COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

REPORT No. 78

Geological Investigations along the Antarctic Coast between Longitudes 108° E and 166° E

BY

I. R. McLEOD and C. M. GREGORY

Issued under the authority of the Hon. David Fairbairn,
Minister for National Development
1967

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

REPORT No. 78

Geological Investigations along the Antarctic Coast between Longitudes 108° E and 166° E

BY

I. R. McLEOD and C. M. GREGORY

Issued under the authority of the Hon. David Fairbairn,
Minister for National Development
1967

14108/65.—LA

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

MINISTER: THE HON. DAVID FAIRBAIRN, D.F.C., M.P.

SECRETARY: R. W. BOSWELL, O.B.E.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

DIRECTOR: J. M. RAYNER, O.B.E.

THIS REPORT WAS PREPARED IN THE GEOLOGICAL BRANCH

ASSISTANT DIRECTOR: N. H. FISHER

Published by the Bureau of Mineral Resources, Geology and Geophysics

Canberra, A.C.T.

This Report is also issued as ANARE Report Series No. 83

CONTENTS

CONTENTS (Cont'd)

ILLUSTRATIONS

FIGURES

SUMMARY

This Report describes the results of reconnaissance geological work along the Antarctic coastline between 108°E. and 166°E. during relief voyages by the Australian National Antarctic Research Expeditions in the early months of 1959, 1960, 1961, and 1962.

The predominant rock type is fine-grained banded, or medium-grained quartz-biotite-feldspar, gneiss, which occurs at the Wilson Hills, Davis Bay, the Windmill Islands and Frazier Islands, and southern Vincennes Bay. Quartzo-feldspathic veins of several kinds are common in parts of the gneisses. The mineralogical composition of the gneisses indicates derivation from sediments by high-grade regional metamorphism. Low-grade metamorphic rocks, originally pelitic sediments, were found near Cape North and Zykov Glacier. Those near Zykov Glacier show evidence of a period of thermal crystallization, which could have been either a concluding phase of the regional metamorphism or a separate later episode associated with the emplacement of granitoid rocks.

Massive granitoid rocks were found near Cape North, on Sputnik Island, Penguin Point, and at southern Vincennes Bay. Gabbro forms two islets of the Balaena Islands. Foliated granitoid rocks occur in the Henry Islands and Windmill Islands. Charnockitic rocks were found in the Windmill Islands and Chick Island. Basalt dykes intrude the metamorphic rocks in the Wilson Hills, Windmill Islands, Frazier Islands, and southern Vincennes Bay. A dyke in the Wilson Hills shows signs of post-injection metamorphism.

Trachyte and red and purple indurated sandstone were found in moraine, principally in the Vincennes Bay region.

Samples from eastern Oates Land give ages of 344 and 356 m.y., and from the Wilson Hills in western Oates Land, 420 and 450 m.y. Ages of samples from the Vincennes Bay region range from 1050 to 1120 m.y., except for a gabbro, the age of which is 510 m.y.

INTRODUCTION

Since Mawson was established in 1954 on the Antarctic continent by the Australian National Antarctic Research Expeditions (ANARE), the relief voyages each year have been extended beyond the immediate requirements of changing personnel and landing stores at the several ANARE stations, to allow for exploration of various accessible parts of the coastline. Landings were made by boat or helicopter at or near the coastline at numerous places between longitudes 45°E. and 166°E., and where rock was exposed the geology was examined and specimens collected.

This Report describes the work done during these voyages from 1959 to 1962, in the sector between 108°E. and 166°E. (Fig.1). It contains descriptions of the geology of all the known rocky areas (with the exception of Albov Rocks, a small group of islands in Porpoise Bay) on the Antarctic coast between the Davis Islands at the head of Vincennes Bay (long. 108°26'E.) and Lewis Island in Davis Bay (long. 132°22'E.); and also of Penguin Point, and parts of the Wilson Hills, Sputnik Island, Zykov Glacier, and Cape North. The investigations ranged from reconnaissance in areas of extensive rock exposures to detailed examination of some of the small isolated islands. A brief account of part of the work has already been published (McLeod, 1964b). Results of geological work by ANARE in the sector 45°E. to 80°E. are described elsewhere (Crohn, 1959; McLeod, 1964a; McLeod & Trail, in prep.). The coast between longitudes 80°E. and 108°E. has not been examined by ANARE; rock exposures in this sector have been described by the Australasian Antarctic Expedition (Nockolds, 1940) and the Soviet Antarctic Expedition (e.g. Klimov, Ravich, & Soloviev, 1964).

Most of the work described in the Report was done in the summers of 1959-60, 1960-61 (McLeod), and 1961-62 (Gregory). McLeod examined the outcrops in southern Vincennes Bay, most of the Windmill Islands, some of the Balaena Islands, the islands in Henry Bay and Davis Bay, and the western Wilson Hills. Gregory examined Cape North, Zykov Glacier, Sputnik Island, Penguin Point, Cape Carr, and Balaena, Donovan, and Frazier Islands, and some of the Windmill Islands. Other ANARE personnel have taken specimens and recorded observations at these and other places.

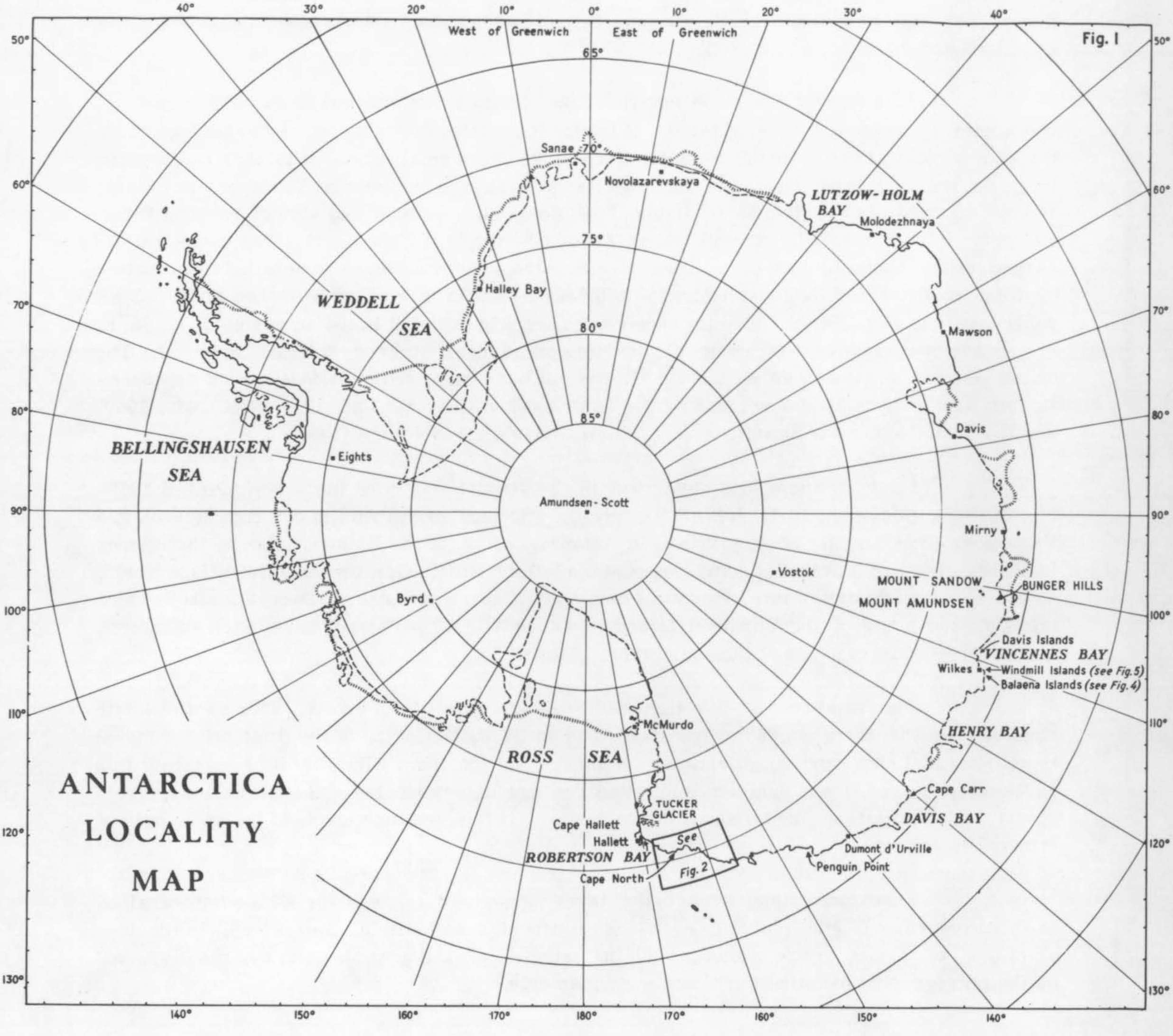
The numbers of the thin sections are given in brackets. Thin sections with numbers in the form 13,983 were described by W.R. McCarthy of the Australian Mineral Development Laboratories, Adelaide. Numbers in the form SR58-59/10/1 designate thin sections prepared from samples submitted for age determination and examined by petrologists of the Bureau of Mineral Resources. All thin sections are held by the Bureau of Mineral Resources.

Throughout this Report the term 'granitoid' is used for all medium-grained or coarse-grained acid plutonic rocks of apparently batholithic dimensions. In the descriptions of areas, rock names, such as adamellite and granodiorite, are mostly based on the petrographic examination of one specimen only.

CAPE NORTH AREA

Outcrops in the vicinity of Cape North (lat.70°41'S., long. 165°46'E.), and Nella Island and Thala Island, about 8 miles to the north-east (Fig. 2), were examined by ANARE in February 1962 (Law, 1964). These landings seem to have been the first

14108/65.—LB



ANTARCTICA LOCALITY MAP

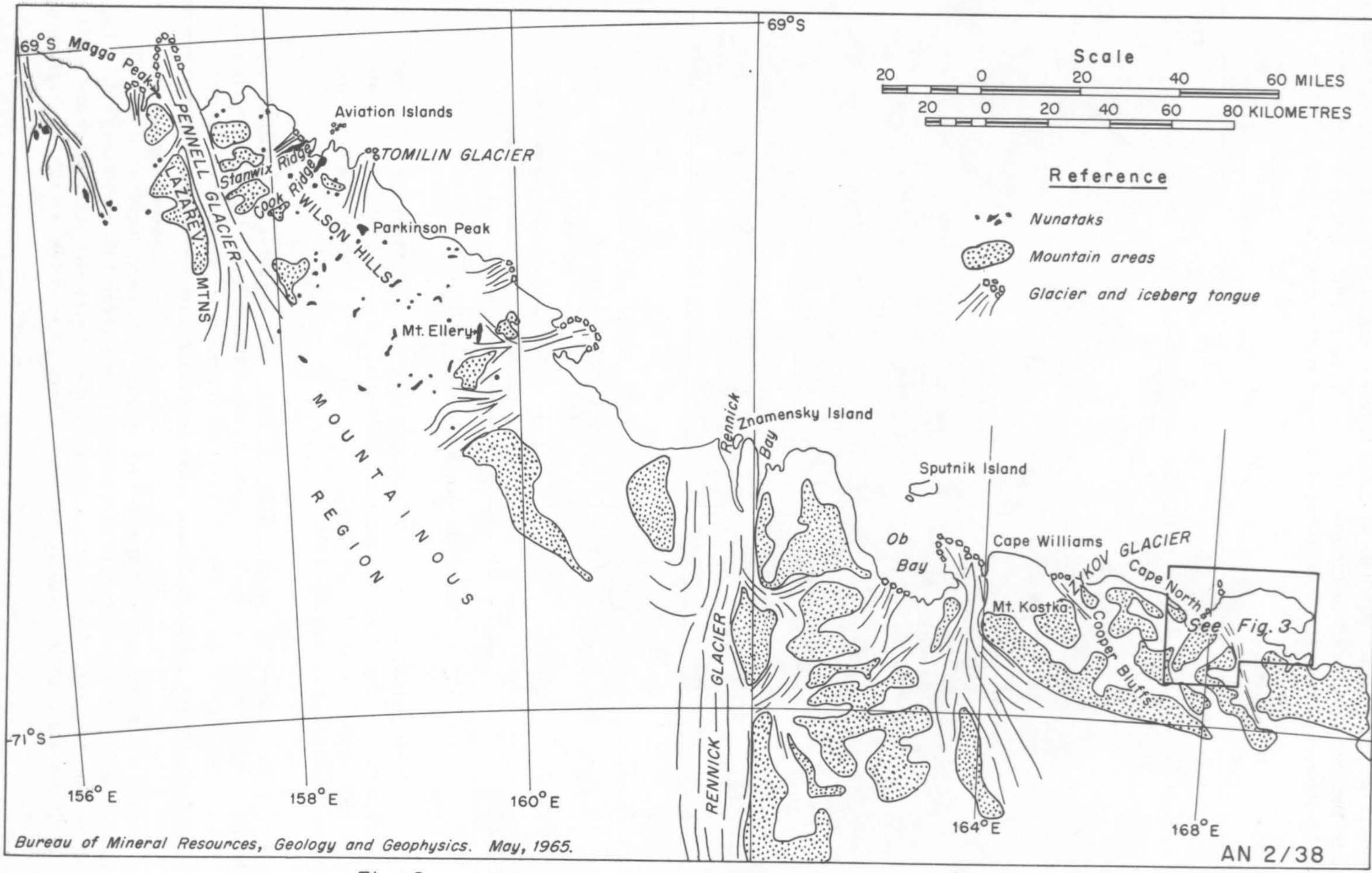


Fig. 2 Locality map of coastal regions 156°E to 168°E

on this part of the Antarctic coast, although the region was photographed from the air during the United States Operation Highjump during the summer of 1946-47.

Two rock units were recognized: adamellite, and low-grade regionally metamorphosed sediments. Although no contacts were seen, it is thought that the adamellite intrudes the metamorphosed sediments, because it is massive and lacks any foliation or signs of metamorphism. The distribution of the units is shown in Figure 3.

Nella Island and Thala Island

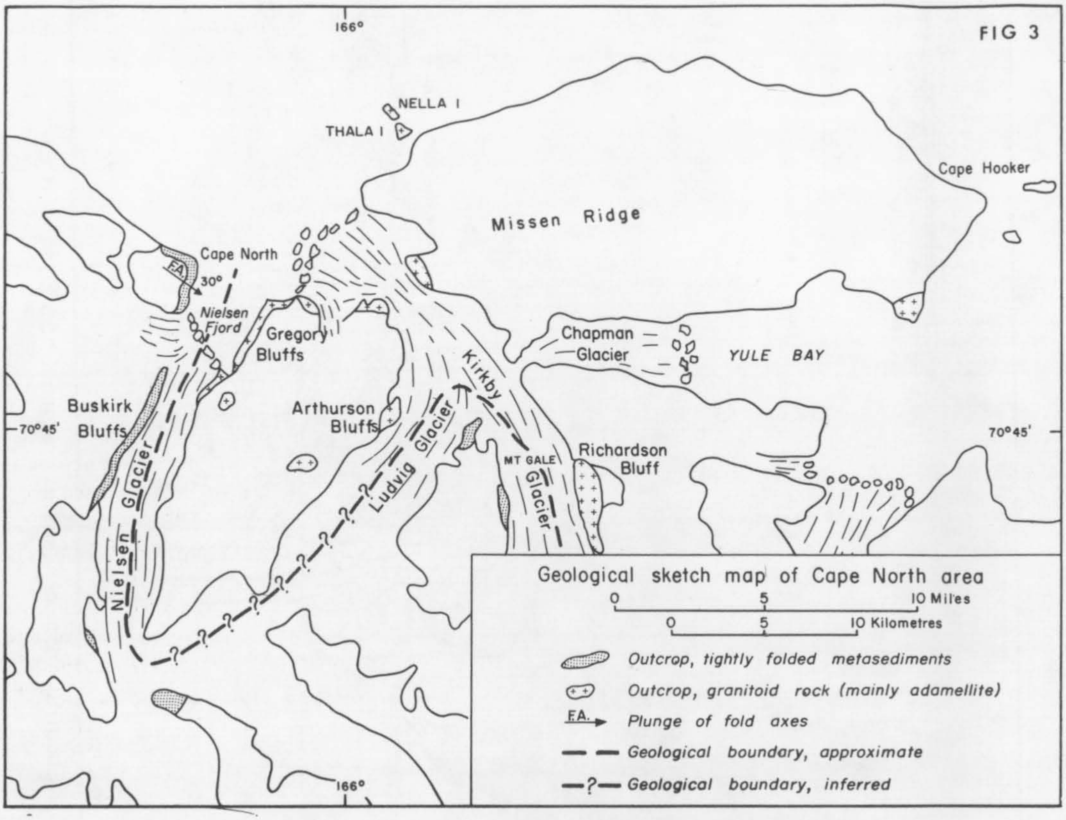


Fig. 3 Geological sketch map of Cape North area

Nella Island and Thala Island are both low features a few miles north-east of Cape North. Nella Island, the more northerly, rises to 30 metres and Thala Island to 60 metres above sea level. Both islands consist of grey homogeneous medium-grained massive adamellite with small xenoliths.

The adamellite (13,988, SR58-59/10/1, SR58-59/10/2) is a medium-grained hypidiomorphic rock. Andesine (about An35) is generally subhedral and forms grains up to 4mm long; the grains show reversed zoning, and many have rims or lobes of myrmekite against potash feldspar. Perthitic microcline forms large anhedral grains poikilitically enclosing the other minerals; some of the microcline may have replaced andesine, which suggests that the rock has undergone potassic metasomatism. Quartz is in anhedral grains up to 4mm in diameter. The subhedral biotite flakes, which range up to 3mm long, are pleochroic from straw-yellow to greyish brown; many are slightly chloritized along their cleavage planes. Rare accessories are sphene, apatite, and zircon.

A modal analysis (1196 points) of a specimen from Thala Island (SR58-59/10/2) is as follows:

	Percent
Quartz	28.2
Potash feldspar	31.2
Plagioclase	26.8
Biotite	13.0
Accessories (including chlorite)	0.8

A chemical analysis of a specimen from each island is given in Appendix I. Ages of 344 and 356 m.y. were measured on specimens from Nella Island and Thala Island respectively (Webb, McDougall, & Cooper, 1964).

