates of biotite and quartz replace ?pyroxene.
76283232	Mesoperthite (62), quartz (35), secondary brown biotite (3), and accessory zircon and opaque grains.	Altered, fine to medium-grained felsic gneiss. Fine-grained biotite and quartz replace ?pyroxene.
76283233	Mesoperthite (62), quartz (33), garnet (4), secondary biotite (1), and accessory zircon and opaque grains.	Altered, fine to medium-grained felsic garnet gneiss. Garnet shows marginal alteration to biotite, and fine-grained biotite replaces ?pyroxene.

UNNAMED NUNATAK 2 KM SOUTH-SOUTHWEST OF MOUNT TORCKLER (SQ 38-39/12)

76283234	Mesoperthite (63), quartz (34), garnet (3), and accessory opaque grains.	Fine to medium-grained felsic garnet gneiss. Extreme granulation along small shear zones.
76283235	Mesoperthite (40), garnet (30), sillimanite (10), quartz (8), cordierite (6), reddish-brown biotite (3), sapphirine (1), rutile (1), and brown spinel, zircon, and opaque grains.	Fine to medium-grained, aluminous (pelitic) gneiss. Sapphirine occurs as inclusions in garnet, and with rims of sillimanite. Spinel occurs as inclusions in garnet and sillimanite.

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Sample	Assemblage	Comments
76283236	Quartz (35), garnet (25), antiperthite (25), sillimanite (14), opaque grains (1), and accessory brown spinel.	Medium-grained aluminous gneiss. Spinel occurs as inclusions in garnet and sillimanite, and with rims of sillimanite. Antiperthite contains abundant K-feldspar.
76283237	Quartz (26), garnet (25), sillimanite (25), mesoperthite (23), opaque grains (1), and accessory brown spinel.	Fine to medium-grained aluminous gneiss.
76283238	Quartz (48), sillimanite (26), garnet (22), mesoperthite (2), opaque grains (1), and greenish-brown spinel (1).	Fine to medium-grained aluminous gneiss. Some granulation of quartz. Quartz is full of rutile inclusions.
76283239	Plagioclase (60), clinopyroxene (22), orthopyroxene (18), and accessory opaque grains.	Medium-grained mafic pyroxene gneiss.
76283240	Orthopyroxene (66), clinopyroxene (32), pale brown hornblende (1), plagioclase (1), and accessory opaque grains.	Medium-grained pyroxenite.
76283241	Mesoperthite and K-feldspar (together 67), quartz (30), garnet (2), altered ?orthopyroxene (1), and accessory zircon and opaque grains.	Altered, fine to medium-grained felsic pyroxene-garnet gneiss. Pyroxene replaced by biotite and 'iddingsite.'

MOUNT McGHEE (SQ 38-39/12)

Sample	Assemblage	Comments
76283242	Plagioclase (60), clinopyroxene (20), opaque grains (7), hornblende (6), biotite (4), quartz (3), and accessory apatite.	Dolerite dyke. Pyroxene rimmed by secondary green hornblende and brown biotite near opaque grains. Subophitic texture.
76283243	Plagioclase (55), pyroxene and secondary biotite and hornblende (together 40), and opaque grains, (5).	Fine-grained dolerite dyke. Subophitic texture.
76283244	Orthopyroxene (50), clinopyroxene (42), reddish-brown biotite (5), opaque grains (2), feldspar (1), and accessory secondary cummingtonite.	Medium-grained pyroxenite (metamorphosed dyke).

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Sample	Assemblage	Comments
76283245	Mesoperthite (63), quartz (35), altered orthopyroxene (2), and accessory zircon and opaque grains.	Altered, fine to medium-grained felsic orthopyroxene gneiss. Orthopyroxene mostly altered to biotite and green amphibole.
76283246	Mesoperthite (60), quartz (35), secondary biotite and pale green amphibole (together 5), and accessory zircon, apatite, and opaque grains.	Altered, fine to medium-grained felsic gneiss. Fine-grained aggregates of biotite and amphibole with minor quartz and carbonate replace ?pyroxene.
76283247	Mesoperthite (61), quartz (35), garnet (3), and secondary biotite and sericite (together 1).	Slightly altered, fine to medium-grained felsic gneiss. Garnet rimmed by secondary biotite and sericite. Feldspar partly sericitised.

BURCH PEAKS (SQ 38-39/12)

Sample	Assemblage	Comments
76283248	Mesoperthite and perthite (together 67), quartz (30), orthopyroxene (3), and accessory clinopyroxene, zircon, apatite, opaque grains, and reddish-brown isotropic mineral.	Fine to medium-grained felsic orthopyroxene gneiss. Orthopyroxene shows some alteration to 'iddingsite'.
76283249	Mesoperthite and perthite (together 59), quartz (40), altered ?orthopyroxene (1), and accessory opaque grains.	Altered, fine to medium-grained felsic pyroxene gneiss. 'Iddingsite' has replaced ?orthopyroxene. Feldspars are sericitised.
76283250	Clinopyroxene (54), orthopyroxene (40), mesoperthite (5), and accessory reddish-brown biotite and opaque grains.	Medium-grained pyroxenite (possibly a metamorphosed dyke). Minor alteration along small veins.
76283251	Clinopyroxene	Very coarse-grained (1-5 cm) clinopyroxenite layer in gneiss.

