COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS:

1963/154

GEOLOGICAL RECONNAISSANCE IN ENDERBY LAND AND SOUTHERN PRINCE CHARLES MOUNTAINS, ANTARCTICA.

(Australian National Antarctic Research Expedition, 1960)

by

R.A. Ruker

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SUMMARY

During 1960 the Australian National Antarctic Research Expedition undertook two field trips to collect geological and geographical information in the interior of the Enderby Land Peninsula and in the southern Prince Charles Mountains. The rocks in Enderby Land (Napier Mountains) are charnockitic gneiss and quartz-feldspar-biotite gneiss grading into quartz-feldspar-pyroxene gneiss, and are intersected by amphibolite schist and pegmatite. Similar rocks have been recorded in neighbouring areas by I.R. McLeod and P.W. Crohn. Rocks in the southern Prince Charles Mountains (north of the Fisher Glacier) are of low metamorphic grade and are derived from sediments of a greywacke suite. At Mount Dummett and Mount McCauley they are intruded by a granite batholith. Sediments with Glossopteris were found in moraine at Mount Rymill, and boulders of hematite, in moraine, at Mount McCauley. The sources of these erratics are unknown. In view of these findings it is advisable that future geological activity be directed towards exploring the mountains south of Fisher Glacier. Four alternative routes across this glacier are suggested.

INTRODUCTION

In 1960 the Australian National Antarctic Research Expedition (A.N.A.R.E.) undertook two major field trips from Mawson in the Australian Antarctic Territory. The purpose was to collect geological and geographical information in Enderby Land, and in the southern Prince Charles Mountains (MacRobertson Land). Geological reconnaissances were also made of the Mawson Escarpment in MacRobertson Land and along the coast west of Casey Bay in Enderby Land. These localities were not previously visited and reconnaissance knowledge was required. The information in this report was collected by R.A. Ruker, the overall programme was prepared by the Bureau of Mineral Resources, and the A.N.A.R.E. organisation provided camping and transport facilities.

GENERAL

The first of the two major field trips was planned to explore the mountains in the interior of the Enderby Land Peninsula. For this purpose a party of three men, consisting of a geologist, surveyor and radio operator, spent 58 days in the field and travelled 180 miles under adverse weather conditions. Two dog teams were used for transport of supplies and equipment. The party landed from the ship "Thala Dan" on the coast 1 mile east of Cape Batterbee (Fig.1), travelled inland to the Napier Mountains, then continued through the Akers Peaks, and ended the journey at Styles Bluff in Edward VIII Gulf (Fig.2).

The second trip was designed to explore the southern Prince Charles Mountains. During the first phase of exploration a base camp was established 300 miles south of Mawson. This was accomplished after 45 days of travel by a party of 5 men who drove two tractor trains with equipment and supplies to an area suitable for aircraft landing at 72°30'S, 62°59'E. Extremely low temperatures were encountered (minimum temperature -68°F) and the weather conditions permitted an average of one day of travel in two.

The second phase consisted of geological reconnaissance of the following mountains: Mount Cresswell, Mount Rymill, Mount Seddon, Mount Dummett, Mount McCauley, and Mount Scherger. A "weasel" and a team of dogs were used for transport and the party of three men covered 200 miles in 30 days, travelling over a severely crevassed route.

A third phase envisaged crossing the Fisher Glacier and exploration of the area between Mount Menzies and Mount Rubin, but this phase was not carried out due to lack of time. An aerial reconnaissance was made over the Goodspeed Nunataks and one landing was made at Mawson Escarpment in the vicinity of 73°13'S, 68°15'E.

A geological reconnaissance of the Enderby Land coast close to the western boundary of the Australian Antarctic Territory was made from the M/S "Thala Dan" in the period 10th to 24th February, 1961. A number of outcrops were visited by motor boat and rock specimens collected in each locality.

Previous Work

The localities visited this year had not been examined before but geological information from neighbouring areas can be found in reports by McLeod (1959) and Crohn (1959). McLeod (1959) has studied the Tula Ranges and the Amundsen Bay area and Crohn (1959) reports on the Prince Edward VIII Gulf area and the Prince Charles Mountains. Descriptions of rocks collected at Proclamation Island are reported by Tilley (1937).

Samples

Typical rock specimens were collected from examined outcrops and later sent to the Australian Mineral Development Laboratories for petrographic examination. (Appendix I). The hand specimens are stored in the museum of the Bureau of Mineral Resources in Canberra under registered numbers 8832-8878.

Conditions of Travel and Means of Transport

Much time was consumed in overcoming travelling difficulties due to surface and climatic conditions. During the Enderby Land journey, deep snow and rafted sea ice made progress slow and the travelling rate was reduced to two days in three by blizzards and whiteouts. On the journey to the southern Prince Charles Mountains the travelling conditions were also severe. To make full use of the available daylight hours the party left Mawson at the end of August and therefore endured extemely low temperatures. Crevassed areas were met with in several places and two serious crevasse incidents occurred. (Figs. 9,20). High drift was common, and accounted for most of the unproductive days. The average rate of travel was one day in two over a period of four months.