The adamellite contains about 2 percent of xenoliths of quartz diorite and porphyritic microgranite. The quartz diorite xenoliths are by far the more abundant. They are subrounded to irregularly shaped masses, from 5cm to a metre in diameter, and are scattered at random through the adamellite. Xenoliths of the porphyritic microgranite are rare; they are subrounded and between 60 cm and 1 metre in diameter. Both types of xenolith weather more readily than the adamellite and form slight depressions in the rock.

Major constituents of the quartz diorite (13,989) are: biotite 10 percent, quartz 35 percent, and sodic andesine 55 percent. Crystals of biotite and andesine are set in a matrix of quartz. Andesine is subhedral to euhedral and is commonly zoned. Accessory sphene and zircon are common, and apatite is rare. The porphyritic microgranite xenoliths consist of fine-grained quartz, feldspar, and biotite, with much larger scattered crystals of feldspar; the biotite is partly replaced by chlorite.

Dykes of medium-grained to coarse-grained alaskite, ranging in thickness from 2cm to $3\frac{1}{2}$ metres, were noted in many places. The dykes tend to occur in one of two sets, one striking 090° and dipping 25°N., the other striking 180° and dipping 80°W.*

The texture of the dykes (13,990) is xenomorphic, and only a few grains of oligoclase have crystal faces; all others have ragged crenulated boundaries. The estimated mineralogical composition is: oligoclase 10 percent, quartz 30 percent, and microcline 58 percent. Accessories form about 2 percent of the rock and are penninite(?) (retrograde from biotite), and sphene.

One quartz vein, about 5cm wide, and occasional pods of quartz, about 30cm in diameter, were noted.

Joints are well developed in the adamellite. One prominent set, striking 180° and dipping 80°W., has slickensides plunging 80°N., and the faces are chloritized. The flat-lying joints form large horizontal slabs in many places.

Very little moraine was noted on either of the islands, except for a few small pebbles of slate and shale which are identical with the rocks cropping out to the south-west of Cape North.

*All bearings in this Report refer to true North.

The two other outcrops of granitoid rocks visited, Gregory Bluffs and Arthurson Bluff, are similar to the adamellite on the two islands.

Cape North

An area of about 10 square miles (25sq. km.) was examined around Cape North. Cape North itself is composed of a sequence of thin-bedded to medium-bedded slate, recrystallized arkose, greenstone, and quartz-mica schist, and allied metamorphosed sediments, including altered greywacke and lithic sandstone. The beds are strongly cleaved and folded into a series of tight folds, plunging south-east at about 30°. The folds are picked out on the cliffs at Cape North and at other steep-sided outcrops by snow lying on jutting beds, and these rocks can be recognized even at a distance of several miles.

Three specimens were collected from an area of a few square metres at the base of the northern face of Cape North.

1. A quartz-mica schist (13,991) has excellent schistosity as shown by the mica. The estimated mineralogical composition is: mica 70 percent, quartz 15 percent, chlorite 13 percent, and opaques and rare zircon 2 percent. The mica is predominantly sericite, with some biotite and stilpnomelane. The quartz forms fine lens-like crystals parallel to the schistosity.

2. A recrystallized arkose (13,992) is weakly schistose in hand-specimen. Major constituents are sericite, feldspar, and quartz. The coarsest grains consist of quartz (0.3mm), and many of them are still rounded despite recrystallization. Sericite forms about 20 percent of the rock: it has grown mainly in the interstices, but has also replaced part of the feldspar. A little biotite, calcite, and tourmaline are also present.

3. In the sericite-feldspar-quartz-calcite schist (13,993) with moderate schistosity, the major constituents are mica 10 percent, plagioclase 15 percent, quartz 35 percent, and calcite 40 percent. The quartz and plagioclase grains range from 0.2mm to less than 0.1mm. Biotite is present as scattered anhedral crystals. The accessories include opaque minerals, zircon, sphene and tourmaline. Originally this rock was a sediment.

All these rocks are assigned to the greenschist facies of metamorphism (Fyfe, Turner, & Verhoogen, 1958).

ZYKOV GLACIER

Two landings were made by ANARE (Law, 1964) in the Zykov Glacier area, at Cooper Bluffs (lat. 70°36'S., long. 164°48'E.) on the northern side of the glacier, and at Mount Kostka (lat. 70°42'S., long. 164°44'E.) on the southern side (Fig. 2). Mount Kostka was visited by the Soviet Antarctic Expedition early in 1958. In a preliminary report, Klimov & Soloviev (1958a) describe the rocks as a 'layered mass of rhythmically alternating micaceous quartzite-sandstones and micaceous shales, of a consistent north-west strike, and having a south-western dip of 50°'.

The examination by ANARE showed Cooper Bluffs to consist of schists, which are purple-brown and fine-grained, and either equigranular or porphyroblastic. They are well bedded, with beds averaging about 60cm in thickness and dipping uniformly to the south-west at 50°; their strike is 140°. Cleavage is generally well developed. Thin quartz veins and quartz blows 15 to 30cm in diameter are common.

The following three specimens from this peak were examined petrographically:

1. A feldspar-quartz-mica schist (13,997) which has a good foliation, due to the parallel orientation of the mica; some of the quartz also occurs as lens-like bodies which are parallel to the foliation. The rock contains about 10 percent feldspar, 40 percent quartz, and 50 percent mica. Mica comprises equal amounts of foliated biotite and sericite, and minor non-foliated aggregates and individual crystals of biotite. Some of the quartz crystals have a diameter of 0.2mm, but most are less than 0.1mm. Feldspar appears to be a minor constituent, but may form more of the finer-grained portion than is apparent. Accessory minerals are zircon and apatite (abundant), opaques (common), and tourmaline (rare).

2. A diopside-actinolite amphibolite (13,999) occurs as green-white pod-like masses, about 1 foot long, in the feldspar-quartz-mica schist. The outer portion, in contact with the schist, is composed of aggregates of acicular actinolite and xenomorphic diopside in a matrix of labradorite and quartz. The accessory minerals include sphene (very common); zircon, apatite, and opaques (common); and tourmaline (rare).

3. An andalusite-quartz-mica schist (13,998) contains about 10 percent andalusite, 15 percent quartz, and 75 percent sericite, biotite, and probable chloritoid. Chloritoid(?) occurs as unoriented crystals formed during thermal metamorphism. Andalusite forms coarse-grained poikiloblasts with inclusions of mica. Quartz generally occurs in aggregates in association with andalusite. Apatite and opaque minerals are rare. The andalusite porphyroblasts cut across the foliation and have pushed the foliated mica aside during their growth. A second generation of unoriented poikiloblastic biotite is also present.

All three rocks are dynamically metamorphosed pelitic sediments. All three show signs of thermal metamorphism which has given them an incipient hornfelsic texture, but the schistose texture is still predominant. The rocks could have been formed during a single period of regional metamorphism, in which thermal conditions predominated in the concluding stages, so that a hornfelsic texture was superimposed on the earlier synkinematic texture. Alternatively, they could have a polymetamorphic history - an initial regional metamorphism (during which the foliated mineral assemblage crystallized), followed by a separate period of thermal metamorphism, when crystallization of unoriented minerals was superimposed on the earlier fabric. In the facies classification, the first interpretation would be described as metamorphism under almandine-amphibolite facies conditions, the second as metamorphism under greenschist facies conditions followed by metamorphism under hornblende-hornfels facies conditions.

The rock at Mount Kostka is similar to the schist at Cooper Bluffs, although it is neither as well cleaved nor as schistose. The strike and dip of the bedding are similar, and the bedding in other outcrops observed from the air appears to have the same attitude.

Comparison of the greenstones and related rocks from Cape North with the rocks from Zykov Glacier indicates that both suites were originally pelitic sediments which have undergone synkinematic metamorphism. The western suite has been subjected to more intense metamorphism and calcite is not an important constituent. The original rocks of the two areas may still be correlated, assuming that the grade of metamorphism increases westward towards Zykov Glacier. The difference in calcite content may be due to the formation of plagioclase or a sedimentary facies change.

No landings were made between Cape North and Cooper Bluffs.

SPUTNIK ISLAND

Sputnik Island (lat. $70^{\circ}20'$S., long. $163^{\circ}35'$E.) was visited by the Soviet Antarctic Expedition in 1958. In their preliminary report, Klimov & Soloviev (1958a) describe Sputnik Island, one of two islands in Ob Bay which they refer to as 'Unnamed islands $70^{\circ}33'$S., $163^{\circ}40'$E.' as consisting of 'homogeneous massive biotite granites and granosyenites'. Ravich & Krylov (1964) quote the age of biotite plagiogranite from Sputnik Islands as 325 m.y.

In 1962, ANARE visited only a very small outcrop on the north-eastern part of the island (Law, 1964). This was found to be a massive fine-grained to medium-grained grey adamellite, containing a few biotite-rich xenoliths about 5cm across. These xenoliths tend to weather more readily than the adamellite.

The adamellite (14,000) has a hypidiomorphic-granular texture. The estimated mineralogical composition is: biotite 5 percent, quartz 15 percent, microcline 35 percent, and andesine 45 percent. Andesine (An48) is generally blocky and subhedral to euhedral; it is mostly zoned and shows both normal and reversed zoning. Microcline is present as anhedral to subhedral crystals; the anhedral crystals are the largest in the rock and are generally poikilitic with inclusions of biotite, andesine, and quartz. Quartz is generally anhedral. Biotite is generally lath-like, although some crystals have a euhedral habit; it has been altered to chlorite on a minor scale. Rare apatite is the only accessory mineral.

WILSON HILLS

The Wilson Hills in Oates Land are a group of rocky ridges and peaks between the Pennell Glacier (long. $157\frac{1}{2}^{\circ}$E.) and about 160°E.; they extend inland at least 40 miles (65 km). Individual exposures range from small peaks and headlands to large massifs covering many square miles. Many of the features of lower relief are almost covered by snow, and only the crests and projecting lateral arêtes are visible. In the central part of the hills the relief is mainly ridges trending north-east. The mountains are very rugged, with steep or precipitous sides surmounted by sharp peaks or jagged ridges. Cirque glaciers are not common in the area visited, but several abandoned cirques were seen, some still partly occupied by masses of stagnant ice.

No direct evidence of major faulting was observed, but between the Pennell and Tomilin Glaciers, step-faulting along lines parallel to the coast (i.e. trending south-east) is indicated by step-like increases in the height of the ridges, which here trend south-west, i.e. normal to the coast; the changes in altitude are approximately collinear from one ridge to another. From the coast inland, at least three steps can be distinguished, at heights of about 150, 600 and 900 metres. Air-photographs of the area east of the Tomilin Glacier show two prominent scarps in the surface of the ice sheet; the scarps trend south-east for about 20 miles (30 km), and are probably due to faults in the underlying rock. The long straight course of the Pennell Glacier probably marks an important line of weakness, trending north-north-west.

Several localities near the coastline between 153°E. and 160°E., including one in the Wilson Hills, were visited by geologists of the Soviet Antarctic Expedition in 1958 (Klimov, 1960a; Soloviev, 1960). A brief report (Klimov & Soloviev, 1958a) mentions 'gabbrodolerite' at latitude 68°33'S., longitude 153°45'E. (Scar Bluff - 'Mount Obruchev' of Russian maps); 'phyllite-like shales with intercalations of grey lime-shales' near latitude 69°13'S., longitude 156°00'E. (Mount Berg of Russian maps); and 'crystalline schists, enriched with biotite' and 'biotitic gneisses' at latitude 69°18'S., longitude 158°01'E. (possibly Ringgold Knoll) in the western Wilson Hills.

Different parts of the Wilson Hills were visited by ANARE in the early months of 1959, 1961, and 1962 (Law, 1964)½

Mount Ellery

A landing was made and specimens collected by S. Kirkby, ANARE surveyor, on top of Mount Ellery, at latitude 69°54'S., longitude 159°39'E.

The rock is a grey adamellite which contains about 25 percent of inclusions of altered medium-grained to fine-grained schist averaging 5cm in diameter.

Biotite forms about 15 percent of the adamellite (13,995), quartz 20 percent, andesine (An32) 30 percent, and orthoclase and microcline about 35 percent. The adamellite has an uneven texture. Biotite occurs as large aggregates or as intergranular patches. Quartz is large and anhedral, or intergranular. Andesine is found as coarse anhedral to subhedral crystals, as finer intergranular crystals, or as inclusions in potash feldspar. Orthoclase and microcline are generally coarse-grained and anhedral.

The schistose inclusions are composed of foliated biotite (mostly altered to chlorite) and muscovite, quartz, calcic andesine, and rare epidote. The inclusions grade into the adamellite. Randomly oriented coarse biotite and feldspar in the central part of the inclusions appear to have been formed by recrystallization of the schist.

More massive dark biotite-rich xenoliths, up to 60cm in diameter, are scattered through the adamellite, but form only 1 or 2 percent of the total rock. Thin veins of quartz are common as joint fillings.

Dykes of both fine-grained and very coarse-grained alaskite, up to 60cm wide, intrude the adamellite.

The dykes (13,996) are composed of 1 percent biotite, 4 percent muscovite, 20 percent albite (An8), 25 percent quartz, and 50 percent microcline. Quartz is coarse and anhedral. Microcline is present as coarse-grained and medium-grained subhedral and anhedral crystals. Albite is generally subhedral and is medium-grained to coarse-grained. Muscovite occurs as large, scattered, ragged flakes. Most of the feldspar in the specimen has been sericitized, presumably by weathering processes.

Parkinson Peak

Parkinson Peak is an isolated peak approximately 1050 metres above sea level, situated at latitude 69°34'S., longitude 158°43'E. It consists of banded gneiss with numerous veins of acid rock.

The banded gneiss is predominantly fine-grained with a moderate schistosity.

A typical specimen (7290) is a banded mica-quartz-feldspar gneiss, assigned to the almandine-amphibolite facies. Dark bands composed of biotite, quartz, and feldspar alternate with light-coloured bands of quartz and feldspar; the bands range in thickness from 2mm to 5mm. The major constituents are plagioclase and quartz, which range in diameter from 0.1mm to 0.5mm, with an average of 0.3mm. Plagioclase forms about 55 percent of the rock, and has a lower refractive index than quartz. Biotite and subordinate muscovite together make up about 5 percent of the rock; they occur as lath-like crystals or tabular poikiloblastic sheets. The accessories include zircon and apatite. The feldspar is cloudy and the biotite has been partly altered to penninite.

The degree of banding ranges from barely distinguishable to sharply defined bands a few millimetres thick. Even the non-banded rock has a slight foliation due to parallelism of the biotite flakes. In places medium-grained plagioclase crystals are scattered through the rock, and segregations of biotite, up to about half an inch across, are occasionally present. A chemical analysis of the gneiss is given in Appendix 1.

The banded gneiss contains irregular masses of pink granite and several varieties of quartzo-feldspathic veins (Pl. 1, fig. 1).

The pink granite masses are common in the country rock (Pl. 1, fig. 2). Their texture is generally coarse, but shows considerable local variation. The mineralogical composition is also variable, the proportions of the predominant minerals - feldspar, quartz, and biotite - changing considerably over distances of a foot or two. The biotite commonly occurs as clots about 5cm across, or as schlieren a few centimetres long. Moderate amounts of muscovite are present in places. The granitic masses also contain scattered crystals of rose-coloured garnet, about 2.5mm across, or small aggregates of garnet associated with biotite.

The granitic veins (7288) are generally composed of mica, quartz, plagioclase, and microcline. The microcline forms about 70 percent of the rock; it occurs as large crystals, many showing Carlsbad twinning, which range from 1mm to 10mm in diameter, with an average of 3.5mm. Zoned oligoclase (An25) forms about 15 percent of the rock. Most of the plagioclase and microcline is anhedral, and many crystals have inclusions of biotite, muscovite, or quartz; the microcline also contains plagioclase inclusions. Quartz (10 percent) is generally interstitial, and forms myrmekitic intergrowths with plagioclase.

The general texture, and the presence of inclusions of quartz in the plagioclase, indicate that this pink granitic rock is of metamorphic origin. If so, it belongs to the almandine-amphibolite facies.

Medium-grained quartzo-feldspathic veins, up to 1cm thick, are common in the banded gneiss. Some have a thin fringe of biotite, and a few contain large augen-like crystals of feldspar. Most of the veins are only a few metres long. They are generally concordant with the banding of the gneiss, but in places they form an irregular network cutting across the banding.

Fine-grained veins consisting of feldspar and quartz with a little chloritized biotite and associated garnet are also fairly common in the banded gneiss. Some of the veins have a granulated appearance.

Most of the veins and masses are roughly concordant with the banding of the gneiss, but discordant representatives are not uncommon (Pl. 1, fig. 1). Their contacts with the enclosing banded gneiss are sharply defined macroscopically. The contact between banded gneiss and a fine-grained cross-cutting vein about 2cm wide was examined in thin section (7290). The vein contains quartz, feldspar, and mica, and is mineralogically similar to the enclosing gneiss, but the minerals in the vein show only a slight preferred orientation. The borders of the veins are slightly dilated in places, but there is no sharp boundary between the vein amd banded gneiss. The minerals in the vein are metamorphic in habit, and the vein was probably formed by replacement along a joint.

Several straight, sharp-edged dykes, a metre or two wide, cut the banded gneiss and veins. They are either parallel to the banding of the gneiss, or cut across it at an acute angle. One dyke is intruded by a thin aplite vein.

The dykes (7289) are composed of mica, quartz, and plagioclase. The main constituents are plagioclase and quartz with a grainsize ranging from 0.4mm to 3.5mm in diameter, and an average of 1.5mm. Both minerals are mostly anhedral, but some of the plagioclase is subhedral. The plagioclase (andesine, An37) is commonly zoned, and forms about 65 percent of the rock. Biotite forms interstitial tabular crystals which appear to be corroded. Muscovite is a rare accessory. Broken and rounded zircon crystals are present. The plagioclase is cloudy and some of the biotite has been altered to penninite.

The origin of this rock is uncertain: the texture has both igneous and metamorphic affinities, but the overall aspect is metamorphic. On the other hand, the field evidence indicates that the dyke-like bodies are intrusive. It is possible that the dykes are rheomorphic, and represent material mobilized by intense metamorphism and injected in much the same way as an ordinary igneous rock.

The general strike of the banded gneiss is 110^{o} and the dip 80^{o} to the south. In many places the gneiss is tightly folded: the folds are about 15cm from crest to crest, with an amplitude of about 60 cm (Pl. 1, fig. 2). All the rocks on the peak are closely jointed, with joint planes striking about north-south. A band of mylonite about 60 cm wide, and striking south-east, was noted on the northern side of the peak.