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Sample	Assemblage	Comments
MOUNT CORDWELL (SQ 38-39/12)		
76283252	Layered. 1. Antiperthite (56), quartz (35), orthopyroxene (7), clinopyroxene (1), opaque grains (1), and accessory zircon. 2. Orthopyroxene (50), andesine/labradorite (40), clinopyroxene (8), reddish-brown biotite (1), opaque grains (1), and accessory apatite and zircon.	Fine to medium-grained, strongly layered mafic pyroxene gneiss. Extreme granulation along a small shear zone.
76283253	Mesoperthite (58), quartz (35), orthopyroxene (6), opaque grains (1), and accessory clinopyroxene, apatite, and zircon.	Fine to medium-grained felsic orthopyroxene gneiss. Slight granulation of pyroxene.
MOUNT STADLER (SQ 38-39/12)		
76283254	Quartz (40), orthopyroxene (35), magnetite (25), and accessory clinopyroxene (in exsolution lamellae).	Medium-grained magnetite-orthopyroxene-quartz gneiss.
76283255	Quartz (60), orthopyroxene (20), magnetite (20), and accessory clinopyroxene (in exsolution lamellae).	Medium-grained orthopyroxene-magnetite-quartz gneiss.
76283256	Altered feldspar (?mesoperthite; 45), quartz (40), garnet (15), and accessory rutile.	Altered fine to medium-grained felsic garnet gneiss. Feldspar is altered to fine grained sericite, etc.
76283257	Quartz (40), antiperthite (40), orthopyroxene (12), garnet (8), and opaque grains (1).	Fine to medium-grained felsic garnet-orthopyroxene gneiss. Rather quartz-rich. Orthopyroxene shows marginal alteration to biotite and ?cummingtonite.
76283258	Plagioclase (60), clinopyroxene and orthopyroxene (together 40), and accessory quartz, biotite, K-feldspar, and opaque grains.	Dolerite dyke. Strong flow foliation. Much recrystallisation of feldspar but texture appears to be igneous. Orthopyroxene phenocrysts are strongly clouded. Little or no secondary amphibole.

Sample	Assemblage	Comments
76283272	Quartz (45), perthite (44), garnet (7), plagioclase (3), opaque grains (1), and accessory apatite and zircon.	Medium-grained felsic garnet gneiss. Quartz-rich. Feldspars rather altered.

MOUNT JEWELL (SQ 38-39/12)

Sample	Assemblage	Comments
76283273	Antiperthite (59), quartz (15), orthopyroxene (15), clinopyroxene (10), opaque grains, and accessory apatite.	Fine to medium-grained felsic two-pyroxene gneiss.
76283274	Mesoperthite (64), quartz (30), orthopyroxene (6), and accessory clinopyroxene, zircon, apatite, and opaque grains.	Fine to medium-grained felsic orthopyroxene gneiss.
76283275	Plagioclase (58), orthopyroxene (21), clinopyroxene (20), and opaque grains (1).	Medium-grained mafic pyroxene gneiss.
76283276	Orthopyroxene (49), clinopyroxene (49), reddish-brown biotite (1), opaque grains (1), and accessory mesoperthite.	Medium-grained pyroxenite dyke.
76283277	Plagioclase (58), clinopyroxene and orthopyroxene (together 40), and opaque grains (2).	Dolerite dyke. Pyroxene phenocrysts are zoned, with clinopyroxene rims and strongly clouded orthopyroxene cores. Pyroxene partly recrystallised, but the texture is subophitic.
76283278	Orthopyroxene (55), quartz (25), garnet (15), cordierite (5), and accessory zircon, rutile and opaque grains.	Medium to coarse-grained pelitic gneiss. Quartz and cordierite partly granulated. Quartz is full of minute rutile needles.
76283279	Orthopyroxene (48), plagioclase (48), quartz (3), opaque grains (1), and accessory apatite and rutile.	Medium-grained mafic orthopyroxene gneiss.

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Sample	Assemblage	Contents
76283280	Perthite (including 10% plagioclase; 69), quartz (30), altered ?orthopyroxene (1), and accessory zircon and opaque grains.	Altered, fine to medium-grained felsic gneiss. Fine-grained biotite replaces ?orthopyroxene.
76283281	Clinopyroxene (60), orthopyroxene (30), plagioclase (7), reddish-brown biotite (1-2), opaque grains (1), and accessory greenish-brown hornblende.	Medium-grained pyroxenite (possibly a metamorphosed dyke).
76283282	Mesoperthite and perthite (together 70), quartz (29), garnet (1), and accessory opaque grains.	Fine to medium-grained felsic garnet gneiss.
76283283	Mesoperthite (68), quartz (30), and garnet (2).	Fine to medium-grained felsic garnet gneiss.
76283284	Layered. 1. Mesoperthite (67), quartz (30), and garnet (3). 2. Quartz (55), garnet (40), and opaque grains (5).	Strongly layered, fine to medium-grained felsic garnet gneiss.
76283285	Quartz (50), orthopyroxene (20), garnet (15), magnetite (15), and accessory plagioclase.	Fine to medium-grained magnetite-garnet-orthopyroxene-quartz gneiss. Garnet rims magnetite grains.
76283286	Quartz (50), orthopyroxene (20), garnet (15), and magnetite (15).	Fine to medium-grained garnet-magnetite-orthopyroxene-quartz gneiss.
76283287	Phlogopite (85), cordierite, sapphirine, and ?enstatite.	Phlogopite-rich gneiss (float). Sapphirine is very pale blue.

MOUNT KING (SQ 38-39/16)

76283001	Mesoperthite (66), quartz (30), orthopyroxene (4), and accessory opaque grains.	Fine to medium-grained felsic orthopyroxene gneiss. Orthopyroxene shows slight alteration to biotite.