During the year several means of transport were used. On the Enderby Land trip sixteen dogs pulled two sledges loaded with/total of 1600lb. The party lived in a tent.(Fig. 5). On the southern Prince Charles Mountains journey two D4 tractors were used to pull 5 two-ton sledges each, loaded with fuel, equipment and living caravans. Weasels and tractors were partly equipped for polar travel.

Access south of Fisher Glacier

Complete reconnaissance knowledge of the southern Prince Charles Mountains area should be gained by visiting the mountains south of Fisher Glacier. This becomes necessary particularly after the finding of sediments with Glossopteris at Mount Rymill and hematite at Mount McCauley in moraine of unknown provenance. The task of crossing the glacier was not carried out during 1960 but information which could be useful to future exploration is given here.

From the Base Camp established by the 1960 party four crossings are possible (Pl.2), they are described in order of personal preference which is the result of two air inspections from an average altitude of 2000 feet above the ground and of ground observation from a distance of up to 15 miles. The first route is between Mount Seddon and the western end of Mount Rubin. This route was observed during a reconnaissance flight (3rd December, 1960). Crevassing is present. The advantage of this route lies in the possibility of reaching Mount Seddon with heavy vehicles to establish the base camp close to the operative area. The second route was observed during the reconnaissance flight on the 2nd December, 1960, after a snowfall, and therefore should be negotiated with caution, and, is possible, following an air inspection.

This route lies in a straight line connecting Base Camp with the mountain glacier flowing from Mount Menzies and is the most direct approach to the area south of Fisher Glacier. A belt of crevassing close to Mount Menzies may force detouring towards Mount Mather or Mount Bayliss.

The third crossing starts at the gap between Mount Dummett and Mount McCauley and ends at Mount Bayliss. This possible route was examined from the distance from Mount McCauley and should not be attempted without air inspection.

The fourth route would lead westward from Goodspeed Nunataks and cross the Fisher Glacier above its "watershed". Nothing is known about the area, and an air reconnaissance is necessary.

REGIONAL GEOLOGY

The rock types encountered in Enderby Land and the coast west of Casey Bay have been previously found in adjoining areas and described by Crohn (1959) and McLeod (1959). They are high to medium grade metamorphic rocks. In the southern Prince Charles Mountains a suite of rocks of low metamorphic grade was found. It originated from a greywacke-sandstone assemblage and the generalised term quartzite has been used in this report. Other terminology used in this report is the same as applied by McLeod (1959).

The sporadic nature of the outcrops and the difficulty of correlating the rocks did not enable definition of formations and the following description is therefore made under geographical features.

ENDERBY LAND PENINSULA

Cape Batterbee

Along the coast of Enderby Land, approximately 10 miles east of Proclamation Island, a group of outcrops consists of two peninsulas, two inland hills and a dozen small islands. One of the two peninsulas is Cape Batterbee which rises several hundred feet above sea-level (Fig.6). The islands were not visited.

The country rock on Cape Batterbee is charnockitic granular gneiss (Fig.7), a dark grey rock containing feldspar, quartz, biotite and pyroxene. It shows banding due to varying concentrations of ferromagnesian minerals. Schistosity strikes east and dips vary from 10° to 40° northwards. Numerous sills and dykes of garnet-pyroxene-feldspar dolerite up to 30 feet thick intrude the inliers and are oriented at random (Sample R.8858). Contact metamorphism ~~not~~ was noticed along the walls of the dykes. Several dykes show superficial staining by secondary copper minerals.

The two inland hills are formed by the same country rock, and dolerite intrusions, and are surrounded by moraine. A variety of high grade metamorphic rocks is found in this moraine Charnockitic gneisses and quartz-feldspar gneisses predominate over acid augen-gneisses, garnetiferous granite gneiss, amphibolite and dolerite.

Mount Armstrong

This steep-sided peak is situated at 66°23'S, 53°13'E, and is one of the northern outcrops in the Napier Mountains. It rises approximately 500 feet above the plateau surface.

The outcrop is formed of coarse grained, dark grey hornblende-quartz-feldspar granulite (Sample R.8860).

The schistosity of the rock is not strongly developed. The outcrop is intensely jointed, folded and faulted. Preferential orientation of faulting and jointing was not observed.

Little moraine was found around the mountain; it was composed of fragments of local rock.

Mount Bennett

This rugged and steep-sided outcrop forms part of the Napier Mountains and is situated 10 miles south-east of Mount Armstrong. It is 2 miles long, 1 mile wide and it rises at least 500 feet above the plateau surface. Its top is outlined by a series of sharp ridges and pinnacles. A number of abandoned cirques have been observed on the sides of the mountain (Fig. 8).