Slight copper staining of the rocks was seen at a few places, and a few specks of pyrite were also found.

Cook Ridge

Cook Ridge is a prominent ridge extending for about 3 miles (5 km) to the south-west from the south-east corner of Davies Bay, at about latitude 69°22'S., longitude 158°23'E. To the south, it gradually merges with the ice-sheet. Most of the ridge is covered with ice and the rock exposures are mainly projecting arêtes and parts of the crest of the ridge.

Only the part of the ridge north of the northernmost peak (which rises to 650 metres) was examined. The rocks consist mainly of light-coloured medium-grained massive gneiss.

The main rock type is a garnet-mica-quartz-plagioclase gneiss (7291) belonging to the almandine-amphibolite facies. About 35 percent of the rock is quartz, which forms elongated anhedral crystals up to 6.6mm long. Plagioclase (andesine, An32) occurs as grains ranging from 0.8 to 3.3mm in diameter, with an average of 2mm; some shows myrmekitic intergrowths. Biotite forms about 2 percent of the rock and occurs as interstitial aggregates of tabular crystals. A little muscovite occurs associated with the biotite or as small inclusions in the plagioclase. Pink garnet, probably almandite, is a rare accessory. Zircon is present as inclusions in the biotite. Some of the biotite has been altered to penninite, and much of the plagioclase is cloudy. Most of the biotite is associated with garnet. The proportion of garnet differs considerably from place to place; it is almost absent from most of the finer-grained varieties of the rock. The proportion of biotite also varies, but not to the same degree as the garnet.

The medium-grained gneiss contains irregular patches, up to about 25cm across, of coarse-grained granitic-textured gneiss. The coarse-grained gneiss is composed of the same minerals as the medium-grained rock, but has a higher proportion of garnet and biotite, which are associated as prominent aggregates a centimetre or so in diameter. The biotite also forms platy aggregates several centimetres across, containing little or no garnet.

The medium-grained gneiss contains scattered remnants, a few metres across, of banded biotite-quartz-feldspar gneiss. The banded gneiss is fine-grained to medium-grained, and contains sporadic pea-sized clusters of pink garnet and aggregates of fine-grained biotite. Veins of the medium-grained gneiss, with well-defined margins, extend through the banded gneiss, mostly parallel to the banding. The banded gneiss also contains irregular quartz-feldspar masses, ranging from fine-grained to very coarse-grained. In places, the veins are so extensive that only small irregular remnants of the banded gneiss are left; most of these have a streaked-out appearance.

The strike and dip of the foliation of the banded gneiss remnants differ considerably from place to place. The general strike appears to be about east-west, with dips ranging from 20° to 60° to the south, but it is evident that the rocks have been intensely folded.

Two dykes of adamellite, each about 6 metres wide and striking north-north-east, were seen cutting the gneiss. The dykes are massive and medium-grained. They grade from adamellite to gneiss over a distance of a few centimetres, and their margins are faintly banded parallel to the contact.

The major constituents of the adamellite (7292) are quartz, plagioclase, or orthoclase. Orthoclase forms about 45 percent of the rock; it is present as subhedral grains, or as large poikilitic crystals over 6mm in diameter, with inclusions of quartz, plagioclase, and mica. Plagioclase forms about 40 percent of the rock; it has a lower refractive index than quartz, is anhedral to subhedral, and mostly zoned; the diameter of the crystals ranges from 0.4mm to 1.6mm, with an average of 0.8mm. Subhedral to anhedral crystals of quartz form about 10 percent of the specimen. Interstitial biotite forms about 2 percent of the rock. Muscovite is rare. A little penninite occurs as an alteration product of biotite, and some of the plagioclase is cloudy.

A few straight parallel-sided pegmatite dykes, a few centimetres wide, intrude the gneiss. They consist of creamy-coloured perthite, some quartz, scattered red-brown garnet, and rare biotite, with a thin central zone of sericite. A few veins of feldspar, aplite, and blue quartz were also noted.

A single dyke of vesicular porphyritic basalt, 1 metre wide, was seen intruding the gneiss; it strikes 120° and probably dips vertically.

The basalt (7293) is composed of fine-grained to cryptocrystalline laths of labradorite, fine-grained interstitial pyroxene, magnetite(?), and a little biotite. The labradorite (An55) forms about 55 percent of the specimen. The majority of the phenocrysts consist of augite(?) with subordinate plagioclase, and one probable xenocryst of quartz. Disseminated magnetite(?) forms about 2 percent of the rock. The vesicles contain calcite, or calcite rimmed with cryptocrystalline silica.

Stanwyx Ridge

Stanwyx Ridge is about 5 miles (8 km) west of Cook Ridge, and extends south-west for about 5 miles (8 km) from the south-western side of Davies Bay. It is ice-covered for most of its length. The northern end of the ridge was briefly examined.

The rocks are banded gneisses similar to those found as remnants in the gneiss on Cook Ridge.

The typical rock (7294) is a garnet-biotite-quartz-plagioclase gneiss assigned to the almandine-amphibolite facies. Plagioclase and quartz are the major constituents and range in grain diameter from 0.2mm to 1.1mm, with an average of 0.4mm. Plagioclase (andesine, An43) forms about 55 percent of the specimen, and quartz about 35 percent; both are generally xenoblastic in habit, but a few subhedral grains of andesine are present. Biotite (about 7 percent) is evenly distributed as lath-like crystals, and often contains pleochroic halos. Garnet, probably almandite, forms about 1 percent, and occurs as anhedral crystals in patches with fine-grained quartz, andesine, and biotite. The accessories include zircon, apatite, and an opaque mineral.

Veining is much less common on Stanwyx Ridge than on Cook Ridge, and expanses of banded gneiss do not contain any veins. Most of the veins consist of medium-grained garnetiferous gneiss with a little biotite and garnet. They form veins half to one inch wide along the foliation of the banded gneiss. Veins of fine-grained aplite and feldspar are also present.

The banded gneiss is contorted into tight folds several feet across, with the axial planes trending about east-south-east and dipping north at 60° to 80°.

Aviation Islands

The Aviation Islands are a group of five small islets (one completely ice-covered) 4 miles (6 km) north of the coast, at about latitude 69°16'S., longitude 158°35'E. Each island is about 200 metres across, and the highest (the westernmost) is only about 75 metres high.

The islands are composed predominantly of fine-grained biotite-quartz-feldspar gneiss with minor amounts of sillimanite and rare garnet.

A typical specimen (7287) is a banded fibrolite-mica-quartz-plagioclase gneiss, assigned to the sillimanite-almandine subfacies of the almandine-amphibolite facies. Biotite is concentrated in layers, with individual crystals parallel to the banding. Plagioclase, which forms about 50 percent of the rock, occurs as xenoblastic porphyroblasts ranging from 0.1mm to 1mm in diameter, with an average of 0.4mm; they are andesine (An32); the remainder of the plagioclase has a lower refractive index than quartz and is only feebly twinned. Quartz forms about 40 percent of the specimen and is generally finer-grained than plagioclase. Fibrolite is present in acicular aggregates, many of which extend from the mica into the quartz and plagioclase. Zircon occurs as fine crystals and as inclusions in biotite. A little apatite is also present.

Banding of the light and dark minerals is generally not as prominent as in similar rocks on the mainland. Small tight folds are visible in places, and ptygmatic veins are fairly common.

The banded gneiss is cut by numerous veins of light-coloured fine-grained to medium-grained granite, composed of white and clear feldspar, quartz, and biotite, with rare sericite. A few phenocrysts of feldspar, some of which show extremely fine albite twinning, are present, and in places form knots several inches in extent. The proportion of biotite varies from vein to vein (Pl. 2, fig. 1). At first glance the veins appear to be massive, but in fact many of the biotite flakes have the same orientation. Most of the veins are only a few centimetres wide, but large irregular ones range up to 2 metres wide. Most of the narrower veins are straight, but others are irregular, and many cut across the banding of the gneiss. The edges of the veins are well defined on a macroscopic scale.

In thin section the granite veins (SR56-57/7/1) are medium-grained and massive. Microcline (40 percent) occurs as anhedral grains up to 2mm across; the grains show some intergrowth with quartz, and alteration to kaolinite. Quartz is of similar size to microcline, and is strongly fractured. Oligoclase, which forms 20 percent of the rock, shows little zoning, and twinning is uncommon; the grains are moderately to strongly altered to saussurite and sericite. Deep red-brown biotite forms 8 percent of the rock; the flakes contain many small haloes, probably around zircons, and many flakes are interlaminated with chlorite. About 3 percent of muscovite is present.

The veins of medium-grained granite are cut by veins or irregular lenses of coarse-grained light-coloured granite (8378), composed mainly of white potash feldspar, with subordinate quartz, some biotite, and rare plagioclase and muscovite. The amount of quartz and biotite differs from place to place, but is commonly small. In places feldspar forms about 90 percent of the veins. Sillimanite and small masses of cordierite (8549)* occur in places. The texture is uneven, with a considerable range in grainsize. Some of the feldspars are more than 3 cm across, and most contain small blebs of quartz, which are probably in optical continuity.

The veins of medium-grained and coarse-grained granite are particularly numerous on the westernmost island; they are much less common in the gneiss on the other three islands.

The gneiss on the westernmost island contains a discordant lens-like body of mica-quartz-plagioclase gneiss about 3 metres wide, with straight sharply-defined edges.

The mica-quartz-plagioclase gneiss (7286) is assigned to the almandine-amphibolite facies. The texture is generally hornfelsic and porphyroblastic, with porphyroblasts of plagioclase forming about 70 percent of the specimen. Plagioclase (andesine, An43) grains range from 0.3 to 1mm across, with an average of 0.6mm; much of it shows both normal and reversed zoning, and inclusions of quartz and muscovite are common. Some of the plagioclase laths appear to have been completely replaced by quartz. Quartz is generally fine-grained, and minute granules with an average diameter of 0.04mm are present in interstices and as inclusions in the plagioclase. Biotite is interstitial as fine-grained to medium-grained subparallel flakes, and forms about 3 percent of the specimen; inclusions of zircon are common in it.

The texture of the rock suggests that the present mineral assemblage is of metamorphic origin, but the relationship of the plagioclase to muscovite or quartz indicates that metasomatism accompanied the metamorphism. Although the rock has a similar mineralogical composition to the enclosing gneiss, the texture is distinctive. The field relationships suggest that the body represents a dyke which was metamorphosed with the enclosing rocks, but the evidence is inconclusive.

The easternmost island of the group consists mainly of medium-grained to coarse-grained gneiss with a granitic texture.

The rock (7285) is a garnet-sillimanite-quartz-feldspar gneiss assigned to the almandine-amphibolite facies. The presence of rounded zircons, broken monazite crystals, and the normally metamorphic minerals garnet and sillimanite indicate that it is a metasediment. The rock has a porphyroblastic texture with microcline porphyroblasts forming about 65 percent of the specimen. The porphyroblasts, which range from 1mm to 3cm in length, contain inclusions of plagioclase, biotite, and muscovite, and show Carlsbad twinning. Some oligoclase occurs as porphyroblasts, but most is enclosed by microcline. Many of the oligoclase crystals show myrmekitic intergrowths, and myrmekite is also present around the border of some of the microcline porphyroblasts. Foxy-red biotite is interstitial, and contains inclusions of zircon surrounded by pleochroic haloes. Quartz,

---

*A notable feature of this rock is that the cordierite in it is optically positive. Optically positive cordierite is characteristic of gneisses from moraine in the Commonwealth Bay area, some 450 miles to the west (Tilley, 1940), and also of boulders dredged from the sea floor by both the Australasian Antarctic Expedition and the British, Australian and New Zealand Antarctic Research Expedition (W.B. Dallwitz, pers. comm.).

which forms about 25 percent of the rock, is present as medium-grained crystals with crenulated borders. Garnet is rare. Fibrous sillimanite (fibrolite) occurs in association with muscovite - some of the muscovite has been altered to fibrolite. Occasional small monazite crystals were also noted.

The foliation in the gneiss is due to the parallel orientation of the feldspar laths, enhanced in places by thin streaks of biotite. A few coarse patches, composed of feldspar, biotite, and phlogopite(?), were noted. Several sharply defined inclusions of dark fine-grained rock were also seen; they are composed mainly of biotite and feldspar, including tabular feldspar porphyroblasts up to an inch long.

This coarse-grained gneiss is cut discordantly by a dyke, $1\frac{1}{2}$ metres wide, of medium-grained granite, similar to the medium-grained granite veins cutting the banded gneiss on the other islands. The dyke is fairly straight and has well-defined edges.

Several dykes of biotite-rich granodiorite, up to 30cm wide, also occur on the easternmost island. They consist of fine-grained to medium-grained plagioclase, biotite, and quartz. A notable feature of these dykes is the pronounced parallelism of the biotite. A single vein of coarse-grained iron-stained quartz was found.

Because of the folding in the gneiss, the strike is not constant, but the general strike appears to be about 130^{o}, and the dip 60^{o} to 80^{o} to the south. Joint planes are moderately widely spaced, except on the island adjacent to the easternmost one, where closely spaced joints form two principal systems, one parallel to the foliation of the gneiss (strike 130^{o} and dip 70^{o} to the south), and the other striking normal to the foliation and dipping vertically.

Magga Peak

Magga Peak, situated at the head of Lauritzen Bay on the western flank of the Pennell Glacier, is part of the Lazarev Mountains rather than of the Wilson Hills. An ANARE party landed in February 1959 (Law, 1964), and specimens were collected by Mr J. Hollin (glaciologist at Wilkes during 1958). Hollin describes the general features of the area as follows:

> 'This area is composed of metamorphic rocks lineated* locally in a generally NNW-SSE direction (true) and similar in general appearance to those found at Wilkes Station, 1500 miles to the west.
>
> Drift: A thin cover, but reaches the highest summit, which has erratics. No special search was made, but no sedimentary rocks were noticed.
>
> Glacial History: From the above, we may infer that at some time the local ice sheet was at least 500 feet thicker than it is today - probably more than 1000 feet. The highest raised beach was difficult to define here, because wasting on the steep slopes had blurred the usually sharp boundary between till covered areas above and wave cleaned areas below. The land has risen post-glacially somewhere between

---

*This probably refers to foliation; there is no macroscopic sign of lineation in any of the specimens.

72 and 96 feet above the current high water mark. The absence of transgressive till on the raised beaches immediately below the western corrie glacier suggests that this glacier has not in post-glacial times been much larger than it is now. The presence of lichens close to the glacier's snout suggests that it is not currently retreating. The glacier has probably been separated from the main ice sheet which delivered the erratics to the ridge behind it for a very long time. The area is well weathered, and blocks now emerging from the basal shears of this corrie glacier seem fresh and local.'.

Hollin's notes and the specimens indicate that the rocks at Magga Peak are generally fine-grained quartz-biotite-feldspar gneiss and associated quartz-feldspathic and granitic material like those farther to the east in the Wilson Hills.

The host rocks appear to be fine-grained quartz-biotite-feldspar gneiss (81)*, garnetiferous in part. Coarser-grained and banded varieties (83), with thin, feldspathic and quartzo-feldspathic veins, some of them ptygmatic, are also present; Hollin also recorded epidote(?). The acid material is represented by a medium-grained biotite-rich granite gneiss (84), a specimen of granite with only a moderate amount of biotite but with ophitic hornblende grains several centimetres across (85), and a massive pink medium-grained granite with little biotite, containing small irregular masses of magnetite (86). A white granite, similar to specimen 86, but with the magnetite occurring as small specks, 'interfingers the neighbouring gneiss (interfingering generally parallel with gneissic lineation), but the contact is sharp and without local metamorphism'.

Other specimens include a light grey medium-grained imperfectly banded biotite gneiss (96) containing sphene and zircon(?), and a rather altered fine-grained porphyritic pyritic dolerite (80), 'probably from a dyke bearing 060^{o} magnetic' (i.e., about north-north-west true).

Moraine includes a fine-grained gneissic biotite granite containing small inclusions of amphibolite with some epidote (87), 'not actually in situ but certainly local', a fine-grained feldspar-amphibole-biotite rock with phenocrysts (or porphyroblasts) of amphibole (99), and a pink aplite (97), 'abundant in the drift and almost certainly in situ'.

PENGUIN POINT

Penguin Point (lat. 67^{o}40'S., long. 146^{o}01'E.) is a cliff of granodiorite which rises 45 metres above sea level (Pl. 2, fig. 2); the top of the outcrop is about 100 metres long by 50 metres wide. This cliff is one of a line of outcrops which extends along the coast for about 15 miles (25 km) between the Mertz and Ninnis Glacier Tongues.

Some of the exposures, including Penguin Point, were visited by the Australasian Antarctic Expedition early in 1913. Summers & Edwards (1940), in detailed petrographic accounts, describe the rock as a granodiorite. Penguin Point, and Cape Bage and Cape Webb, respectively about 8 miles (13 km) and 20 miles (32 km) south-east of Penguin Point, were visited by the Soviet Antarctic Expedition in 1958 (Klimov, 1960b). In a preliminary account, Klimov & Soloviev (1958a) describe the rocks as biotite-amphibole and biotite granites (including rapakivi types), and comment on the abundance of xenoliths.

Penguin Point was visited by ANARE early in 1962.

---

*Numbers are Mr. Hollin's specimen numbers.

The rock forming Penguin Point is a coarsely porphyritic granodiorite (13,987). The estimated mineralogical composition is: biotite 10 percent, quartz 15 percent, microcline 25 percent, and andesine 50 percent. The texture is generally coarse-grained and allotriomorphic. The andesine (An31) is occasionally subhedral with individual crystals up to 3 inches long. Some of the microcline crystals contain inclusions of biotite, plagioclase, quartz, and occasionally zircon. Muscovite is a minor constituent. Accessory apatite is common, and a little zircon occurs as inclusions in biotite. Some of the biotite has been altered to chlorite and in places the plagioclase has been sericitized.

Biotite-rich and aplite xenoliths are abundant. The dark-coloured xenoliths contain up to 90 percent biotite; they have a maximum diameter of 30cm and are either round or elongate. The aplitic xenoliths, which contain about 5 percent biotite, are generally about a metre long by 15 cm wide. On the flat top of Penguin Point, the xenoliths appear to be randomly oriented, but in the vertical cliff face they are aligned with their long axes approximately vertical.

Two strong sets of joints were noted, both striking east-west, and dipping 30° north and 80° north respectively.