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Sample	Assemblage	Comments
76283002	Antiperthite (with 20% K-feldspar; 62), quartz (30), secondary biotite, etc (8), and accessory zircon, apatite, and opaque grains.	Altered, fine to medium-grained felsic ?pyroxene gneiss. Fine-grained aggregates of brown and greenish-brown biotite, with opaque minerals, carbonate and epidote, have replaced pyroxene. Some granulation of quartz and feldspar. Biotite flakes have a preferred orientation.
76283003	Secondary green hornblende (59), plagioclase (40), opaque grains (1), and accessory secondary biotite.	Altered, medium-grained mafic pyroxene gneiss. Pyroxene is almost entirely replaced by secondary amphibole, but minor relict pyroxene is present.
76283004	Clinopyroxene.	Coarse-grained clinopyroxenite pod. Deformation lamellae in pyroxene.
76283005	Mesoperthite (plus K-feldspar and plagioclase; 65), quartz (30), secondary biotite (5), and accessory sericite, carbonate, zircon, apatite, and opaque grains.	Augen gneiss from shear zone. Strongly deformed rock with extensive granulation of feldspars and quartz, mesoperthite porphyroclasts and streaked out biotite aggregates.
76283093	Mesoperthite (64), quartz (35), biotite (1), and accessory zircon and opaque grains.	Altered, fine to medium-grained felsic gneiss. Fine-grained aggregates of biotite, with quartz and carbonate, replace ?pyroxene. Some granulation of quartz and feldspar.
76283094	Mesoperthite (65), quartz (30), orthopyroxene (3), clinopyroxene (1), opaque grains (1), and accessory zircon and apatite.	Medium-grained felsic two-pyroxene gneiss. Orthopyroxene shows some alteration to 'iddingsite'. Some granulation of quartz and feldspar.
76283095	Orthopyroxene (60), ?spinel (16), phlogopite (12), olivine (12), and accessory opaque grains.	Medium-grained olivine-phlogopite-?spinel-orthopyroxenite (float).

SEAVERS RIDGE (SQ 38-39/16)

76283006	Mesoperthite (59), quartz (30), orthopyroxene (10), opaque grains (1), and accessory clinopyroxene, zircon, and apatite.	Fine to medium-grained felsic orthopyroxene gneiss.

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Sample	Assemblages	Comments
76283007	Mesoperthite (65), quartz (27), orthopyroxene (7), opaque grains (1), and accessory zircon and apatite.	Fine to medium-grained felsic orthopyroxene gneiss.
76283008	Andesine/labradorite (50), orthopyroxene (36), clinopyroxene (13), perthite (1), and accessory opaque grains and reddish-brown biotite.	Fine to medium-grained mafic pyroxene gneiss.
76283009	Antiperthite (47), orthopyroxene (25), clinopyroxene (10), perthite (10), quartz (8), and accessory zircon and opaque grains.	Medium grained, strongly layered pyroxene gneiss. Granulation of feldspars and pyroxene along thin crush zones.
76283010	Plagioclase (56), brownish-green hornblende (24), clinopyroxene (13), opaque grains (4), quartz (3), and accessory reddish-brown biotite.	Porphyritic dolerite dyke. Pyroxene phenocrysts (up to 3 mm) show marginal alteration to hornblende. Groundmass contains both secondary and primary hornblende. Plagioclase microphenocrysts have a strong reddish-brown clouding; groundmass plagioclase has a weaker greyish clouding. Subophitic texture.
76283011	Strongly clouded plagioclase (60), clinopyroxene (20), hornblende (10), opaque grains (5), quartz (3), reddish-brown biotite (2), and accessory apatite.	Dolerite dyke. Primary green hornblende and secondary amphibole replace pyroxene. Biotite mostly associated with opaque minerals and quartz. Coarser-grained than 76283010 with subophitic texture.
76283012	Plagioclase (60), clinopyroxene (21), opaque grains (10), biotite (5), brownish-green hornblende (4), and accessory quartz.	Dolerite dyke. Plagioclase is zoned, and clouded. Subophitic texture. Similar to 76283011, but less altered.
76283013	Dyke: relict plagioclase and pyroxene crystals in strongly deformed, hornblende-rich groundmass. Gneiss: mesoperthite porphyroclasts in fine-grained quartzo-feldspathic matrix.	Mylonitised mafic dyke margin.

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Sample	Assemblage	Comments
76283014	Dyke: plagioclase microphenocrysts, with minor opaque grains and pyroxene in fine-grained groundmass. Gneiss: mesoperthite, quartz, clinopyroxene, orthopyroxene, and accessory secondary biotite and amphibole, apatite, zircon, and opaque grains.	Chilled margin of dolerite dyke. Pyroxenes in gneiss are extensively recrystallised (granulated) and tend to be concentrated along dyke contact.
76283015	Clinopyroxene (80) and orthopyroxene (20).	Medium-grained pyroxenite pod. Pyroxenes show deformation lamellae.
76283016	Reddish-brown glass.	Pseudotachylite vein.
76283017	Mesoperthite (60), quartz (25), secondary hornblende (10), secondary biotite (5), and accessory zircon, apatite, and opaque grains.	Altered, fine to medium-grained felsic gneiss. Pyroxene replaced by fine-grained aggregates of green hornblende, brown biotite (especially near opaque grains), quartz, and minor opaque minerals and carbonate. Adjacent to dolerite dyke.
76283018	Mesoperthite (65), quartz (26), orthopyroxene (4), clinopyroxene (3), opaque grains (2), and accessory apatite.	Fine to medium-grained felsic two-pyroxene gneiss.

NUNATAK 1.5 KILOMETRES NORTHEAST OF SEAVERS RIDGE (SQ 38-39/16)

Sample	Assemblage	Comments
76283019	Antiperthite (including 10% K-feldspar) and mesoperthite (together 60), clinopyroxene (18), orthopyroxene (18), secondary biotite and amphibole (2), opaque grains (2), and accessory apatite.	Fine to medium-grained mafic pyroxene gneiss. Pyroxenes are slightly altered. Rather more potassic than most mafic gneiss.

FYFE HILLS (SQ 38-39/15)

Sample	Assemblage	Comments
76283122	Plagioclase, orthoclase, and microcline (together 54), quartz (40), biotite (5), muscovite (1), and accessory zircon and opaque grains.	Mylonitised muscovite-biotite granite pegmatite. Feldspar augen up to 6 mm across. Plagioclase and orthoclase partly sericitised. Layers of recrystallised quartz.

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Sample	Assemblage	Comments
76283123	Quartz (60), garnet (15), sillimanite and fibrolite (together 15), cordierite (?10), and accessory zircon, opaque grains and ?leucoxene after sphene.	Fine to medium-grained pelitic gneiss. Garnet altered partly to sillimanite and cordierite. Quartz grain boundaries are sutured.
76283124	Quartz (50), plagioclase and minor microcline (together 33), garnet (7), biotite (5), sillimanite (3), opaque grains (2), and accessory zircon.	Mylonitised, felsic sillimanite-biotite-garnet gneiss. Fine-grained. Plagioclase partly sericitised and twin lamellae deformed. Sillimanite generally confined to the biotite-poor layers.
76283125	Quartz (45), plagioclase and ?microcline (together 35), aggregates of brown biotite, sillimanite and garnet (together 20), and accessory opaque grains, zircon, and sphene.	Fine to medium-grained felsic biotite-sillimanite-garnet gneiss. Garnet altered along some fractures and margins to green biotite.
76283126	Actinolite and tremolite (together 69), orthopyroxene and subordinate clinopyroxene (together 15), plagioclase (10), garnet (5), opaque grains (1), and accessory biotite and quartz.	Fine to medium-grained garnet pyroxene amphibolite. The garnet is localised along the amphibole-plagioclase grain boundaries. Amphibole encloses pyroxene. Opaque grains commonly form a vermicular intergrowth with garnet. Plagioclase twin lamellae deformed.
76283127	Quartz (55), kyanite (20), gedrite (10), garnet (3), brown and green biotite (3), cordierite (?), opaque grains (1), and minor plagioclase, zircon and sphene.	Strongly foliated (deformed) fine-grained pelitic gneiss.
76283128	Layered. 1. Quartz and cordierite (together 67), gedrite (20), kyanite (10), garnet (3) in places rimmed by ?cordierite, and accessory biotite, opaque grains, sphene, and zircon. 2. Green hornblende (85), plagioclase (13), opaque grains (2), and accessory garnet. 3. Quartz (70), biotite (30), and accessory garnet.	Strongly foliated (deformed), fine to medium-grained, interlayered pelitic gneiss, amphibolite, and biotite-quartz gneiss.

Sample	Assemblage	Comments
76283131	Pale green clinopyroxene and subordinate orthopyroxene (together 99), and light green hornblende (1).	Medium-grained pyroxenite. Pyroxenes altered at margins to hornblende.
76283132	Plagioclase and antiperthite (together 64), quartz (30), orthopyroxene (5), opaque grains (1), and accessory green hornblende and zircon.	Deformed fine to medium-grained felsic orthopyroxene gneiss.
76283133	Mesoperthite (55), quartz (35), garnet (6), sillimanite (4), reddish-brown biotite and accessory zircon, opaque grains, brown spinel, and ?sphene.	Medium-grained felsic sillimanite-garnet gneiss. Some sillimanite partly enclosed by garnet. Biotite commonly located in garnet fractures.
76283134	Mesoperthite and subordinate plagioclase (together 63), quartz (35), garnet (2), reddish-brown biotite, and accessory opaque grains and zircon.	Medium-grained felsic garnet gneiss. Biotite commonly located in garnet fractures.
76283135	Quartz (30), garnet (30), orthopyroxene (30), anhedral magnetite (10), and accessory green hornblende.	Medium-grained magnetite-orthopyroxene-garnet-quartz gneiss.
76283136	Plagioclase (65), quartz (25), orthopyroxene (8), opaque grains and limonite (2), and accessory green hornblende, reddish-brown biotite, and apatite.	Fine to medium-grained felsic orthopyroxene gneiss. Plagioclase lamellae deformed. Orthopyroxene partly altered to hornblende and biotite.
76283137	Pale green clinopyroxene and subordinate orthopyroxene (together 99), opaque grains (1), and accessory reddish-brown biotite and light green hornblende.	Medium-grained pyroxenite. Pyroxene partly altered to hornblende.
76283138	Layered. 1. Orthopyroxene and clinopyroxene (together 50), plagioclase (40), brown hornblende (5) and reddish-brown biotite (5). 2. Plagioclase (55), quartz (40), orthopyroxene and clinopyroxene (together 5), and accessory perthitic orthoclase. Sphene and opaque grains are common to both layers.	Fine to medium-grained layered pyroxene gneiss. The plagioclase is partly antiperthitic. Plagioclase twin lamellae commonly bent. Pyroxene is extensively altered to hornblende and biotite in the mafic layer.

Sample	Assemblage	Comments
76283139	Layered. 1. Garnet (48), quartz (30), orthopyroxene (20), and opaque grains (2). 2. Quartz (55), garnet (23), orthopyroxene (20), opaque grains (2), and accessory plagioclase.	Fine-grained layered orthopyroxene-garnet-quartz gneiss.
76283140	Garnet (40), quartz (35), orthopyroxene (20), and magnetite (5).	Medium-grained magnetite-orthopyroxene-quartz-garnet gneiss.
76283141	Strongly brecciated pyroxene (40), olivine (30), pale greenish yellow serpentine (15), opaque grains (10), phlogopite partly altered to green biotite (5), and accessory calcite.	Sheared, partly serpentinised olivine pyroxenite. The fractured mineral aggregates are medium-grained. Serpentine and opaque mineral(s) fill the numerous fractures throughout the rock.
76283143	Mesoperthite and subordinate plagioclase (together 65), quartz (32), dark green hornblende (2), opaque grains (1), and accessory pale green pyroxene, garnet, zircon, and apatite.	Fine to medium-grained felsic garnet-pyroxene-hornblende gneiss. Hornblende and pyroxene commonly associated with orange mineral and opaque grains.
76283144	Pale green clinopyroxene (98), phlogopite (2), and accessory plagioclase.	Medium to coarse-grained clinopyroxenite.
76283145	Mesoperthite and subordinate plagioclase (together 70), quartz (28), garnet (2), and accessory opaque grains.	Fine to medium-grained felsic garnet gneiss. Microcline may be present.
76283146A	Layered. 1. Orthopyroxene and pale green clinopyroxene (together 88), brown hornblende (10), opaque grains (2) and accessory green spinel. 2. Orthopyroxene and pale green clinopyroxene (99), opaque grains (1), and accessory green spinel.	Medium to coarse-grained hornblende pyroxenite. Layer 1 is medium-grained, layer 2 is coarse-grained.