DAVIS BAY

Davis Bay is situated near the western side of the Dibble Iceberg Tongue at about latitude 66°08'S., longitude 134°05'E. It contains several small islands; the largest, Lewis Island, is the site of an ANARE automatic weather station. ANARE appears to have been the first expedition to visit the bay (Law, 1958).

Lewis Island

Lewis island is a small dome-shaped island 30 yards from the edge of the continental ice sheet on the eastern side of Davis Bay at latitude 66°06'S., longitude 134°22'E. It is about 300 metres long, 200 metres wide, and 30 metres high, and is connected by a partly submerged rock shelf to outcrops in the adjacent cliffs of the ice sheet.

The island is composed mainly of grey medium-grained biotite-granodiorite gneiss with bands of subordinate finer-grained banded gneiss up to 1½ metres wide, though mostly thinner, and discontinuous. The boundaries between the two gneisses are generally well defined. In several places the granodiorite gneiss contains elongate streaky biotite-rich inclusions, many of which have a rim of feldspar a centimetre wide.

The banded gneiss is a fine-grained to medium-grained rock composed mainly of feldspar and biotite, with small nests of epidote and scattered grains of pyrite; the proportion of biotite ranges from less than 10 percent up to about 60 percent. The rock has a prominent banded structure, which is further emphasized by thin parallel layers of coarser felsic material.

The granodiorite gneiss (4556) consists of andesine (An40), quartz, biotite, and perthite, with accessory pyrite, magnetite, spinel and sphene; calcite, clinozoisite, muscovite, and some of the magnetite are concentrated along lines of granulation, and may have been formed during the crushing of the rock. Perthite is generally subordinate but in places is common as pink crystals up to 2.5mm across; the parts of the rock containing these are richer than usual in biotite. Along lines of granulation the quartz especially has been partly recrystallized, with strongly sutured boundaries.

The gneiss contains narrow veins of pegmatite composed of white plagioclase and pink potash feldspar, with some quartz, brown garnet, biotite or hornblende, magnetite, and pyrite. The quartz and feldspar are zoned in some of the wider veins; a few of the veins contain white feldspar only. The acid veins trend both across and parallel to the foliation of the gneisses.

In a few places networks of thin epidote veins occur in narrow elongated zones, and veinlets and knots of white quartz with small brown garnets, and of clear quartz with sporadic pyrite, also occur.

The strike of the gneisses is a constant 070°, and they dip to the south at 50° to 70°.

A few feet below the summit of the island (i.e., 25 metres above sea level), is a small flat area of rounded boulders. The boulders could be a moraine deposit, but the high degree of rounding, the rarity of faceting, the regularity of size (most are between 15 and 30cm in diameter), the flatness of the exposure, and rarity of other moraine on the island suggest that the boulders were rounded by wave action when the sea level was higher.

Ice-polished surfaces were seen at several places on the island.

Anton Island

Anton Island, a small island about 5 miles (8 km) north-east of Lewis Island, is made of pinkish grey adamellite gneiss. The rock consists of phenocrysts (or porphyroblasts) of pink microcline up to 3cm long, light green plagioclase, and quartz, set in a medium-grained matrix of dark minerals. The large microcline crystals, which form about 25 percent of the rock, are similar to the perthite phenocrysts in the granodiorite gneiss of Lewis Island. Both the matrix and phenocrysts are well foliated; the foliation strikes 020° and dips at 45° to the west. The rock contains a few small remnants of fine-grained banded gneiss, like that on Lewis Island.

The adamellite gneiss (5566) contains about 40 percent plagioclase, 30 percent microcline, 15 percent quartz, and 10 percent penninite. Occasional crystals of orthoclase are also present. Microcline is unaltered. The plagioclase (An32) is anhedral, with an average diameter of 1.3mm. Part of it is altered to aggregates of fine sericite, and in places it contains inclusions of chlorite and epidote. Most of the penninite has been formed retrogressively from biotite. A little green hornblende and epidote are intergrown with the penninite and accessory sphene, zircon, apatite, and opaques also occur in association with it.

Several pegmatite veins, composed of pink perthite, biotite, and quartz, and thin veins of feldspar cut across the adamellite gneiss. A few thin shear-zones parallel with the foliation were noted.

The joints are widely spaced. The rock slabs have been smoothed, presumably by ice, but no polishing or moraine was seen.

The adamellite gneiss may be metamorphic or igneous in origin. The enclosed remnants of banded gneiss, and the similarity of the large potash feldspar crystals to those on Lewis Island, suggest that the rocks on the two islands are closely related, but it is uncertain whether the adamellite gneiss on Anton Island is the result of more extreme metamorphism (or metasomatism), or whether it represents a granitoid intrusion which was responsible for the formation of the feldspar porphyroblasts in the Lewis Island granodiorite gneiss.

Several other small islands exist in this part of Davis Bay. Most are less than 20 metres across, and all are completely covered by a vertical-sided cap of frozen sea spray and accumulated snow, rising to 6 metres above sea level. The rock exposed at the base of each appears to be medium-grained gneiss like that on Anton Island.

CAPE CARR

In early 1962, an overturned iceberg was found locked in the bay-ice about 2 miles (3 km) from the coast, 20 miles (32 km) east of Cape Carr (lat. 66°S., long. 131°E.). Four samples of rock were collected from moraine in the base of the iceberg:

1. A leucocratic massive granite containing brown quartz, pink and white feldspar, and a little biotite.

2. A biotite-plagioclase-quartz gneiss with elongated patches of plagioclase up to 5cm long, the most common rock in the moraine. The matrix is composed of granular quartz and plagioclase with fine flakes of biotite. The rock appears to be granulated.

3. A porphyritic pink granitoid rock, containing large pink orthoclase crystals in a groundmass of medium-grained greenish plagioclase, chlorite, and quartz.

4. A clinozoisite-chlorite-feldspar-quartz mylonite (13,983). It is a dark green finely banded rock with bands from 0.1mm to 0.4mm wide. Both quartz and feldspar are present as clastic fragments and porphyroclasts, the largest of which is about 0.5mm in diameter. Much of the quartz has recrystallized in streaky lenses. The chlorite and clinozoisite fill interlaminar and intergranular spaces: they form about 20 percent of the rock and give it its dark colour.

HENRY BAY

Henry Bay is a shallow indentation in the coastline at about latitude 66°50'S., longitude 120°40'E., near the western side of the base of the Dalton Iceberg Tongue.

In the south-eastern part of the bay the coastline is formed by a low-lying ice shelf which, a quarter of a mile inland, rises steeply about 30 metres. However, this rise is not the edge of the ice sheet, because remnants of icebergs jut above the surface of the higher area, and frozen sea can be seen in crevasses more than half a mile from the open sea. Another scarp, several miles to the south, may represent the edge of the ice sheet.

At the edge of the ice shelf are two small groups of rock exposures, the Henry Islands, almost at the head of Henry Bay, and Chick Island, 8 miles (13 km) to the north-east, the site of an ANARE automatic weather station. These are the only rock outcrops known on the coast for almost 300 miles (480 km) to the west and 150 miles (240 km) to the east.

The area was visited by the Soviet Antarctic Expedition early in 1958. In a brief account of their findings (Klimov & Soloviev, 1958a), Chick Island is described as 'intrusive charnockite' and Henry Islands as 'porphyry-like pyroxene-containing granitoids'. Ravich & Krylov (1964) give the age of intermediate charnockite from Chick Island as 700 m.y., and biotite-amphibole granite (altered charnockite) from Henry Island as 755 m.y. ANARE first visited the area early in 1960 (Law, 1962).

Chick Island

Chick Island consists of two tor-like masses of rock, about 50 metres apart, rising above the ice; each is about 70 metres long, 20 metres wide, and rises to about 15 metres above sea level. A third exposure, almost covered by ice and only a few square metres in area, lies between these two.

The outcrops are composed of a uniform dark coarse-grained altered biotite-hypersthene-hornblende charnockite (5567). The major constituents are: about 40 percent plagioclase, 35 percent microcline, and 15 percent quartz. The texture is heteroblastic, with an average grainsize of 2.0mm, but finer-grained minerals occur in interstices. The plagioclase includes untwinned oligoclase and twinned crystals of sodic andesine. Feldspar is xenoblastic, and myrmekitic intergrowths are common along crystal boundaries. The quartz and mafic minerals are interstitial. Hypersthene generally occurs as corroded crystals enclosed by hornblende. Dark green and dark brown hornblende is the most common mafic mineral; it has been formed by the alteration of pyroxene and also as a primary metamineral constituent. Biotite is red-brown and apparently primary. Red garnet occurs very rarely in the outcrop. The rock is a charnockite of adamellitic composition, which is thought to have been metamorphosed under granulite facies conditions.

The rock has a slight foliation, due to the alignment of the feldspars, which strikes 090° and dips subvertically.

Inclusions are moderately common; they are generally only a few centimetres across, with occasional blocks up to 3 metres. Most of the inclusions are elongated and oriented parallel to the foliation and nearly all have well-defined edges. The most common type is a fine-grained granulite consisting of various proportions of feldspar and pyroxene; some of the granulite inclusions are banded, but the banding is not parallel to the foliation of the charnockite. Other inclusions are massive, and range in texture from aplitic to pegmatitic. They are composed of pink feldspar, quartz, small amounts of hornblende and biotite, and rare garnet. Others contain the same minerals as the charnockite but are finer-grained, and still others are similar in texture to the charnockite but have few dark minerals; most of these are massive, but some have a gneissic texture. The sporadic rounded brown feldspar crystals, 7 to 10 cm across, in the charnockite could be xenocrysts or porphyroblasts. One thin pink coarse-grained feldspar-quartz vein cuts the charnockite.

Jointing is cubic, with two vertical sets and one near-horizontal set. The best developed vertical set strikes north-north-west, with joints 60 cm to 2 metres apart; the second set is normal to this, with joints 3 to 6 metres apart, and the horizontal joints are about 6 metres apart. Patches of ice-polished surface stand up in slight relief on the rock; most are remnants which have survived exfoliation.

The origin of the charnockite is uncertain. Mr McCarthy suggests that it is a metamorphic rock, but its homogeneity, the variety of inclusions, and the presence of inclusions whose banding is not parallel to the foliation of the charnockite suggest that it is intrusive. The hornblende and biotite in the Chick Island charnockite appear to be primary, which indicates the presence of a moderate amount of water, but nevertheless we think that its origin is probably similar to that suggested by Crohn (1959) for the Mawson Granite, that is, partial mobilization and subsequent injection of material under conditions of extreme metamorphism. The hornblende rims around the biotite could have been formed either during the declining stages of this metamorphic episode or in a later less intense period of metamorphism.

Henry Islands

The Henry Islands consist of two main outcrops, 400 metres apart. Each outcrop is about 50 metres in diameter, with several smaller exposures around it. The main islands rise about 10 metres above the low-lying surrounding ice shelf.

All the outcrops consist of a uniform medium-grained pinkish grey granite gneiss (5568). It is composed of pale pink feldspar porphyroblasts set in a medium-grained aggregate of biotite, hornblende, quartz, and feldspar, and belongs to the almandine-amphibolite facies. The rock contains 80 percent feldspar, 10 percent quartz, and about 10 percent ferromagnesian minerals and accessories. The feldspars consist of microcline and perthite with subordinate andesine (An33). The feldspar is xenoblastic; most of the grains are over 3.0mm across with larger grains up to 6.8mm. Biotite and hornblende, which are present in about equal amounts, occur as fine-grained to coarse-grained interstitial aggregates. Some of the biotite appears to have been formed retrogressively from hornblende, and in places it replaces plagioclase. Quartz and accessories occur in association with the ferromagnesian aggregates. Zircon and apatite occur mainly as inclusions in hornblende and biotite. Epidote and clinozoisite are generally associated with the ferromagnesian minerals, but also occur as inclusions in the feldspar. Sphene is present as inclusions in feldspar and in association with hornblende and biotite. Opaques are rare.

The large feldspars show a weak parallel orientation trending 160°. A suggestion of a vertical foliation is present in parts of the rock.

Inclusions are common; most are less than 30cm across. Some are equant, either rounded or with fairly sharp corners; others are lenticular and aligned parallel to the foliation of the granite gneiss. The most common type is a banded feldspar-biotite gneiss which usually contains some hornblende. The inclusions are sharply defined, and the orientation of the banding is irregular.

Inclusions of non-banded gneiss, some of which contain feldspar porphyroblasts, are also present. Some of these inclusions are ill defined, probably due to partial assimilation. The granite gneiss also contains a few small patches of fine-grained pink feldspar flecked with biotite, which have irregular but well-defined edges.

Several long straight thin veins composed of alaskite, coarse-grained feldspar, or biotite, cut across the gneiss.

The granite gneiss is broken by widely spaced vertical joints, a major set striking north-west and a minor set normal to this. The rock surface has been rounded and smoothed, and in places polished, by ice (Pl. 3, fig. 1), but no glacial striae were found.

The origin of the granite gneiss is uncertain, but the petrographic evidence strongly suggests that it is metamorphic. The two generations of biotite point to two periods of metamorphism; the epidote and clinozoisite were probably formed during the second period, which was of only moderate intensity.

BALAENA ISLANDS

The Balaena Islands is a group of five islands (Fig. 4) situated at latitude 66°00'S., longitude 111°10'E. near the edge of the continent, about 25 miles (40 km) north-east of Wilkes. Various islands of the group were visited by ANARE (Law, 1958), the Soviet Antarctic Expedition, and the United States Deep Freeze I Expedition in 1956, and by American parties after the establishment of Wilkes.

The southernmost and easternmost islands of the group are composed of gabbro, and the other three of adamellite. No contact was seen between the two rock types.

Thompson Island, the largest, consists of two varieties of grey adamellite, with a very poorly defined foliation striking 080° and dipping south at 20°. The two types have a sharp contact, which can be traced for 50 metres.

The first type of adamellite (5574, 13,985, SQ48-49/12/3) contains up to 60 percent microcline and antiperthite and up to 25 percent andesine (An35); ragged feldspar grains range from 7.0mm to 1.1mm in diameter, and average about 1.8mm. Myrmekitic intergrowths between plagioclase and microcline are common. The potassic feldspar is relatively little altered, but the plagioclase contains numerous inclusions of sericite and some epidote or clinozoisite. Quartz is fine-grained to coarse-grained, and forms up to 20 percent of the rock. Biotite flakes, up to 1.5mm long, are pleochroic from greyish yellow to medium olive brown; many are partly altered to chlorite. Some of the chlorite may have been formed by alteration of other ferromagnesian minerals, although no remnants have been perceived. The last minerals to form were epidote and minor amounts of clinozoisite, which generally occur in association with the chlorite. Sphene is a common accessory, occurring as poikiloblastic anhedral crystals, and zircon, apatite, and iron oxide are also present. Red garnet occurs in parts of the rock.

The second variety of adamellite is texturally similar to the first, but contains up to 10 percent biotite and 1 percent iron oxide.

The adamellite is cut by numerous pegmatite veins ranging up to about 30cm wide. They consist of coarse-grained creamy perthite (commonly sericitized), quartz, and occasional euhedral magnetite. In places the veins swell into irregular coarse-grained masses, the largest of which measure 2½ metres across. Pyrite and chalcopyrite are common in some. Some of the pegmatites grade into the surrounding adamellite, which assumes an irregular texture. Most of the pegmatite veins trend either 010° or 340°.

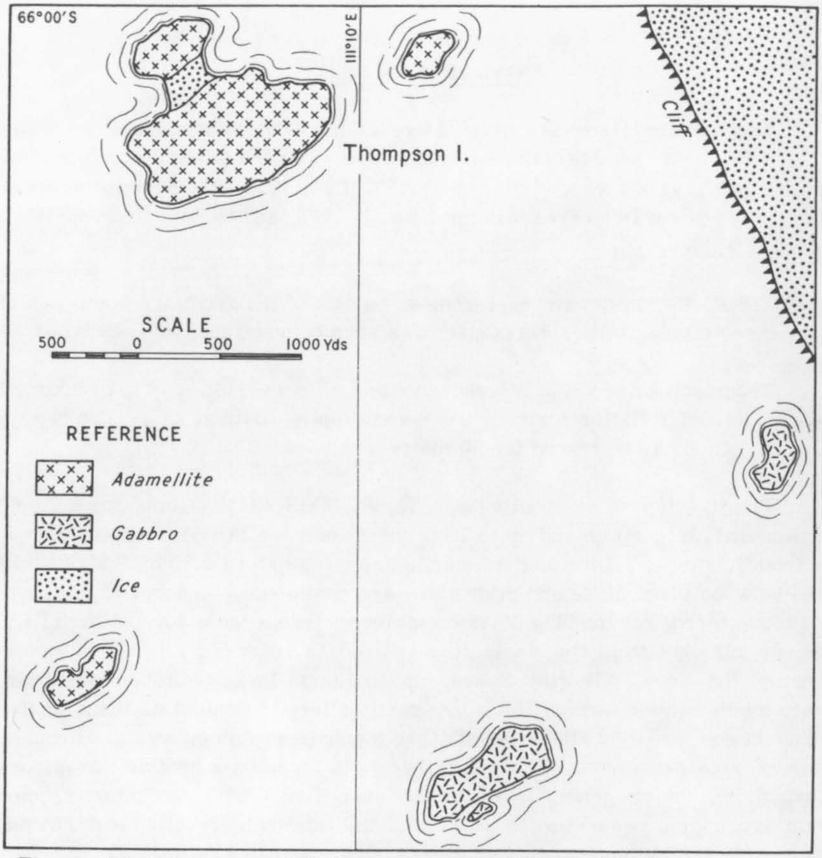


Fig. 4 - Sketch map of Balaena Islands, Wilkes Land

Dark gneissic inclusions rich in hornblende and biotite are distributed throughout the adamellite, but they increase markedly in number and size towards the south-west of the Balaena Islands. The inclusions range from a few centimetres to a metre in diameter, and form from 1 to 5 percent of the rock.

A medium to coarse-grained inclusion (13,986) was found to contain about 35 percent andesine (An35), 25 percent microcline, 20 to 25 percent biotite and hornblende, and 15 percent interstitial quartz. The accessories include abundant sphene, and apatite and iron oxide. Some of the biotite and hornblende is altered to chlorite.

High readings were obtained over Thompson Island during an airborne scintillation counter survey by ANARE in 1956. However, no concentrations of radioactive minerals have been found, and the high readings are probably due to the mass effect of accessory minerals.