Sample	Assemblage	Comments
76283146B	Orthopyroxene and pale green clinopyroxene (together 55), olivine (40), reddish-brown biotite (5), opaque grains and serpentine.	Medium-grained biotite-olivine pyroxenite layer in gneiss. Fractured and partly altered.
76283147	Plagioclase (54), orthopyroxene and clinopyroxene (together 45), biotite (1), and accessory opaque grains and garnet.	Medium-grained mafic pyroxene gneiss. Clinopyroxene with some exsolution lamellae. Garnet located at grain boundaries between pyroxene and plagioclase.
76283148	Pale green clinopyroxene and orthopyroxene (together 98), phlogopite, and accessory plagioclase and perthitic orthoclase.	Medium-grained pyroxenite.

MOUNT PARDOE (SQ 38-39/15)

Sample	Assemblage	Comments
76283055	Mesoperthite (plus K-feldspar and plagioclase; 65), quartz (33), orthopyroxene (1), garnet (1), and accessory secondary biotite and opaque grains.	Deformed, fine to medium-grained felsic orthopyroxene-garnet gneiss. Extensive granulation of feldspar, quartz, and garnet. Mesoperthite occurs as porphyroclasts, and is partly recrystallised to 2 feldspars.
76283056	Mesoperthite (plus K-feldspar and plagioclase; 68), quartz (30), orthopyroxene (2), and accessory zircon and opaque grains.	Deformed, fine to medium-grained felsic orthopyroxene gneiss. Orthopyroxene partly replaced by fine-grained biotite and 'iddingsite'. Similar to 76283055, but even more extensive granulation.
76283057	Mesoperthite (plus K-feldspar and plagioclase; 67), quartz (31), orthopyroxene (2), and accessory opaque grains.	Deformed, fine to medium-grained felsic orthopyroxene gneiss. Similar to 76283055.
76283058	Mesoperthite (plus microcline and plagioclase: 62), quartz (33), brown biotite (3), green hornblende (2), and accessory opaque grains.	Deformed and altered, fine to medium-grained felsic gneiss from retrogression zone. Much granulation, with mesoperthite porphyroclasts. Fine-grained aggregates of biotite and quartz, with some dark green ferrohastingsite replace ?pyroxene.

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Sample	Assemblage	Comments
76283059A	Mesoperthite (plus K-feldspar and plagioclase; 65), quartz (35), and accessory garnet.	Deformed, fine to medium-grained garnet leucogneiss.
76283059B	Mesoperthite (plus K-feldspar and plagioclase; 70), quartz (25), garnet (3), orthopyroxene (1), secondary brown biotite (1), and accessory zircon and opaque grains.	Deformed, fine to medium-grained felsic orthopyroxene-garnet gneiss. Orthopyroxene is partly altered to biotite. Garnet occurs as aggregates of small grains, and in some places forms rims around orthopyroxene.
76283060	Plagioclase (60), orthopyroxene (20), clinopyroxene (16), brownish-green hornblende (4), opaque grains (1), and accessory garnet and apatite.	Fine to medium-grained mafic pyroxene gneiss. Primary hornblende. Some granulation of plagioclase, hornblende, and pyroxene.
76283061	Plagioclase (50), orthopyroxene (20), clinopyroxene (19), brownish-green hornblende (6), garnet (4), opaque grains (1), and accessory apatite and secondary biotite.	Fine to medium-grained mafic pyroxene gneiss. Extensive granulation. Garnet forms rims around opaque minerals, pyroxene, and hornblende.
76283062	Plagioclase (41), orthopyroxene (25), secondary green amphibole (14), garnet (12), secondary brown biotite (5), clinopyroxene (2), opaque grains (1), and accessory apatite.	Retrogressed, fine to medium-grained mafic pyroxene gneiss. Extensive granulation. Alteration is most intense along small shears. Garnet rims pyroxene and secondary amphibole and tends to be concentrated along shears. No brownish-green hornblende.
76283063	Orthopyroxene, clinopyroxene, cloudy, almost colourless amphibole, olivine, phlogopite, and opaque grains.	Fine to medium-grained phlogopite-amphibole-olivine-pyroxenite layer in gneiss. Some granulation.
76283064	Mesoperthite (plus K-feldspar and plagioclase; 65), quartz (35), and accessory garnet and opaque grains.	Fine to medium-grained garnet leucogneiss. Some granulation of mesoperthite and quartz.
76283065	Andesine (39), quartz (35), dark green hornblende (25), opaque grains (1), and accessory sphene and apatite.	Sheared, retrogressed, fine to medium-grained felsic gneiss. Well foliated. Quartz-rich.
76283066	Perthite (45), quartz (32), plagioclase (20), secondary biotite (2), opaque grains (1), and accessory garnet, apatite, and zircon.	Altered, fine to medium-grained felsic gneiss. Rock is thoroughly recrystallised, biotite has replaced ?pyroxene and there is development of secondary garnet.