The gabbro forming the three islands in the south-east of the group is an equigranular coarse to medium-grained rock composed mainly of labradorite and clinopyroxene. In parts the clinopyroxene forms small aggregates up to 5 cm in diameter.

The gabbro (5575) is composed of medium-grained plagioclase and coarse-grained aggregates of pyroxene. The pyroxene tends to be interstitial to plagioclase, but it appears that both minerals crystallized simultaneously. The plagioclase is labradorite (An67), and is generally lath-like. The pyroxene is generally anhedral and consists of augite and probable clinoferrosilite.

The gabbro is well jointed and veins of epidote up to 3 cm wide fill some of the joints. The gabbro on each side of the veins has been extensively altered for about 30 cm from the vein. In the altered zones (13,984) the clinopyroxene has been completely replaced by hornblende, and abundant epidote has been formed. The original labradorite has been only slightly altered to epidote.

Several erratics were found on the large island at the southern end of the Balaena Islands. They include boulders of red or purple quartzite similar to erratics on the islands in Vincennes Bay, and a medium-grained biotite granite in which all the minerals except quartz have been uniformly and heavily stained purple, probably by manganese.

The quartzite (9530) is composed of rounded to well-rounded quartz grains (80 percent) and altered feldspar grains (20 percent). The grains are well sorted; the grain diameter ranges from 0.2mm to 0.9mm, and averages 0.7mm. They are cemented by overgrowths of quartz in optical continuity with the quartz grains. The feldspar is almost entirely altered to aggregates of sericite and kaolinite. Rare grains of tourmaline also occur. The red colour of the quartzite is due to a film of hydrated iron oxide around the grains. The film was formed around the grains before the quartz overgrowths.

Age measurements made on specimens from the Balaena Islands by Webb et al. (1964) yielded ages of 1060 and 1110 m.y. for two specimens of adamellite, and 510 m.y. for a specimen of gabbro. Chemical analyses of the adamellite and gabbro are given in Appendix 1.

DONOVAN ISLANDS AND FRAZIER ISLANDS

The Donovan Islands (lat. 66°11'S., long. 110°24'E), and Frazier Islands (lat. 66°14'S., long 110°10'E.), are two groups of islands between 5 and 11 miles (8 and 18 km) north-west of Wilkes (Fig. 5). Some of the islands were visited by ANARE early in 1956 (Law, 1958). All the islands are composed of banded gneiss and pegmatite.

The gneiss consists of alternating bands of dark biotite-rich gneiss and light-coloured quartz-feldspar gneiss. All the bands are fine-grained and range in thickness from 2 to about 60 cm. The general strike of the gneiss on Nelly Island is 120°, and the dip 60° south. Small crystals of red garnet are common in the gneiss. The biotite-rich gneiss becomes more abundant towards the west, with a correspondong decrease in the proportion of quartz-feldspar gneiss.

The biotite-rich gneiss is a dark fine to medium-grained slightly foliated rock (SQ48-49/11/9, SQ48-49/11/10). Quartz forms anhedral, commonly amoeboid, grains up to 0.8mm in diameter. Plagioclase, when present, is oligoclase-andesine and occurs as grains similar to the quartz. Biotite forms subparallel flakes, up to 2mm long, which are pleochroic from yellowish orange to reddish brown; some flakes are slightly bent and intergrown with sillimanite. Cordierite occurs as anhedral amoeboid grains associated with sillimanite; some grains show yellow pleochroic haloes. Sillimanite forms aggregates of subparallel needles up to 0.5mm long, and garnet occurs as rounded grains about 0.5 mm in diameter. The accessories include iron oxides and apatite.

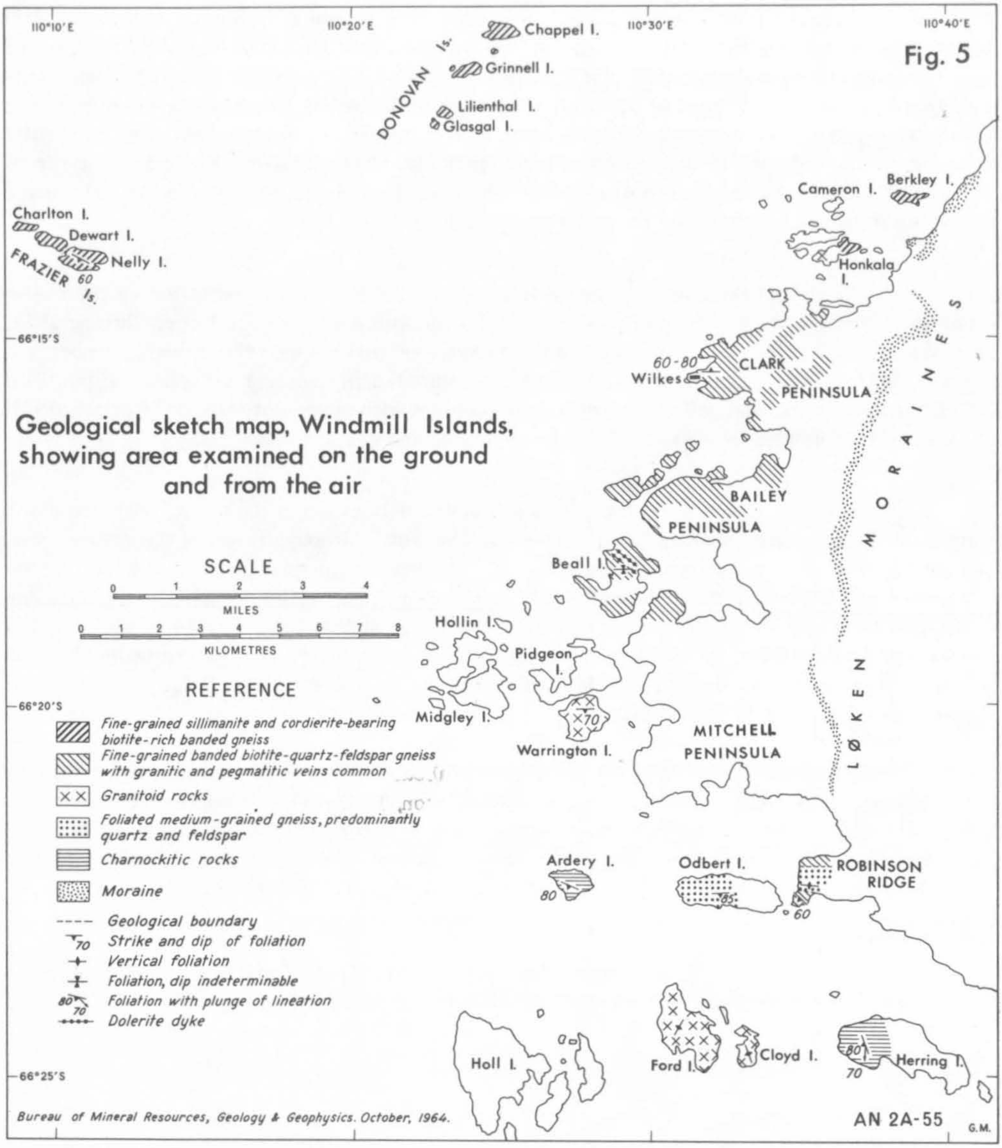
The quartz-feldspar gneiss is a fine to medium-grained equigranular rock with a slight foliation. Quartz forms anhedral amoeboid grains up to 0.8mm in diameter, or aggregates elongated parallel to the foliation. Oligoclase-andesine is present as anhedral grains similar in size to the quartz. Biotite forms subhedral amoeboid grains up to 1mm in diameter; many contain quartz inclusions. The small interstitial aggregates of kaolin and sericite in a specimen from Charlton Island may be secondary after potash feldspar. A little iron oxide and zircon are also present.

Pegmatite occurs as thin veins and as pods up to 2½ metres across. The pegmatites are composed of quartz and feldspar with minor muscovite and red garnet. The garnet occurs as small crystals or as aggregates up to 5 cm in diameter. Pegmatite becomes less common towards the west and is rare in the Frazier Islands.

Age measurements were made on specimens from several of the islands in the Donovan and Frazier groups (Webb et al., 1964). The ages found range from 1050 to 1140 m.y. (see Table 1). Chemical analyses are given in Appendix 1.

WINDMILL ISLANDS

The Windmill Islands are scattered over an area of about 150 square miles (400 sq.km) on the north-east coast of Vincennes Bay. Wilkes station, in the north of the group, is situated at latitude 66°15'S., longitude 110°31'E. (Fig. 5).



110°10'E
110°20'E
110°30'E
110°40'E
Fig. 5
Chappel I.
Grinnell I.
Lilienthal I.
Glasgal I.
DONOVAN Is.
Cameron I.
Berkley I.
Charlton I.
Dewart I.
Nelly I.
FRAZIER Is.
Honkala I.
66°15'S
60-80
Wilkes
CLARK
PENINSULA
Geological sketch map, Windmill Islands, showing area examined on the ground and from the air
BAILEY
PENINSULA
MORAINES
SCALE
MILES
KILOMETRES
Beall I.
Hollin I.
Pidgeon I.
REFERENCE
66°20'S
Fine-grained sillimanite and cordierite-bearing biotite-rich banded gneiss
Fine-grained banded biotite-quartz-feldspar gneiss with granitic and pegmatitic veins common
Granitoid rocks
Foliated medium-grained gneiss, predominantly quartz and feldspar
Charnockitic rocks
Moraine
Geological boundary
Strike and dip of foliation
Vertical foliation
Foliation, dip indeterminable
Foliation with plunge of lineation
Dolerite dyke
Midgley I.
Warrington I.
MITCHELL PENINSULA
LØKEN
Ardery I.
Odbert I.
ROBINSON RIDGE
Holl I.
Ford I.
Cloyd I.
Herring I.
66°25'S
Bureau of Mineral Resources, Geology & Geophysics. October, 1964.
AN 2A-55
G.M.

The area was first visited in 1947, when personnel of the United States Navy Operation Windmill landed on several of the islands. In January 1956, members of ANARE landed on some of the islands in the north of the group (Law, 1958). There was no geologist in the party, but rock specimens were collected. Several airborne scintillation counter runs were flown: high readings were obtained over Ford Island, but no formal report was prepared on the results. The Soviet Antarctic Expedition examined the area, part of which they refer to as the Grearson Oasis, early in 1956 (Ravich, 1960). In a preliminary report (Ravich & Voronov, 1958) the islands in the northern half of the group are described as consisting of 'pyroxene and amphibolite-pyroxene melanocratic plagiogneisses and crystalline schists in one or other stage of migmatization', while those of the southern half 'are formed by charnockite granitoids and seem to be in part coarsely plutonic'. Starik et al. (1959) and Starik et al. (1960) list the results of age measurements on granitic rocks collected in the Windmill Islands; the ages range from 765 to 1020 m.y., with a grouping about 900 m.y. (Age measurements by American and Australian workers are noted in the descriptions below).

At almost the same time as the Russian visit, the area was revisited by the United States in Operation Deep-Freeze I, and Wilkes station was set up a year later. During 1958, members of the United States party at Wilkes examined and mapped the islands. Robertson (1961) described the area as consisting of Precambrian metamorphic rocks, 'migmatised biotite, hornblende, or magnetite-garnetiferous gneisses with intercalated bands of pegmatite in various habits' intruded by a stock of diorite, syenite, and granite.

Most of the islands form a north-south belt close to the coast, with two small groups, the Frazier and Donovan Islands, to the north-west. Although many of the rock exposures are partly or completely surrounded by ice, the low topographic level of the ice and the presence of a long line of shear moraine (the Løken Moraines, which probably mark the edge of the ice sheet) several miles inland from the sea, suggest that the ice is very thick bay ice trapped and immobilized by the numerous islands and probably resting on the bedrock. The outcrops forming Clark, Bailey, and Mitchell Peninsulas and Robinson Ridge are therefore regarded as part of the Windmill Islands.

The highest points in the islands are about 90 metres above sea level, but many summits have an altitude of about 75 metres (Robertson, 1961). The relief is moderate, consisting of shallow valleys floored with detritus, many of which contain permanent snow drifts (Pl. 3, fig. 2). The permanent snow cover is most extensive in the northern part of the group, particularly on Clark and Mitchell Peninsulas. Raised beaches have been noted at several places.

The effects of frost action are very marked; many boulders, even of massive rocks, are being disintegrated by repeated exfoliation and frost shattering.

Honkala and Berkley Islands

Two distinct types of rock are present on Honkala Island. The first is a massive leucocratic granitoid rock which contains some dark biotite-rich xenoliths and dykes of pegmatite. This part of the island is similar to Ford and Cloyd Islands, 13 miles (21 km) to the south.

The granitoid rock is intrusive into gneiss similar to the gneiss on the Donovan and Frazier Islands. It consists of alternating light and dark bands, averaging 10 cm in thickness;

the dark bands are rich in biotite, and the light-coloured bands are composed of quartz and feldspar. The bands are not continuous: the shortest are only 30 cm, and the longest many metres, long. Thin veins of coarse pegmatite and of quartz are common. Augen of biotite-rich gneiss outlined by quartz, and quartz-feldspar augen, are plentiful. Berkley Island is formed of a similar banded gneiss.

Clark Peninsula

Clark Peninsula, on which Wilkes station is situated, consists of several rock masses wholly or partly surrounded by ice, the whole forming a peninsula several square miles in area. The country rock is predominantly banded gneiss invaded by large irregular masses of pegmatite.

The banded gneiss is a fine to medium-grained rock in which the light and dark minerals are segregated into well-defined bands less than 2 cm wide (Pl.4, fig.2). The banding is accentuated by the presence of parallel veins of slightly coarser quartz and feldspar, ranging from a few centimetres to (rarely) 30 cm thick. In places, the light-coloured bands display boudinage structure near thin mylonite zones. Lines of white feldspar porphyroblasts and scattered reddish brown garnets are also present in places.

> The gneiss (5572) is an altered mica-hornblende-quartz-feldspar gneiss belonging to the almandine-amphibolite facies. Several lamina-like quartz-feldspar segregations cut the rock and the ferromagnesian minerals show definite alignment with these laminae. The presence of rounded and broken zircons indicates that the rock is a granitized sediment. The rock is medium-grained except for coarse-grained quartz in the laminae. The feldspar is mainly andesine (An45) with subordinate microcline and antiperthite; the andesine is partly altered to fine-grained sericite and clinozoisite. Biotite and hornblende occur as anhedral crystals; both minerals have been partly altered to chlorite and epidote. The extensive alteration of the biotite indicates that the rock has undergone considerable re-adjustment after reaching almandine-amphibolite grade. Magnetite and pyrite are common accessories, and a little apatite is also present.

The general strike of the banding of the gneiss in the north-western part of the peninsula is east-west, and the dip is to the north at 60° to 80°. A folded zone, with a syncline overturned to the north, occurs along the northern side of the subsidiary peninsula on which the station is built.

Veins of creamy-coloured pegmatite up to 16 metres wide are common. Most are irregular in width, and they generally follow the banding of the gneiss, but cut across it in places. Parts of the pegmatite veins consist of medium-grained feldspar with minor quartz, and nebular patches of reddish brown garnet, but elsewhere the pegmatite is composed of quartz-feldspar intergrowths up to 30 cm across. Patches of fine-grained, almost felsic, material occur in the coarse-grained rock, parallel to the direction of strike.

A few thin veins of red coarse-grained granite were found in the gneiss.

Pyrite and chalcopyrite grains are abundant in the gneiss and pegmatite, and copper staining is a common feature, particularly in the gneiss.

In several places near the station, long straight veins of muscovite pegmatite cut across the other rocks. The veins were emplaced along faults trending north-west. The displacement of the faults is not known, but the direction of drag indicates that the horizontal component of movement was right-handed.

A mass of tephroite ($MnSiO_4$), about 3 metres across, occurs east of the station; rhodonite ($MnSiO_3$) and spessartite are common on its margins. A grab sample of the main tephroite mass was found to contain 39.1 percent manganese and 1.91 percent iron. Mason (1959) described the mineralogy and occurrence of the manganese-rich mass in detail.

Small veins and patches of rhodonite occur in strongly folded banded biotite-feldspar gneiss south of the four Jamesway huts east of the main station area. Several thin iron-stained quartz-rich veins with pyrite specks are associated with this occurrence.

Beall Island

Beall Island, a few miles south-west of Clark Peninsula, consists of gneiss like that of Clark Peninsula, but contains a higher proportion of acid material. The typical veins are medium-grained plagioclase-quartz-garnet rocks rather than pegmatite. The gneiss strikes about 090^{o}, but the dip is irregular.

Several vertical basalt dykes a few feet in width strike 130^{o}, and several narrow shear zones in the gneiss trend in the same direction.

The basalt (5573) is composed of labradorite (An67) laths and interstitial pyroxene (augite(?)) with a doleritic texture. About 3 percent of the rock consists of interstitial magnetite and a little pyrite.

Several pieces of highly saussuritized gabbro were found amongst the moraine on the island.

Warrington Island

Warrington Island is composed of massive light-coloured medium-grained equigranular granodiorite consisting of plagioclase, quartz, and scattered phenocrysts of potash feldspar containing numerous quartz inclusions. Small amounts of chlorite, magnetite, and, rarely, red garnet occur as faint bands striking 090^{o}, and dipping south at 70^{o}. Thin veins of coarse-grained feldspar and biotite trend both along and across the banding. A few thin veins of red alaskite containing some red garnet also cut the granodiorite.

Much of the island is covered by moraine. The debris ranges in size from sand to boulders a metre across, with a few large boulders.

Several valleys which trend west-north-west across the island and adjoining Pidgeon Island may represent shears.

Ardery Island

Ardery Island is made up of a uniform dark-coloured medium-grained porphyritic charnockite. Feldspar crystals, up to 2.5 cm long, form 5 to 10 percent of the rock, and show a rough platy alignment striking 115° and dipping south at 80°. The dark minerals form small patches elongated in the same direction.

The rock (5570) is a hornblende-biotite charnockite of adamellite composition, assigned to the granulite facies. The texture is heteroblastic, with large feldspar crystals set in a finer-grained matrix of ferromagnesian minerals, feldspar, and quartz. Andesine (An42) forms about 45 percent of the rock, and orthoclase about 30 percent. The feldspar is xenoblastic, the grains ranging from less than 2mm to 7mm; many show myrmekitic intergrowths. Both the andesine and orthoclase contain inclusions of quartz. The mafic minerals form about 8 percent of the rock. The chief mafic constituent is anhedral hypersthene with minor amounts of clinopyroxene. The hornblende is mostly uralitic and has been formed from pyroxene. Iron oxide is a common accessory, associated with the mafic minerals; apatite and rare zircon occur as inclusions in hornblende or biotite.

A few small round or oval inclusions composed predominantly of hornblende occur in the rock.

The age of a sample from this island (called quartz diorite by Robertson, 1961) was found to be 1075 ± 25 m.y. (Cameron, Goldich, & Hoffman, 1960).

Odbert Island

The rock on Odbert Island is a medium-grained gneiss containing feldspar crystals up to 2cm long.

It is a pyroxene-hornblende-biotite-quartz-feldspar gneiss (5569) and is assigned to the almandine-amphibolite facies. The texture is heteroblastic with coarser-grained feldspar and quartz partly enclosed by finer-grained ferromagnesian minerals and some fine-grained quartz and feldspar. Microcline, perthite, and andesine (An40) form about 75 percent of the rock. Most of the feldspar grains are between 18mm and 5.8mm in diameter. The plagioclase is xenoblastic: some grains are zoned, and many show myrmekitic intergrowths. Hornblende and biotite are generally interstitial. Augite forms less than 1 percent of the rock, and some of it has been altered to hornblende. Accessory apatite, zircon, and opaques occur, and are associated with the ferromagnesian minerals.

Parallelism of the coarse-grained quartz and feldspar grains and biotite-rich lenses imparts a foliation striking 085° and dipping south at 85°. The gneiss is cut by several medium-grained veins composed of plagioclase, quartz, and a small amount of biotite. These veins have an easterly trend, and are approximately horizontal.

Despite a close aerial examination, the altered diabase dykes described by Robertson (1961) could not be located. However, in the position of the northernmost dyke, there are two masses of dark fine-grained to medium-grained rock, each irregular in shape, about 3 metres wide and 6 to 9 metres long. These dark rocks are cut by numerous coarse-grained feldspar-quartz veins, and by medium-grained granite veins, some of which carry small amounts of magnetite. The rock (8379) is a granoblastic to poikiloblastic aggregate of labradorite, greenish brown hornblende, orthopyroxene, clinopyroxene, and magnetite. Most of the clinopyroxene occurs as remnants of large grains which have been partly replaced by the hornblende and magnetite.

The country rock on Odbert Island is mineralogically and texturally similar to that on Ardery Island, and Robertson (1961) equated the two. However, they differ in that the Odbert Island gneiss contains perthite, only a small amount of augite is present, and hypersthene is absent. The Ardery Island rock has the typical dark colour of charnockite, whereas the Odbert Island rock has the grey colour of a normal granite, with white or pale grey feldspars.

Robinson Ridge

Robinson Ridge, a small promontory of rock and ice projecting from the coastline in the central part of the Windmill Islands, consists of granodiorite gneiss flanked by quartz-biotite-feldspar gneiss. The latter is strongly banded, with well-defined bands, from 1 to 5 cm wide. The bands consist of plagioclase and quartz with minor biotite alternating with bands of plagioclase and biotite with minor quartz; the biotite is completely chloritized. The gneiss displays many small tight folds. On the southern side of the ridge the general strike is 130° and the dip 60° to the south.

The granodiorite gneiss is a medium-grained rock not unlike the gneiss on nearby Odbert Island. A vertical foliation, striking 095°, is marked by the alignment of small elongate concentrations of biotite, scattered coarse crystals of feldspar, and small lenticular inclusions of fine-grained feldspar-biotite rock. Near the contact with the banded gneiss, the granodiorite gneiss is darker, richer in biotite, and almost devoid of quartz.

Near the northern contact between the banded gneiss and granodiorite gneiss, a thin sinuous pegmatite vein cuts the gneisses, and a small body of unaltered amphibolite was also noted.

The granodiorite gneiss appears to intrude the banded gneiss. For a distance of 9 metres from the contact, the banded gneiss is rather coarser in grain and it contains a network of veins of coarse-grained granite and veins and masses of biotite-rich quartz diorite.

Ford Island

Ford Island consists of several varieties of granitoid rocks which appear to have been emplaced as separate phases. The most common type is porphyritic, with tabular potash phenocrysts in a fine-grained to medium-grained matrix of feldspar, quartz, biotite, and a little red garnet and magnetite. Most of the rock is stained by limonite. The phenocrysts generally form about 20 percent of the rock, but in a few places the proportion is only 5 percent, and garnets and limonite staining are rare. The junction between the typical porphyritic rock and the less porphyritic is sharp, with stringers of the former in the latter.

Other varieties found include a coarse-grained alaskite composed of pink feldspar and quartz, and a rock, not unlike some found on Herring Island, with brown feldspars and a faint greenish blue tinge to some of the quartz. No chilled margins were observed at the contact between the different types. The feldspar phenocrysts are generally similar in appearance in the various phases.

The parallel orientation of the feldspar phenocrysts imparts a vertical foliation striking 020°. Several small irregular veins of pegmatite, one rich in muscovite, intrude the granitoid rocks.

Webb et al. (1964) measured the age of a specimen of hypersthene adamellite from Ford Island as 1110 m.y.

In 1956 uniformly high readings were observed over Ford Island during an airborne scintillograph survey by ANARE. According to Dr Law (pers. comm.) the count-rate changed abruptly over the coastline. Examination with a portable ratemeter in 1960 showed that the background count was slightly higher on the island than in other parts of the Windmill Islands, but no concentrations of radioactive minerals were found. The high scintillation counter readings are attributed to the total effect of the radioactive accessory minerals in the granitoid rocks.

Cloyd Island

Cloyd Island is composed of massive and slightly foliated, coarse-grained granitoid rock. The strike of the foliation is 160° and the dip is vertical. Quartz veins and thin dykes of pegmatite and aplite occur throughout. The pegmatite is commonly zoned, with coarse feldspar in the centre and finer-grained quartz and feldspar in the outer zones. Most of the pegmatite veins are parallel to the foliation of the country rock.

Pods of richly garnetiferous pegmatite, up to 30 cm long, were noted, also wispy and pod-like biotite-rich inclusions.

The bulk of the rocks on Ford Island closely resemble those on Cloyd Island, and they also resemble the granodiorite on Warrington Island and the granitoid rock on Honkala Island. All the intermediate to acid igneous rocks in the Windmill Islands are probably part of an intrusive stock, or phases of the same igneous episode.

Herring Island

Herring Island is composed of dark fine-grained to medium-grained granulite, and coarser quartz-feldspar gneiss with a more granitic texture.

> The granulite (5571) is a hornblende-pyroxene-labradorite granulite, assigned to the hornblende-granulite subfacies of the granulite facies. (Under earlier classifications the rock would have been termed a 'basic charnockite'). The texture is granoblastic. The rock contains about 55 percent labradorite and 45 percent ferromagnesians. The labradorite (An56) grains have an average diameter of about 1.0mm. Pyroxenes and green-brown hornblende are present in about equal proportions. The pyroxenes, in order of abundance, are hypersthene, augite(?), and enstatite(?). Quartz is rare; so too is biotite, which probably formed retrogressively from hornblende. The accessories include abundant iron oxide and rare apatite and zircon.

The granulite generally has a uniform texture. In places, small coarse-grained masses of feldspar and biotite occur, and small segregations of biotite and sillimanite are locally abundant. The gneiss has a poorly defined foliation striking 160° and dipping west at 80°. A variety with less biotite contains small elongate lenses of feldspar or masses of pink granite with chloritized biotite, and has a lineation plunging south at 70°.

The quartz-feldspar gneiss is a medium-grained equigranular rock composed of quartz and brown feldspar, with very minor biotite and iron oxide. The relationship of the quartz-feldspar gneiss to the granulite is unknown. In the south, the quartz-feldspar gneiss contains bands of a massive medium-grained rock with brown feldspar up to a centimetre across, pale greenish blue quartz, and minor biotite. This brown rock contains feldspar-pyroxene veins, and irregular masses of a lighter-coloured rock, composed mainly of feldspar and biotite, in which the foliation strikes 010^{o} and dips east at 80^{o}.

In several places the granulite contains green copper staining.

Løken Moraines

The Løken Moraines are the lines of shear moraine inland behind Clark, Bailey, and Mitchell Peninsulas, and Robinson Ridge (Pl. 4, fig. 1). They are thought to represent the edge of the continental ice sheet.

A description of the various types of rock in the moraine has been given by Robertson (1961). The only additional type noted is a pink epidote-quartz-feldspar hornfels composed of small grains of feldspar and quartz set in a fine crystalline groundmass; epidote is common along joints.

The epidote-quartz-feldspar hornfels (9528) has a blastoporphyritic or porphyroblastic texture, with medium-grained crystals of microcline and subordinate quartz; both minerals have sutured margins. The matrix has a hornfelsic texture, and the quartz occurs as inclusions in a mosaic of interlocking feldspar crystals. The estimated mineralogical composition is: epidote 5 percent, quartz 30 percent, and feldspar 65 percent. Fine to medium grains of epidote are scattered through the matrix and a later generation occurs as fine grains in irregular fractures cutting the rock. Microcline occurs as porphyroblasts up to 1.2mm in diameter, and in the matrix, and albite(?) is also present in the fine-grained matrix. The accessories are rare apatite and sphene.

The rock has been altered by thermal metamorphism. It is not known whether the original rock was a sediment or a quartz porphyry.

SOUTHERN VINCENNES BAY

Three groups of rock outcrops occur near the head of Vincennes Bay, about 60 miles (100km) south-west of Wilkes. ANARE visited the area early in 1960 (Law, 1962). The Hatch Islands were not examined, but visits were made to Ivanoff Head and to the Davis Islands, some 20 miles (32km) to the north-west. No geological work had previously been done in the area.

Ivanoff Head

Ivanoff Head is situated at latitude 66^{o}53'S., longitude 109^{o}08'E. The outcrop is about 300 metres long and 150 metres wide, and rises about 30 metres above sea level. It is joined to the edge of the continental ice sheet by a narrow low-lying isthmus strewn with moraine.

The rocks are predominantly medium-grained grey quartz-diorite gneiss, which contains lenses and layers of fine-grained banded quartz-biotite-plagioclase gneiss.

The quartz-diorite gneiss (5562) is composed of biotite, pyroxene, quartz, and feldspar. The texture is metamorphic and the rock is assigned to the granulite facies. The rock contains about 45 percent plagioclase (An37), 25 percent quartz, and 20 percent antiperthite. The texture is xenoblastic, but a few of the andesine crystals are subhedral; the grains range from 7.3mm to 0.3mm in diameter, with an average of 1.5mm. Some of the andesine is zoned; some shows myrmekitic intergrowths; and some has inclusions of plagioclase, quartz, and rarely biotite. The antiperthite is patchy and appears to have been formed by replacement. The hypersthene is xenoblastic and forms about 5 percent of the rock. The biotite is interstitial, and contains inclusions of apatite and zircon.

In the banded quartz-biotite-plagioclase gneiss the bands range from a few millimetres to several centimetres in width. Reddish brown garnet is common in parts of the gneiss. Some of the biotite-rich layers contain thin anastomosing veins of red feldspar, and also large red garnets. Many of the lenses of quartz-biotite-plagioclase gneiss do not show any banding, but contain feldspar porphyroblasts similar to the feldspars in the quartz-diorite gneiss.

The proportion of quartz-diorite gneiss to quartz-biotite-plagioclase gneiss differs from place to place, but the former is generally predominant. Where the two varieties of gneiss are interlayered, the quartz-diorite gneiss generally conforms to the foliation of the banded gneiss, but crosscutting offshoots are not uncommon. The margins of the tongues are irregular, with fingers projecting along the foliation of the banded gneiss. In places bands of quartz-diorite gneiss pinch and swell irregularly, producing a form of boudinage structure.

Ptygmatic feldspar veins and long thin veins of fine-grained quartz and feldspar cut across both quartz-diorite gneiss and banded gneiss.

The gneisses strike 120^{o} and dip south at 30^{o}.

On the north-west side of the peninsula, several dykes of fine-grained garnetiferous granite, composed of feldspar, quartz, pink garnet, and biotite, cut the gneisses. One of the dykes, which is 1.25 metres wide, is cut by a dyke of pegmatite containing pink and white feldspars, quartz, and some biotite. Thin tongues of pegmatite project into the granite.

One dyke of porphyritic basalt, 1.5mm wide and striking east-south-east, was found intruding the gneisses.

Bands of shear moraine are clearly exposed in the ice cliffs on the southern side of the isthmus. Moraine is piled along the foot of the cliff. Some boulders in this debris are up to 2 metres across, but most are less than 30 cm in diameter; sand and rock flour are common. The morainal material at the foot of the cliff is angular, but most of the boulders on the low-lying isthmus have been rounded by wave action during a period of higher sea level.

The most common lithological type in the moraine is a pink coarse-grained biotite granite with large feldspar phenocrysts and abundant zircon; this type was not found in situ on the peninsula. The quartz-diorite gneiss and quartz-biotite-plagioclase gneiss forming the peninsula are rare in the moraine, but fine-grained massive biotite hornfels occurs. A notable rock type is a red or purple fine-grained feldspathic quartzite, most fragments of which appear to have been slightly metamorphosed.

The quartzite (9533) is composed of about 85 percent quartz and 15 percent feldspar. The grains range in diameter from 0.7mm to 0.5mm; they are subangular to rounded, and are cemented by overgrowths of quartz, and recrystallized sericitic matrix. The feldspar has altered to sericite and kaolinite. Detrital iron oxide, zircon, tourmaline, biotite, and muscovite are present. Many of the quartz and feldspar grains are coated with hydrated iron oxide.

Several pieces of trachyte were also found in the moraine; some consist of plagioclase phenocrysts in a reddish brown fine-grained matrix, others are uniformly fine-grained (5563, 5564).

The trachyte is composed mainly of fine-grained laths of albite, with interstitial magnetite or hematite, and a few fine crystals of diopside (?). Some of the plagioclase laths are partly coated with goethite.

Davis Islands

The Davis Islands lie near the coast on the west side of Vincennes Bay at latitude 66°40'S., longitude 108°26'E. The group consists of half a dozen islands, the largest of which (Hudson Island) is 1½ km long and 400 metres wide; the others are much smaller.

Hudson Island is made up of several types of granitoid rocks; the contacts show no sign of chilling. A massive porphyritic biotite adamellite, with pink feldspar phenocrysts in a medium-grained matrix, is predominant.

The adamellite (SQ48-49/11/1, originally 5565) contains 35 percent quartz, 30 percent microcline, and 30 percent plagioclase. Plagioclase is sericitized and strongly zoned. Biotite is present as large books containing inclusions of apatite and possible zircon. Sphene occurs as unusually large grains, and a little iron oxide is present.

The inclusions in the adamellite display all stages of granitization from fine-grained biotite-rich types to granites with a finer-grained texture than the host rock; however, the edges of all are well-defined, with no macroscopic gradation from inclusion to country rock. A chemical analysis of the adamellite is given in Appendix 1.

The second type of granitoid rock is similar mineralogically to the adamellite, but the texture is more equigranular because phenocrysts are much less common. Another variety, to the east of the highest point of the island, is a pink coarse-grained hornblende-biotite granodiorite with abundant accessory rutile(?) and few inclusions. The proportion of mafic minerals varies considerably, and in places the rock is composed almost entirely of quartz and feldspar.

In the centre of the island the porphyritic biotite adamellite is intruded by irregular masses of red medium-grained granite containing scattered plates of partly altered biotite. Nearby is a vein of coarse-grained rock consisting of red feldspar phenocrysts in a biotite-rich matrix; the vein is up to 10 metres wide, and has been eroded much more than the surrounding adamellite.

In places, the porphyritic biotite adamellite is weakly foliated: near the western end of the island the foliation strikes 110° and dips south at 80°. A few veins of white quartz and epidotized shears about 30cm wide trend about north-east.

The rock surfaces are well polished, and glacial striae and chatter marks are common; the direction of ice movement was towards the north.

Moraine is not common. It includes boulders of red partly recrystallized feldspathic sandstone similar to that in moraine on Ivanoff Head, Thompson Island, and the Windmill Islands. Other erratics found include impure chert or siliceous siltstone, and probable greywacke, both of which have been slightly metamorphosed, and a slightly recrystallized arkose. The arkose (9532) is composed of poorly sorted quartz (75 percent) and feldspar (25 percent), with clasts of feldspar up to 7mm in diameter set in a matrix of grains up to 1.3mm in diameter.

The chert (9529) was probably metamorphosed under synkinematic conditions and is therefore assigned to the greenschist facies. The specimen contains porphyroblasts of orthoclase and albite in a matrix of fine-grained to microcrystalline silica, chlorite, sericite, epidote, and occasional rounded grains of zircon. Silica forms about 90 percent of the rock. The chert is cut by veinlets of quartz with some carbonate and orthoclase.

The greywacke (9531) was probably originally composed of clastic quartz, subordinate feldspar, and composite grains of quartz and feldspar which range in diameter from less than 0.06mm to 1.5mm. The clastic fragments appear to have formed about 40 percent of the rock; the matrix apparently consisted of carbonate and argillaceous material. The rock is now composed of broken and unbroken quartz and feldspar grains in a matrix of clinozoisite and pistacite. Accessory sphene is abundant. The rock has been extensively sheared and crushed.

Several small lakes occur on the island. An analysis of the water from the westernmost is given below:

	gm/litre		gm/litre
Na^{+}	0.135	Cl^{-}	0.280
K^{+}	0.0037	SO^{--}	0.064
Ca^{++}	0.01	HCO_3^{-}	0.007
Mg^{++}	0.02		

Calculated total salts 0.520 gm/litre

Salts at 180° 0.514 gm/litre.

The other islands of the Davis group were examined from the air; they appear to consist of granitoid rocks similar to those on Hudson Island.

AGE MEASUREMENTS

Fourteen specimens from the Vincennes Bay region and Oates Land were dated by the Department of Geophysics, Australian National University. The measurements were made by the potassium-argon method, using biotite, except for the gabbro from Balaena Islands, for which plagioclase was used. The results are listed in Table 1. Details of the measurements are given elsewhere by Webb et al. (1964).

The results for the Vincennes Bay region are similar to those reported by Cameron et al. (1960), (1050 to 1120 m.y.), but are rather older than those (755 [731] to 1080 [1045] m.y.)* reported by Starik et al. (1960), and Ravich & Krylov (1964). The range in measured ages (1050 to 1140 m.y.) of the granitoid and metamorphic rocks found by Webb et al. is greater than the experimental error, and may indicate either a period of prolonged plutonic activity or variable argon loss during a mild reheating subsequent to the emplacement of the granitoid rocks.