Sample	Assemblage	Comments
MOUNT DOUGLAS (SQ 38-39/15)		
76283020	Plagioclase (including antiperthite; 61), orthopyroxene (18), quartz (16), clinopyroxene (4), reddish-brown biotite (1), and accessory apatite and opaque grains.	Fine to medium-grained felsic two-pyroxene gneiss. Cut by thin crush zones.
76283021	Plagioclase (45), quartz (30), K-feldspar (13), garnet (7), orthopyroxene (5), and accessory reddish-brown biotite, apatite, and opaque grains.	Fine to medium-grained felsic orthopyroxene-garnet gneiss. Garnet occurs as aggregates of small grains.
76283022	Plagioclase (45), quartz (27), orthopyroxene (20), reddish-brown biotite (8), and accessory apatite and opaque grains.	Fine to medium-grained felsic biotite-orthopyroxene gneiss. Biotite appears to be primary and has a slight preferred orientation.
76283023	Plagioclase (40), quartz (30), K-feldspar (perthite and antiperthite; 25), orthopyroxene (4), reddish-brown biotite (1), and accessory opaque grains.	Medium-grained felsic orthopyroxene gneiss. Garnet is present in the hand-specimen.
76283024	Plagioclase (50), orthopyroxene (20), clinopyroxene (15), reddish-brown biotite (14), opaque grains (1), and accessory apatite and K-feldspar (in antiperthite and perthite).	Fine to medium-grained mafic biotite-pyroxene gneiss. Biotite is fresh.
76283025	Feldspar, quartz, pyroxene and opaque grains.	Felsic gneiss from crush zone. Thoroughly granulated, with thin mylonite zones.
76283026	Plagioclase (45), garnet (24), perthite (20), reddish-brown biotite (11), and accessory zircon and opaque grains.	Medium-grained biotite-garnet-feldspar gneiss. Little or no quartz.
76283027	Oligoclase antiperthite (46), quartz (28), perthite (20), garnet (5), reddish-brown biotite (1), and accessory altered pyroxene and opaque grains.	Medium to coarse-grained, pegmatitic felsic garnet gneiss

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Sample	Assemblage	Comments
76283028	Plagioclase (53), orthopyroxene (35), quartz (10), reddish-brown biotite (2), and accessory apatite and opaque grains.	Fine to medium-grained mafic orthopyroxene gneiss.
76283029	Antiperthite (30), perthite (30), quartz (25), garnet (12), orthopyroxene (2), reddish-brown biotite (1), and accessory opaque grains.	Medium-grained felsic orthopyroxene-garnet gneiss.
76283030	Plagioclase (60), clinopyroxene and minor orthopyroxene (together 33), brownish-green hornblende (5), quartz (1), opaque grains (1), and accessory apatite.	Dolerite dyke. Greenish-brown hornblende rims pyroxene and occurs near opaque grains. Pyroxenes also show some alteration to very pale greenish amphibole and minor biotite. Subophitic texture. Quartz occurs in granophyric intergrowths.
76283031	Plagioclase (61), clinopyroxene and minor orthopyroxene (together 30), olive green hornblende and secondary green amphibole (together 6), quartz (2), and opaque grains (1).	Dolerite dyke. Subophitic texture. Similar to 76283030.
76283032	Mylonitised dolerite dyke margin.	Pseudotachylite vein cuts the dyke margin.
76283033	Plagioclase (60), quartz (25), orthopyroxene (12), reddish-brown biotite (3), and accessory zircon, opaque grains, and K-feldspar (in antiperthite).	Fine to medium-grained felsic orthopyroxene gneiss.
76283034	Antiperthite (30), perthite (30), quartz (26), orthopyroxene (7), garnet (5), reddish-brown biotite (2), and accessory opaque grains.	Fine to medium-grained felsic garnet-orthopyroxene gneiss.
76283035	Quartz (50), orthopyroxene (25), garnet (25), and accessory opaque grains.	Medium to coarse-grained quartz-orthopyroxene-garnet rock.
76283036	Quartz (45), plagioclase (22), perthite (15), garnet (15), reddish-brown biotite (2), altered orthopyroxene (1), and accessory opaque grains.	Fine to medium-grained felsic garnet gneiss. Quartz-rich.

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Sample	Assemblage	Comments
OBLACHNAYA NUNATAK (SQ 38-39/16)		
76283306	Quartz (65), mesoperthite and subordinate plagioclase (together 30), garnet (5), and accessory reddish-brown biotite and opaque grains.	Felsic mylonite. Trails of fine-grained mosaic quartz. Garnet and feldspar fine to medium-grained.
76283308	Garnet (75), reddish-brown biotite (20), quartz and feldspar (together 5), and accessory opaque grains and ?leucoxene.	Medium-grained biotite-garnet rock.
76283309	Mesoperthite and subordinate plagioclase (together 63), quartz (35), garnet (2), and accessory reddish-brown biotite and opaque grains.	Fine to medium-grained felsic garnet gneiss. Mosaic quartz. Biotite associated with the garnet. Feldspar partly sericitised.
76283310	Mesoperthite and subordinate plagioclase (together 55), quartz (30), garnet and orthopyroxene (together 15), and accessory reddish-brown biotite, opaque grains, ?leucoxene, and apatite.	Fine-grained felsic orthopyroxene-garnet gneiss. Mosaic quartz. Biotite associated with the garnet. Orthopyroxene partly altered to brown mineral. Garnet porphyroblasts up to 1.5 mm across.
76283311	Plagioclase and subordinate perthite (together 44), quartz (35), garnet (10), reddish-brown biotite (10), and accessory opaque grains (1).	Fine to medium-grained felsic biotite-garnet gneiss. Some areas of mosaic quartz. Fine granular grains marginal to larger feldspar grains. Biotite associated with garnet.
76283313	Mesoperthite and subordinate plagioclase (together 52), quartz (25), garnet (15) with associated reddish and orange-brown biotite (3), and orthopyroxene, partly altered to greenish-brown biotite (5).	Medium-grained felsic orthopyroxene-garnet gneiss.
76283316	Perthite and antiperthite (together 55), brown and green biotite (20), garnet (15), quartz (10), and accessory opaque grains and zircon.	Fine to medium-grained felsic garnet-biotite gneiss. Fine granular quartz and marginal recrystallisation of feldspar grains. Brown biotite associated with garnet.
76283317	Mesoperthite and plagioclase (together 64), quartz (30), garnet (5), opaque grains (1), and accessory orthopyroxene, reddish and orange-brown biotite, apatite, sphene, and zircon.	Medium-grained felsic garnet gneiss. Biotite marginal to garnet, opaque grains and sphene. Sphene partly altered to ?leucoxene. Orthopyroxene is partly altered to biotite.