The Cambrian age (510 m.y.) of the gabbro from the Balaena Islands was measured on feldspar, and must be regarded as a minimum pending confirmatory work.

The results from the Oates Land rocks fall into two groups. The ages of 420 and 450 m.y. for rocks from the Wilson Hills are about the same (450 [434] to 480 [463] m.y.) as those found by Russian workers (Ravich & Krylov, 1964), and indicate an Ordovician age for the latest metamorphic event in this region.

The ages of 344 and 356 m.y. for the adamellite from Nella and Thala Islands indicate that the rocks were emplaced in Devonian to Carboniferous times. A Carboniferous age (325 and 330 [318] m.y.) was also obtained for granites from Sputnik Islands and Znamensky Island, 60 and 100 miles (100 and 160 km) to the west, by Russian workers (Ravich & Krylov, 1964).

---

* Different constants for the disintegration of 40K have been used by various workers in calculating the ages of specimens from Antarctica. Picciotto & Coppez (1963) have, where possible, recalculated all available ages for Antarctic rocks, using the same constant. Where the recalculated age differs significantly from the original figure, it is shown in square brackets.

TABLE I - POTASSIUM-ARGON AGE MEASUREMENTS

BMR NO.	ANU NO.	ROCK	LOCALITY	AGE m.y.
SR58-59/10/1	GA742	Biotite adamellite	Nella Island	344
SR58-59/10/2	GA743	Biotite adamellite	Thala Island	356
SR56-57/8/1	GA384	Biotite-quartz-feldspar gneiss	Parkinson Peak	450
SR56/57/7/1	GA385	Muscovite-biotite granite	Westernmost of Aviation Islands	420
SQ48-49/12/1	GA739	Gabbro	Southernmost of Balaena Islands	510
SQ48-49/12/2	GA740	Biotite adamellite	Island 1 mile east of Thompson Island, Balaena Islands	1110
SQ48-49/12/3	GA741	Biotite adamellite	Thompson Island, Balaena Islands	1060
SQ48-49/11/10	GA737	Sillimanite-biotite-cordierite schist	Nelly Island, Frazier Islands	1130
SQ48-49/11/11	GA738	Garnet-biotite granulite	Charlton Island, Frazier Islands	1050
SQ48-49/11/8	GA735	Biotite-plagioclase schist	Chappel Island, Donovan Islands	1050
SQ48-49/11/9	GA736	Garnet-sillimanite-cordierite-biotite gneiss	Lilienthal Island, Donovan Islands	1140
SQ48-49/11/7	GA734	Biotite-plagioclase gneiss	Berkley Island, Windmill Islands	1080
SQ48-49/11/3	GA733	Hypersthene adamellite	Ford Island, Windmill Islands	1110
SQ48-49/11/1	GA383	Biotite adamellite	Hudson Island, Davis Islands	1070

REGIONAL CORRELATIONS

The detailed descriptions provide a basis for regional correlation, but because of the great distances between outcrops and the reconnaissance nature of the survey, the conclusions regarding the regional relationships and origin of the major rock units are only tentative.

Eastern Oates Land

The metasediments of the greenschist facies in the Cape North area can be correlated fairly confidently with the Robertson Bay Group (Grindley & Warren, 1964), which has been described by Harrington et al. (1964) and Le Couteur & Leitch (1964) in the Tucker Glacier/Cape Hallett region about 150 miles (240 km) south-east of Cape North. In this region, the Group is composed mainly of alternating greywacke and argillite, which have been regionally metamorphosed to the greenschist facies with a well developed cleavage. In both places, the rocks are strongly folded on north-west lines, but in the Cape North area the folds plunge to the south-east at 30°, whereas in the Tucker Glacier/Cape Hallett region they are horizontal. In the Tucker Glacier/Cape Hallett region the metasediments have been thermally metamorphosed by the intrusion of the Tucker Granodiorite, but in the Cape North area the granitoid rocks are only presumed to be later than the metasediments.

The metasediments of the Cooper Bluff area also are tentatively correlated with the Robertson Bay Group. The metasediments, which were originally pelitic, are well bedded and have a north-west trend (but folding was not seen), and possess a well-developed cleavage. If the recrystallization under thermal conditions, which is apparent in the specimens, occurred as the final phase of regional metamorphism, correlation of these rocks with those of Cape North implies an increased grade of metamorphism towards Cooper Bluffs compared with the Cape North area. Alternatively, the thermal metamorphism may have been a later episode associated with the emplacement of the granitoid rocks and the grade of regional metamorphism would be the same at Cape North as at Cooper Bluffs.

The adamellite of the Cape North area can be correlated with the adamellite on Sputnik Island, and also with the biotite-hornblende granite on Znamensky Island near Rennick Bay, described by Klimov & Soloviev (1958b). The potassium-argon ages of 330 [318] m.y. and 325 m.y. for rocks from Znamensky Island and Sputnik Island (Ravich & Krylov, 1964) are comparable with the ages of 344 and 356 m.y. (Webb et al. 1964) for the adamellite from Nella Island and Thala Island, near Cape North.

These granitoid rocks can also be tentatively correlated with the Tucker Granodiorite (Grindley & Warren, 1964). The rocks in both regions are massive, and intrude folded and cleaved metasediments which appear to be part of the same unit. The Tucker Granodiorite is typically a hornblende-biotite granodiorite, with plagioclase of composition about An50, but the typical rock in the Cape North area is biotite adamellite, with plagioclase of composition about An35, and Sputnik Island is also a biotite adamellite, but with plagioclase of composition about An50.

The age measurements indicate that the granitoid rocks are Carboniferous, and therefore the Tucker Granodiorite, if it can be correlated, is also Carboniferous. The age of the folding of the metasediments is not known. As the granitoid rocks do not show signs of widespread shearing, it appears that the metasediments were folded before the granitoid rocks were emplaced. Le Couteur & Leitch (1964) thought that the folding in northernmost Victoria Land was possibly synchronous with, or even later than, the formation of the Kukri Peneplain (Grindley & Warren, 1964), which is so well developed farther south in the Trans-Antarctic mountain system, and which had probably been formed by the beginning of the Devonian. Ravich & Krylov (1964) quote the age of phyllite from near the Zykov Glacier (lat. $70\frac{1}{2}^{o}$S., long. 164^{o}E.), considered by Soloviev (1960) to be equivalent to the Robertson Bay Group, as 435 [420] and 425 [410] m.y., i.e., Silurian.

The age of deposition of the Robertson Bay Group is not definitely known. In the upper Tucker Glacier area, where the Group is overlain by at least 1800 metres of predominantly nonmarine quartzose sediments, Le Couteur & Leitch (1964) suggest that deposition began in late Precambrian times and did not continue beyond the Cambrian. Grindley & Warren (1964) thought that the Robertson Bay Group was in part younger than the Berg Group - a sequence of metasediments in western Oates Land (Soloviev, 1960) which seems to be of uppermost Precambrian or Cambrian age.

Wilson Hills

The predominant rock type in the western Wilson Hills is a banded biotite-quartz-plagioclase gneiss which has been invaded by irregular granitic veins, which in places are so abundant that only remnants of gneiss remain. The veins seldom grade into gneiss, and it is uncertain whether they are igneous or metamorphic in origin.

The xenolith-rich adamellite at Mount Ellery was not visited by either author. The high proportion of xenoliths (25 percent) and their schistose nature, suggests that the adamellite is related to the granitoid rocks in the Wilson Hills to the west, rather than to those farther east in Oates Land.

A feature of the high-grade metamorphic rocks in the coastal region of Oates Land is the absence of calcareous varieties - the country rocks are invariably biotite-quartz-plagioclase gneiss. The uniformity of the metamorphic rocks over a wide area suggests that the original sediments formed a thick sequence of uniform composition. If the analysis of the banded gneiss is assumed to be typical, the high silica content indicates a high proportion of quartz in the original sediments, and the bulk composition was probably similar to that of a subgreywacke as defined by Pettijohn (1957).

These rocks are part of the Wilson Group of Klimov & Soloviev (1958b). Soloviev (1960) drew the meridional boundaries of the Group along the Pennell Glacier ($157\frac{1}{2}^{o}$E.) on the west, and along a line due south from Rennick Bay, i.e., the Rennick Glacier ($161\frac{1}{2}^{o}$E.), on the east. He considered that the boundaries 'have a tectonic (faulted) character and are determined clearly'. The position of the western boundary is debatable, because high-grade metamorphic rocks occur at Magga Peak on the western edge of the glacier, and on the air-photographs the mountains west of the Pennell Glacier have the same appearance as the high-grade metamorphic rocks on the east side of the Glacier.

The Rennick Group, which has been mapped along the western margin of the upper part of the Rennick Glacier, and extends south to about latitude 73^{o}S., consists predominantly of muscovite-biotite schist intimately invaded by granitic rocks (Gair, 1964); and Welcome Mountain (lat. 72 $1/4^{o}$S., long. 160 $1/4^{o}$E.) is described as quartz-feldspar schist and gneiss invaded by granitic rocks (Weihaupt, 1961). These high-grade metamorphic rocks may be related to those of the coastal part of the Wilson Hills, and we agree with Grindley & Warren (1964) that the high-grade metamorphic rocks are probably continuous along the full length of the western margin of the Rennick Glacier, and that the name Wilson Group is appropriate for all occurrences of intimately mixed granitic and metasedimentary rocks in this region.

Ages of specimens from the Wilson Hills have been measured as 420 and 450 m.y. (Webb et al., 1964), and 450 [434], 475 [458], and 480 [463] m.y. (Ravich & Krylov, 1964). Despite the Ordovician ages, most workers (including the present authors) consider that the rocks of the Wilson Group are Precambrian, and that the measured ages reflect a Lower Palaeozoic orogeny. High-grade metamorphic rocks at many places in the Antarctica shield also have apparent lower Palaeozoic ages: in Oates Land and Dronning Maud Land, low-grade metamorphic rocks also occur in the region, and it is possible that the measured age of the high-grade rocks represents the age of the later period of low-grade metamorphism. This hypothesis is supported by the presence of biotite, and the almost complete alteration of the pyroxene, in the basic dyke on Cook Ridge, which suggests that the rock has been slightly metamorphosed after intrusion, and also, that the dyke should not be correlated with the Jurassic Ferrar Dolerites (Grindley & Warren, 1964) of the Ross Sea region, and that it is Ordovician or older.

Further work is required to determine whether the Wilson Group is part of the shield area of Antarctica or a separate metamorphic zone bordering the Ross Sea in Victoria Land. Gravity and magnetic observations near the coast indicate a major structural break roughly coincident with longitude 155^{o}E., about 50 miles (80 km) west of the Wilson Hills. Ushakov (1960) considers that this break marks the transition from the shield area of East Antarctica to the Caledonian(?) fold zone bordering the Ross Sea. High-grade metamorphic rocks (the Nimrod Group of Grindley et al., 1964) occur to the west of the lower-grade metasediments of the Ross Supergroup in the Nimrod Glacier and Liv Glacier areas. These high-grade rocks are evidence for an orogenic episode at places as far south as latitude 85^{o}S., before deposition of the Ross Supergroup commenced.

Windmill, Balaena, Frazier, and Donovan Islands

Although many places in these island groups were visited, time did not allow any geological mapping. The rocks are predominantly high-grade gneisses. Biotite-rich gneiss, containing sillimanite and cordierite, is predominant in the north-west, and biotite gneiss predominates in the north-eastern part of the Windmill/Frazier/Donovan Islands area. The biotite-quartz-feldspar gneiss has been invaded by granitic and pegmatite veins. Granitoid rocks and rocks with charnockitic affinities are predominant in the central part of the Windmill Islands. The islands in the south were not examined. Ravich (1960) refers to bipyroxene gneiss and sillimanite-biotite-cordierite gneiss, and Ravich & Voronov (1958) to charnockitic granitoids, in the southern part of the group.

The biotite-quartz-feldspar gneiss of Clark Peninsula is distinguished from the gneiss in other areas described in this Report by the presence of significant amounts of potash feldspar and hornblende. The myriad discordant granite veins in the banded gneiss of the Wilson Hills do not occur at Clark Peninsula or Beall Island. The acid veins at Clark Peninsula and Beall Island are mostly thin and concordant with the banding of the gneiss, although large discordant bodies of pegmatite occur on Clark Peninsula. The retrogressive mineral changes in the gneiss on Clark Peninsula and in the charnockite of Ardery

Island are due either to a later, milder metamorphic episode or a prolonged waning in intensity of the metamorphism which formed the high-grade rocks.

The relationship between the large granitoid bodies and the gneisses is uncertain; on Robinson Ridge, the coarser-grained granodiorite gneiss appears to intrude the finer-grained banded gneiss. All the granitoid rocks examined are foliated. On Warrington, Ford, and Cloyd Islands the rocks have a granitoid texture, and the weak foliation is due to parallelism of feldspar phenocrysts. On Odbert Island and Robinson Ridge, the foliation is due to the parallel alignment of feldspar phenocrysts and the presence of oriented biotite-rich lenses; because these rocks have a more gneissic texture they have been described as gneiss. Except on Ford, Cloyd, and Herring Island, the trend of the foliation is about east-west, as in the gneisses in the north. Although the rocks are foliated the authors consider that the medium-grained and coarse-grained intermediate to acid rocks are probably all related and of igneous origin. They may have been emplaced and foliated during the period of metamorphism which formed the finer-grained gneisses.

Age measurements on the coarse-grained granitoid rocks and the fine-grained gneisses suggest that they are synorogenic. Webb et al. (1964) measured the age of adamellite from Ford Island as 1110 m.y.; the gneiss ranges from 1050 to 1140 m.y.; two samples of adamellite from the Balaena Islands, 25 miles (40 km) north-east of Wilkes, gave ages of 1060 and 1110 m.y. They point out that the spread is appreciably greater than the experimental error, and ascribe this to reheating at some subsequent time. Cameron et al. (1960) obtained ages of 1120 m.y., for contorted migmatite from a small unnamed island 5 miles (8 km) north of Wilkes, and 1050 and 1110 m.y. for quartz diorite from Ardery Island; but a garnet-biotite gneiss from Haupt Nunatak, some 20 miles (32 km) south of Wilkes, yielded an age of 950 m.y.

All these results were obtained from potassium-argon measurements on biotite; Cameron et al. (1960) made additional measurements by the strontium-rubidium method on the contorted migmatite, and obtained ages of 1110 and 1120 m.y. Russian potassium-argon measurements, using whole rock samples, gave an age of 1080 [1045] m.y. for leucocratic vein material in biotite-garnet gneiss, a range of 880 [852] to 954 [915] m.y. for acid charnockite (Ravich & Krylov, 1964), and a range of 755 [731] to 935 [905] m.y. for gneisses and a porphyritic granite (Starik et al., 1960). The whole-rock age of a rock apparently from Ardery Island* is given by Ravich & Krylov (1964) as 895 [866] m.y., while Cameron et al. (1960) measured the age, using biotite, as 1050 and 1110 m.y. Webb et al. (1964) ascribe the lower ages obtained by Russian workers to the loss of argon from the potash feldspars, which are known to leak argon more readily than the biotite.

The total extent of the gabbro in the Balaena Islands is not known. The age measurements of 510 m.y. shows that it is apparently much younger than the other rocks in the region. The relationship of the gabbro to the few basalt dykes in the Windmill Islands is unknown. Both gabbro and basalt consist of pyroxene and plagioclase, and the plagioclase in both has a similar composition (An67).

The sedimentary rocks found as moraine in the islands are discussed on p. 44.

---

* The location of Russian specimens can be deduced by comparing specimen numbers quoted by Ravich & Krylov (1964) with sampling sites shown in fig. 1 of Ravich (1960).

Southern Vincennes Bay

The banded gneiss on Ivanoff Head can probably be correlated with the biotite-quartz-feldspar gneiss in the Windmill Islands. It is distinguished by the almost complete absence of discordant quartzo-feldspathic veins. The banded quartz-biotite-feldspar gneiss is subordinate to medium-grained quartz-diorite gneiss; the bands are quite distinct, but the thickness and proportion of each type is variable. Locally, the quartz-diorite gneiss cuts across the strike of the banded gneiss, and the banded gneiss contains small vein-like off-shoots of quartz-diorite gneiss. The two gneisses have a similar mineralogical composition, except that biotite is only a minor constituent of the quartz-diorite gneiss. The petrographic evidence suggests that the quartz-diorite gneiss is of metamorphic origin, but intrusive contacts with the banded gneiss suggest that the quartz-diorite gneiss was partly mobilized.

The granitoid rocks of the Davis Islands were not seen in contact with other rocks, but the age of 1070 m.y. measured by Webb et al. (1964) suggests that they are closely related to the granitoid rocks of the Windmill Islands. The east-west trend of the weak foliation is similar to the trend in the Windmill Islands, and on Ivanoff Head.

The granitoid outcrops at the Snyder Rocks, about 20 miles (30 km) to the north-west of the Davis Islands (Vialov & Voronov, 1956), are probably related to the granitoid rocks in the Davis Islands, but at Snyder Rocks the trend of the foliation is north-north-east.

The basalt dyke on Ivanoff Head can probably be correlated with the basalt dykes in the Windmill Islands.

The trachytes in the moraine on Ivanoff Head are presumed to be of volcanic origin because of their very fine grainsize. As far as we know, this is the first record of trachytic rocks from this region of Antarctica.

The sedimentary rocks in the moraine on Ivanoff Head, and on Thompson and Hudson Islands, are similar to the erratics reported by Robertson (1961) in the Windmill Islands and by Vialov & Voronov (1956) at Snyder Rocks.

Most of the specimens are sandstone, but the erratics also include a micro-conglomerate containing fragments of quartz, feldspar, and granite, a slightly metamorphosed greywacke, and a chert. Feldspar occurs in small to moderate amounts in all the sandstones, and is common in the microconglomerate and metagreywacke. The sandstone is red or reddish purple, and is commonly silicified. The silicification may have been associated with diagenesis or it may have been due to slight metamorphism. In connexion with thin sections 9530 and 9533 (which were cut from rocks showing, in the hand specimen, the strongest silicification) Mr McCarthy of the Australian Mineral Development Laboratories writes: 'Mineralogical evidence appears to be the only type available. Just one mineral, sericite, seems likely to produce results. Both rocks contain newly crystallized sericite; it appears to be of three types:- (1) formed by alteration of feldspar, (2) formed by crystallization or recrystallization of detrital argillaceous mud in intergranular areas, and (3) formed by replacement of portions of rounded quartz grains. Type 3 is only present in specimen 9530. If sericite of types 1 and 2 is considered to be authigenic, then specimen 9533 has probably been silicified without metamorphism; research by Yoder & Eugster (1955) indicated that muscovite is an authigenic clay mineral in many sediments. Authigenic growth of muscovite is probably inadequate to explain the replacement of quartz by unoriented aggregates of sericite in specimen 9530.

Hydrothermal alteration appears unlikely, as the rock shows no zonal alteration. Metamorphism, if it accompanied silicification of specimen 9530, was only an incipient type.'

The only known sedimentary rocks in the Wilkes Land region of Antarctica are those at Mount Amundsen and Mount Sandow, two small nunataks south of the Bunger Hills and 250 miles (400 km) west of the head of Vincennes Bay. Voronov, Klimov, & Ravich (1959) describe the rocks as slightly metamorphosed argillites, siltstones, sandstones, and conglomerates of possible late Precambrian age. They appear to be similar to the rocks found as erratics on the islands in Vincennes Bay. The sediments on Mount Sandow are underlain with a stratigraphic break by greenschists, and Robertson (1961) found erratics of greenschist in the Windmill Islands.

Other Areas

The granodiorite at Penguin Point appears to be part of the same mass as the rocks at nearby Cape Bage and Cape Webb. Age measurements indicate that these rocks are appreciably older than the granitoid rocks near Cape North and at Sputnik Island and Znamensky Island. Ravich & Krylov (1964) found the ages of specimens (including xenoliths in the granite) from Cape Bage and Cape Webb to range from 470 [453] to 505 [487] m.y. These lower Ordovician ages are similar to those found by Deutsch & Webb (1964) for granitoid and metamorphic rocks from the McMurdo Sound region.

The outcrops at Davis Bay and Henry Bay are small and geographically isolated, and their regional relationships are uncertain. Ravich & Krylov (1964) quote ages of 700 [675] and 755 [731] m.y. for rocks from Henry Bay. Ages of this magnitude have been recorded from only a few localities in Antarctica, mostly in the vicinity of the Bunger Hills, more than 500 miles (800 km) west of Henry Bay. Age determinations are not available for the rocks in the Davis Bay area. The gneisses on Lewis Island in Davis Bay probably have a similar origin to those on Ivanoff Head.

ACKNOWLEDGEMENTS

We have pleasure in acknowledging the assistance given by Dr P.G. Law, lately Director of the Antarctic Division of the Department of External Affairs, who led the expeditions, and took an interest in the work at all times. The achievements during the coastal exploration were due in no small measure to his perseverance in the face of many difficulties. The work could not have been done without the co-operation of the helicopter pilots (Captains R. Hudson and P. Ivanoff in 1960, and Captains J. Stanwyx and J. Arthurson in 1961 and 1962), who had to operate in difficult and, at times, dangerous flying conditions. Assistance in various aspects of the work was given by many other members of the expeditions, particularly the surveyors, D.P. Cook and S. Kirkby.

REFERENCES

CAMERON, R.L., GOLDICH, S.S., and HOFFMAN, J.H., 1960 - Radioactivity age of rocks from the Windmill Islands, Budd Coast, Antarctica. Acta Univ. Stock. (Stock. Contr.Geol.), 6(1), 1-6.

CROHN, P.W., 1959 - A contribution to the geology and glaciology of the western part of Australian Antarctic Territory. Bur.Min.Resour.Aust.Bull. 52.

DEUTSCH, SARAH, and WEBB, P.N., 1964 - Sr/Rb dating on basement rocks from Victoria Land; evidence for a 1000 million year old event. In ANTARCTIC GEOLOGY, 557-562. North-Holland, Amsterdam.

FYFE, W.S., TURNER, F.J., and VERHOOGEN, J., 1958 - Metamorphic reactions and metamorphic facies. Mem.geol.Soc.Amer., 72.

GAIR, H.S., 1964 - Geology of the Upper Rennick, Campbell and Aviator Glaciers, northern Victoria Land. In ANTARCTIC GEOLOGY, 188-198. North-Holland, Amsterdam.

GRINDLEY, G.W., and WARREN, G., 1964 - Stratigraphic nomenclature and correlation in the western Ross Sea region. In ANTARCTIC GEOLOGY, 314-333. North-Holland, Amsterdam.

GRINDLEY, G.W., McGREGOR, V.R., and WALCOTT, R.I., 1964 - Outline of the geology of the Nimrod-Beardmore-Axel Heiberg Glaciers region, Ross Dependency. Ibid., 206-219.

HARRINGTON, H.J., WOOD, B.L., McKELLAR, I.C., and LENSEN, G.J., 1964 - The geology of the Cape Hallett-Tucker Glacier district. In ANTARCTIC GEOLOGY, 220-228. North-Holland, Amsterdam.

KLIMOV, L.V., 1960a - The gneiss complex of the eastern Wilson Hills, Oates Coast. In Collected Pap. Antarctic Geol., Pt 2. Sci.Invest.Inst.Arctic Geol., 113, 82-97 (in Russian).

KLIMOV, L.V., 1960b - Granites of the coastal part of Ainsworth Bay (King George V Coast). Ibid., 123-146 (in Russian).

KLIMOV, L.V., RAVICH, M.G., and SOLOVIEV, D.S., 1964 - Geology of the Antarctic platform. In ANTARCTIC GEOLOGY, 681-691. North-Holland, Amsterdam.

KLIMOV, L.V., and SOLOVIEV, D.S., 1958a - A preliminary communication about geological observations in the Eastern Antarctic. Inf.Bull.Sov.Antarctic Exped., 1, 27-30 (transl.).

KLIMOV, L.V., and SOLOVIEV, D.S., 1958b - Some geological features of the littoral of Wilkes Land, of King George V Coast and Oates Coast (East Antarctica). Dokl.Acad. Nauk SSSR, 123(1), 141-144 (in Russian).

LAW, P.G., 1958 - Australian coastal exploration in Antarctica. Geogr. J., 124 (2), 151-162.

REFERENCES (Cont'd)

LAW, P.G., 1962 - New ANARE landings in Australian Antarctic Territory 1960. Ibid., 128 (2), 174-183.

LAW, P.G., 1964 - The exploration of Oates Land, Antarctica. ANARE Rep.Ser.A., 1.

Le COUTEUR, P.C., and LEITCH, E.C., 1964 - Preliminary report on the geology of an area south-west of upper Tucker Glacier, northern Victoria Land. In ANTARCTIC GEOLOGY, 229-236. North-Holland, Amsterdam.

MASON, B.H., 1959 - Tephroite from Clarke Peninsula, Wilkes Land, Antarctica. Amer.Miner., 44, 428-430.

McLEOD, I.R., 1964a - An outline of the geology of the sector from longitude 45°E to 80°E, Antarctica. In ANTARCTIC GEOLOGY, 237-247. North-Holland, Amsterdam.

McLEOD, I.R., 1964b - Geological observations in Oates Land. Ibid., 482-486.

McLEOD, I.R., and TRAIL, D.S., (in prep.) - Bur.Min.Resour.Aust.Bull.

NOCKOLDS, S.R., 1940 - Petrology of rocks from Queen Mary Land. Aust. Antarctic Exped., 1911-14, sci.Rep., Ser.A. (2), 19-86.

PETTIJOHN, F.J., 1957 - SEDIMENTARY ROCKS (2nd ed.). N.Y., Harper.

PICCIOTTO, E., and COPPEZ, A., 1963 - Bibliographie des mesures d'âges absolus en Antarctique. Ann.Soc.géol.Belg., 85 (1961-1962), bull.8, B263-308.

RAVICH, M.G., 1960 - Rocks of the Grearson Hills and the Windmill Islands (Grearson Oasis). In Collected Pap. Antarctic Geol., Pt 2. Sci.Invest.Inst.Arctic Geol., 113, 53-81 (in Russian).

RAVICH, M.G., and KRYLOV, A. Ya., 1964 - Absolute ages of rocks from East Antarctica. In ANTARCTIC GEOLOGY, 579-589. North-Holland, Amsterdam.

RAVICH, M.G., and VORONOV, P.S., 1958 - Geological structure of the coast of the East Antarctic continent (between 55° and 110° east longitude). Soviet Geol., 2 (1958) 3-26. (transl.).

ROBERTSON, R., 1961 - Preliminary report on the bedrock geology of the Windmill Islands. In Reports of Antarctic geological observations 1956-1960. IGY Glaciol.Rep.No.4., IGY World Data Centre 4: Glaciology. Amer.geogr.Soc., N.Y.

SOLOVIEV, D.S., 1960 - The Lower Palaeozoic slates of Oates Coast. In Collected Pap.Antarctic Geol., Pt 2. Sci.Invest.Inst.Arctic Geol., 113, 147-158 (transl. Introduction only).

STARIK, I.E., RAVICH, M.G., KRYLOV, A. Ya., and SILIN, Yu. I., 1959 - On the absolute age of rocks of the Eastern Antarctic platform. Dokl.Acad.Nauk SSSR, 126(1) 144-146 (transl.).

REFERENCES (Cont'd)

STARIK, I.E., RAVICH, M.G., KRYLOV, A. Ya., SILIN, Yu. I., ASTRASHENOK, L. Ya., and LOVTSYUS, A.V., 1960 - New data on the absolute age of rocks of the eastern Antarctic continent. Ibid., 134(6), 1441-1443.

SUMMERS, H.S., and EDWARDS, A.B., 1940 - Granites of King George Land and Adelie Land. Aust.Antarctic Exped. 1911-14, sci.Rep.Ser.A, 4 (3), 89-113.

TILLEY, C.E., 1940 - A group of gneisses (sillimanitic and cordieritic) from the moraines at Cape Denison, Antarctica. Aust.Antarctic Exped. 1911-14. sci.Rep.Ser.A, 4(10), 339-344.

USHAKOV, S.A., 1960 - Certain features of the geological structure of King George V and Oates Land coastal areas. Inf.Bull.Sov.Antarctic Exped., 18, 11-14 (trans.).

VIALOV, O.S., and VORONOV, P.S., 1956 - Granite outcrops on the Knox Coast in the Antarctic. Dokl.Acad.Nauk SSSR, 109(6), 1187-1190.

VORONOV, P.S., KLIMOV, L.V., and RAVICH, M.G., 1959 - Late Cambrian deposits from Amundsen and Sandow Mountains on Queen Mary Land in Eastern Antarctic. Izv. Acad.Sci.USSR, geol.Ser., 1959(3), 3-18.

WEBB, A.W., McDOUGALL, I., and COOPER, J.A., 1964 - Potassium-argon dates from the Vincennes Bay region and Oates Land. In ANTARCTIC GEOLOGY, 597-600. North-Holland, Amsterdam.

WEIHAUPT, J.G., 1961 - Geophysical studies in Victoria Land, Antarctica. Univ. Wisconsin, Dep.Geol.Res.Rep.1.

YODER, H.S., and EUGSTER, H.P., 1955 - Synthetic and natural muscovites. Geochim. cosmochim.Acta, (8), 225-280.

APPENDIX 1

CHEMICAL ANALYSES

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SiO_2	68.9	72.3	76.8	72.5	49.8	65.1	67.7	63.5	68.8	68.5	71.9	67.0	70.9	68.8
Al_2O_3	14.2	14.2	10.8	13.7	13.9	13.4	13.7	13.9	12.7	13.2	11.8	13.2	14.1	13.5
Fe_2O_3	0.50	0.41	0.59	0.43	2.00	3.05	2.50	2.35	1.36	0.90	1.55	1.73	1.00	1.01
FeO	3.00	3.20	2.72	1.62	10.5	3.05	2.80	6.90	5.75	5.25	5.60	4.75	1.44	3.65
MgO	1.26	1.09	1.20	0.52	5.75	1.26	0.83	2.95	2.20	2.20	1.87	2.45	0.72	0.82
CaO	2.45	2.40	1.73	1.25	10.4	3.45	2.55	1.30	2.25	2.40	1.60	2.65	2.70	2.90
Na_2O	3.15	1.37	1.94	2.20	2.50	2.70	2.55	3.60	2.15	2.35	1.37	2.45	3.70	2.55
K_2O	4.35	3.25	2.70	6.25	0.78	4.50	5.15	3.20	2.40	2.20	1.98	2.85	4.05	4.70
H_2O+	0.95	0.49	0.72	0.65	0.86	0.86	0.38	0.62	1.14	1.39	0.52	1.36	0.63	0.63
H_2O-	0.09	0.09	0.09	0.04	0.13	0.14	0.08	0.12	0.12	0.10	0.10	0.14	0.15	0.02
CO_2	0.12	0.02	0.13	0.03	0.48	0.19	0.05	0.03	0.12	0.12	0.04	0.10	0.17	0.04
TiO_2	0.53	0.55	0.46	0.35	2.15	1.08	0.90	1.44	0.84	0.86	1.14	0.75	0.36	0.76
P_2O_5	0.17	0.11	0.14	0.20	0.25	0.65	0.46	0.18	0.08	0.11	0.12	0.19	0.11	0.21
MnO	0.05	0.21	0.03	0.02	0.18	0.13	0.15	0.06	0.13	0.07	0.20	0.11	0.05	0.08
TOTAL	99.7	99.7	100.1	99.8	99.7	99.6	99.8	100.2	100.0	99.7	99.8	99.7	100.1	99.7

(1)x SR58-59/10/1. Biotite adamellite, Nella Island.

(2)+ SR58-59/10/2. Biotite adamellite, Thala Island.

(3)x SR56-57/8/1. Biotite-quartz-feldspar gneiss, Parkinson Peak.

(4)+ SR56-57/7/1. Muscovite-biotite granite, westernmost of Aviation Islands.

(5)x SR48-49/12/1. Gabbro, southernmost of Balaena Islands.

(6)x SQ48-49/12/3. Biotite adamellite, Thompson Island, Balaena Islands.

(7)+ SQ48-49/12/2. Biotite adamellite, island 1 mile east of Thompson Island, Balaena Islands.

(8)+ SQ48-49/11/10. Sillimanite-biotite-cordierite schist, Nelly Island, Frazier Islands.

(9)x SQ48-49/11/11. Garnet-biotite granulite, Charlton Island, Frazier Islands.

(10)x SQ48-49/11/8. Biotite-plagioclase schist, Chappel Island, Donovan Islands.

(11)+ SQ48-49/11/9. Garnet-sillimanite-cordierite-biotite gneiss, Lilienthal Island, Donovan Islands.

(12)x SQ48-49/11/7. Biotite-plagioclase gneiss, Berkley Island, Windmill Islands.

(13)x SQ48-49/11/3. Leucocratic hypersthene adamellite, north-west end of Ford Island, Windmill Islands.

(14)+ SQ48-49/11/1. Biotite adamellite, Hudson Island, Davis Islands.

x Analyst: H.W. Sears

\+ Analyst: C.R. Edmond.

14108/65.—4

PLATE 1

Fig. 1: Veins of coarse pink granite in banded biotite-quartz-feldspar gneiss on Parkinson Peak, Wilson Hills; the small dark patches in the granite are biotite clots. Fine-grained quartzo-feldspathic veins can be seen cutting the granitic veins.

Fig. 2: Irregular masses of granitic material in tightly folded biotite-quartz-feldspar gneiss on Parkinson Peak, Wilson Hills.

Fig. 1: Granite veins in fibrolite-mica-quartz-plagioclase gneiss on the westernmost of the Aviation Islands, off the Wilson Hills.

Fig. 2: Well-jointed massive granodiorite, Penguin Point, George V Land. Comparison with Plate 76, fig. 2 of Series A, Vol. 1 of the Scientific Reports of the Australasian Antarctic Expedition (a photograph taken from a similar viewpoint) shows that the joint patterns in the two photographs are almost identical, so that no large blocks have fallen from the bluff in the 50 years between the two visits.

PLATE 3

Fig. 1: Ice-smoothed slabs of granite gneiss, Henry Islands. Several thin feldspar veins can be seen in the centre of the photo.

Fig. 2: Odbert Island, showing typical Windmill Islands scenery - a shallow valley with steep rocky sides, partly filled with moraine and exfoliated rock detritus, and ridges with a fairly uniform summit level. The rock is medium-grained gneiss. (Photo by B.H. Stinear).

PLATE 4

Fig. 1: Shear moraine behind Clark Peninsula, looking south. The dark line in the far left distance is part of the moraine.

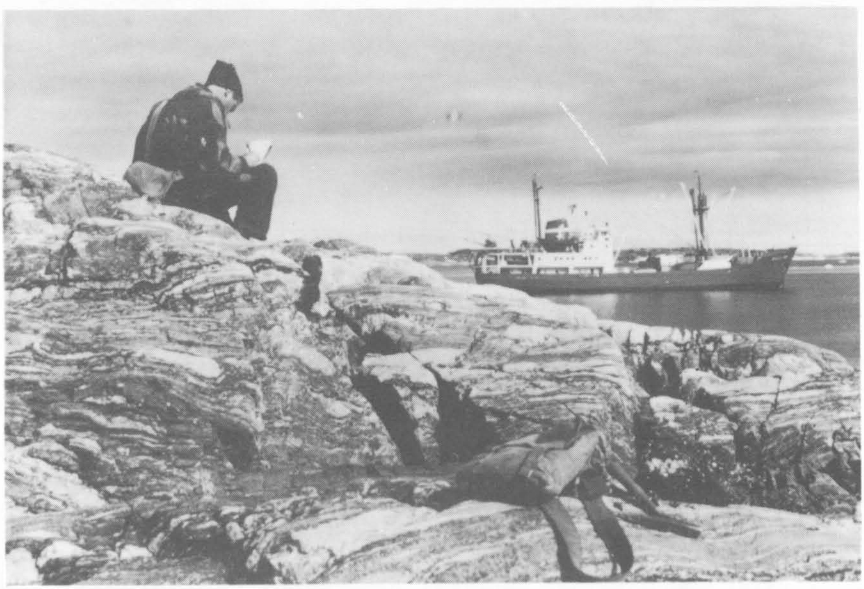


Fig. 2: Banded gneiss near Wilkes on Clark Peninsula. Thin quartzo-feldspathic bands and lenses are common to the right of the seated figure. (Photo by B.H. Stinear).