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Sample	Assemblage	Comments
McLEOD NUNATAKS (SQ 38-39/16)		
76283192	Pale pink orthopyroxene (75), anthophyllite (15), green-brown spinel (5), plagioclase (5), and accessory green biotite, near-colourless phlogopite, and opaque grains.	Medium-grained plagioclase-spinel-anthophyllite-orthopyroxenite.
76283193	Antiperthite (45), garnet (40), rutilated quartz (15), and accessory dark green spinel, sillimanite, reddish-brown biotite, opaque grains, and zircon.	Medium-grained felsic garnet gneiss. Spinel commonly enclosed by garnet or sillimanite. Blebs and veins of ?chalcedony. Reddish-brown rim around some spinel grains. Brown alteration of some plagioclase grains.
76283194	Quartz (50), orthopyroxene (25), magnetite (25), and accessory garnet.	Fine to medium-grained magnetite-orthopyroxene-quartz gneiss. Clusters of mosaic quartz.
76283195	Orthopyroxene (60), garnet (36), plagioclase (2), reddish-brown biotite (2), and accessory opaque grains and dark green spinel.	Medium-grained garnet-orthopyroxene rock containing coarse garnet porphyroblasts. Partly granuloblastic.
76283196A	Orthopyroxene and colourless clinopyroxene (together 55), plagioclase, partly altered to ?calcite (45), and accessory reddish-brown biotite and opaque grains.	Fine to medium-grained mafic pyroxene granulite.
76283198	Layered. Core of wollastonite; subordinate scapolite, calcite, and quartz. Marginal scapolite, pale green clinopyroxene, calcite, sphene, and quartz. Country rock pale green clinopyroxene, plagioclase, and accessory biotite.	Medium-grained vein. Wollastonite altered along fractures.
76283199	Layered. 1. Wollastonite (90) altered along fractures to ?epidote and ?calcite, quartz (5), and calcite (5). 2. Scapolite (50), pale green clinopyroxene (40), sphene (6), apatite (3), and accessory calcite. 3. Plagioclase (60) and pale green clinopyroxene (40).	Fine to medium-grained vein.

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Sample	Assemblage	Comments
76283302	**Layered.** **1. Pale green clinopyroxene (80) and plagioclase with deformed twin lamellae (20).** **2. Wollastonite (80), pale green clinopyroxene (10), scapolite (8), calcite, sphene, and quartz.**	Medium-grained vein. Wollastonite altered along fractures to ?calcite.

POINT WIDDOWS (SQ 38-39/14)

Sample	Assemblage	Comments
76283120	Plagioclase (?oligoclase; 65-70), orthopyroxene, green hornblende and dark brown biotite (together 15-20), quartz (15), and accessory opaque grains and apatite.	Medium-grained felsic biotite-hornblende-orthopyroxene gneiss. Orthopyroxene altered at margins and along fractures to opaque and brown minerals.

MOLODEZHNAYA (SQ 38-39/14)

Southwest of station

Sample	Assemblage	Comments
76283037	Plagioclase (50), green hornblende (35), and quartz (15).	Fine to medium-grained mafic hornblende gneiss. Rather quartz-rich. Strongly foliated.
76283038	Sodic andesine (70), quartz (12), orthopyroxene (4), clinopyroxene (4), dark brown biotite (4), browish-green hornblende (2), and accessory apatite, zircon, K-feldspar (in antiperthite), and opaque grains.	Fine to medium-grained felsic hornblende-biotite-pyroxene gneiss. Major phases appear to be in equilibrium.
76283039	Plagioclase (46), quartz (46), olive green hornblende (7), epidote (1), and accessory chlorite, apatite, and opaque grains.	Fine to medium-grained felsic hornblende gneiss. Rather quartz-rich.
76283040	Perthite (45), quartz (30), oligoclase (23), dark brown biotite (2), and accessory zircon and opaque grains.	Pink medium-grained biotite adamellite vein. Perthite shows incipient development of microcline twinning.

Sample	Assemblage	Comments
76283041	Oligoclase (54), quartz (40), brown biotite (5), opaque grains (1), and accessory zircon, apatite, and K-feldspar (in antiperthite).	Biotite pegmatite.
76283042	Quartz (35), sodic andesine (34), perthite (30), dark brown biotite (1), and accessory opaque grains.	Fine to medium-grained felsic biotite gneiss.
76283043	Sodic andesine (60), green hornblende (23), brown biotite (8), quartz (8), opaque grains (1), and accessory apatite.	Medium-grained mafic biotite-hornblende gneiss. Hornblende crystals full of quartz inclusions, suggesting replacement of pyroxene.
76283044	Microcline (41), quartz (30), zoned, sericitized plagioclase (26), brown biotite (2), opaque grains (1), and accessory.	Strongly foliated, fine-grained felsic biotite gneiss.
North of station		
76283045	Perthite (40), quartz (35), oligoclase/andesine (20), dark brown biotite (5), and accessory apatite and opaque grains.	Fine to medium-grained felsic biotite gneiss.
76283046	Oligoclase/andesine (35), quartz (35), perthite (20), dark brown biotite (6), olive green hornblende (2), apatite (1), opaque grains (1), and accessory sphene and zircon.	Fine to medium-grained felsic hornblende-biotite gneiss.
76283047	Dark green hornblende (46), plagioclase (30), quartz (16), dark brown biotite (5), epidote (3), and accessory opaque grains.	Fine-grained amphibolite. Strongly foliated. Quartz-rich calc-silicate rock.
76283048	Quartz (41), perthite (25), plagioclase (25), garnet (6), reddish-brown biotite (3), and accessory zircon and opaque grains.	Medium-grained felsic biotite-garnet gneiss (float). Some biotite has replaced ?pyroxene.

Sample	Assemblage	Comments
76283049	Plagioclase (48), quartz (40), olive green hornblende (5), brown biotite (2), chlorite (2), garnet (1), carbonate (1), opaque grains (1), and accessory clinozoisite.	Slightly altered, fine to medium-grained felsic garnet-biotite-hornblende gneiss. Quartz-rich. Secondary chlorite (after biotite?) and carbonate.
76283050	Perthite (33), calcic oligoclase (30), quartz (30), dark brown biotite (5), apatite (1), and opaque grains (1).	Fine to medium-grained felsic biotite gneiss.
76283051	Quartz, garnet, reddish-brown biotite, perthite, plagioclase, and cordierite.	Medium to coarse-grained pelitic gneiss (float).
76283052	Microcline (38), oligoclase (30), quartz (30), dark brown biotite (2), and accessory zircon, ?allanite, and opaque grains.	Pink fine to medium-grained biotite adamellite vein. Feldspars rather altered.

East of station

Sample	Assemblage	Comments
76283053	Oligoclase antiperthite (87), perthite (6), brown biotite (4), quartz (2), opaque grains (1), and accessory apatite.	Medium to coarse-grained biotite augen gneiss. Probably a deformed pegmatite (thin section not representative).
76283054	Sodic andesine (52), olive green hornblende (37), quartz (6), dark brown biotite (5), and accessory apatite and opaque grains.	Fine to medium-grained amphibolite.

PINN ISLAND (SQ 38-39/14)

Sample	Assemblage	Comments
76283177	Perthitic microcline and partly sericitised plagioclase (together 65), quartz (30), chlorite and orange-brown biotite (together 5), and accessory opaque grains and apatite.	Medium-grained felsic biotite granulite (locally derived moraine). Biotite altered partly to chlorite.

Sample	Assemblage	Comments
76283178	Green hornblende (47), orthopyroxene and pale green clinopyroxene (together 25), plagioclase (20), and biotite (8).	Medium-grained mafic pyroxene-hornblende gneiss (locally derived moraine).
76283179	Orthopyroxene and pale green clinopyroxene (together 55), plagioclase (23), orange-brown biotite (20), light green amphibole (2) and zircon.	Fine to medium-grained mafic pyroxene gneiss (locally derived moraine).
76283180	Clinopyroxene (55), plagioclase (40), opaque grains (5), and secondary green amphibole.	Fine to medium-grained dolerite dyke (locally derived moraine). Pyroxene and feldspar partly altered. Subophitic texture.

MOUNT CHRISTENSEN (SQ 38-39/14)

Sample	Assemblage	Comments
76283116	Perthitic orthoclase and antiperthite (together 60), quartz (25), green hornblende and biotite (together 15), and accessory epidote, apatite, opaque grains, and ?allanite.	Medium-grained felsic biotite-hornblende gneiss. Minor myrmekite.

KRASIN NUNATKAS (SR 38-39/3)

Sample	Assemblage	Comments
76283181	Plagioclase (55), orthopyroxene and pale green clinopyroxene (together 25), green hornblende (15), biotite (5), and accessory opaque grains and quartz.	Medium-grained mafic hornblende-pyroxene gneiss. Secondary growth of clinopyroxene at contacts of orthopyroxene-plagioclase and hornblende-plagioclase grains.
76283182	Antiperthite (70), orthopyroxene (28), opaque grains (2), and accessory biotite, green hornblende, and apatite.	Medium-grained orthopyroxene-antiperthite gneiss.
76283183	Antiperthite and orthoclase (together 60), quartz (40), and accessory calcite.	Medium-grained leucogneiss. Numerous veinlets of ?mica-limonite.

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Sample	Assemblage	Comments
76283184	Perthitic orthoclase and antiperthite (together 70), quartz (30), and accessory chlorite (alteration from feldspar), opaque grains, pyroxene, and zircon.	Medium-grained leucogneiss. Some coarse quartz grains.
76283185	Plagioclase (57), quartz (20), green hornblende (15), biotite (5), orthopyroxene partly altered to secondary biotite (3), and accessory opaque grains and apatite.	Fine-grained felsic orthopyroxene-biotite-hornblende gneiss.
76283186	Perthitic orthoclase and plagioclase (together 65), quartz (35), and accessory biotite and opaque grains.	Medium-grained biotite leucogneiss. Myrmekite. Hazy cross-hatching suggests microcline may be present.
76283188	Orthopyroxene and pale green clinopyroxene (together 44), olivine (30), light green amphibole (23), opaque grains (2), and phlogopite (1).	Medium-grained amphibole-olivine pyroxenite layer in gneiss. Alteration of some olivine to yellow serpentine.

SANDERCOCK NUNATAKS (SR 38-39/4)

Sample	Assemblage	Comments
76283303	Perthitic orthoclase and plagioclase (together 57), quartz (35), biotite (4), orthopyroxene (2), poikilitic garnet (1), opaque grains (1), and accessory apatite and zircon.	Fine to medium-grained felsic garnet-orthopyroxene-biotite gneiss. Orthopyroxene partly altered to opaque and reddish-brown minerals. Myrmekite.

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Mt Paish   Locality visited during 1976 season

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