Quartz-feldspar-biotite gneiss, grading into quartz-feldspar-garnet gneiss, forms this mountain (Sample R.8859). It is a hard, grey and pink rock, with well defined schistosity. The varying texture and amount of biotite, garnet and quartz produce banding in places. A superficial, dark brown and red patina of metallic oxides covers all exposed surfaces.

The outstanding feature of this outcrop is the quantity and the height of the morainic deposits. The mountain is surrounded by a thick layer of moraine arranged in four concentric rows. The moraine on the sides of the mountain rises to an estimated 300 feet above the plateau level, where it forms a flat terrace. This terrace is particularly well preserved on the saddles.

The structure of the mountain is complicated. The rocks have undergone intense folding and later jointing. Numerous quartz veins, up to 6 feet wide, intersect or follow the planes of schistosity. The strike and dip change from one outcrop to the next but the general strike is east with steep dips to the north. From the isolated information available it was not possible to form a structural picture of this part of the Napier Mountains.

East of Mount Bennett, the Napier Mountains are formed of a series of isolated peaks each a few hundred yards in extent and rising up to 300 feet above the plateau surface. One of these was visited and found to consist of quartz-feldspar-biotite gneiss with the same texturial and structural characteristics found at Mount Bennett.

Akers Peaks

The northernmost outcrop of Akers Peaks was visited. This ridge rises 300 feet above the ice sheet on the north side and 50 feet on the southern side. This difference in level of the ice sheet was observed in the vicinity of most outcrops in the Napier Mountains. It is probably due to the damming of the ice flow by the outcrops.

The rock forming this outcrop and other peaks in the area is charnockitic granular gneiss. Locally it is finely banded due to concentration of biotite. Lithologically the rock is similar to that at Cape Batterbee and to the rocks collected by B. Stinear in Magnet Bay, on the coast of western Kemp Land. Numerous quartz veins and some superficial copper staining were found. The rock is intensely jointed and the average strike is north-west with dips from 30° to 50° north-eastwards.

Martin Island to Kloa Point

Martin Island is situated on the north coast of Edward VIII Gulf, 500 yards from the edge of the ice sheet. It is 300 feet high with vertical cliffs falling to the sea and covers approximately 900 square yards.

The island is formed by hypersthene-quartz-feldspar charnockite (Sample R 8861) with bands of pyroxene gneiss which possibly derive from sills and dykes of basic igneous rocks (Sample R.8862). The charnockite is light grey and yellow, red on weathered surfaces. It is medium to coarse grained and the gneissosity is well defined. Dark bands are common due to varying concentration of hypersthene.

The pyroxene gneiss forms dykes of hard, dark green, medium to fine-grained rock with a poor gneissosity. The contacts between pyroxene gneiss and the intruded rock are well defined but no contact metamorphism is apparent. The dykes are up to a dozen feet wide, and numerous narrow veins extend into the intruded rock. Blue quartz in veins up to one inch thick is widespread.

Along the coast between Martin Island and Cape Gotley there are a dozen small, low-lying outcrops protruding from the edge of the ice sheet. The rocks are similar to the charnockite found at Martin Island. Microscopic analysis reveals differences in mineral content so that the rocks range from charnockite to quartz-feldspar-hypersthene gneiss. Further north, along the coast towards Styles Bluff, the reduction of pyroxene content and increase in quartz gives rise to quartz-feldspar-biotite gneiss (Sample R.8864) which alternates with quartz-feldspar-pyroxene gneiss (Sample R.8863). Both rocks are medium to fine-grained, finely banded and laminated. The strike is north-west with vertical dip. Styles Bluff is an island situated a few hundred yards from the coast; it is 100 feet high and covers approximately 1000 square yards (Fig.2). The rock is quartz-feldspar-biotite gneiss alternating with quartz-feldspar-pyroxene gneiss. The rocks are intruded by a pegmatite dyke composed mainly of quartz, orthoclase and biotite. Biotite crystals range up to several inches in diameter in the centre of the dyke. Minor garnet crystals are present at the margins of the dyke. Quartz veins extend from the margins of the dyke into the intruded rock.

Charnockitic gneiss with the same features as those described at Martin Island is present on the coast opposite Styles Bluff and in the Kloa Point and Kloa Rookery areas.

The general strike of gneissosity is east with moderate to steep dips to the north, but intense folding and faulting complicate the structure. Drag-folds and isoclinal folds are shown by the banding of dark minerals.

Cape Boothby was not visited but aerial observation indicates a rock type similar to that in the Kloa Point area, namely charnockitic gneiss with bands rich in pyroxene.

Amundsen Bay - Casey Bay area

Between 10th and 24th February, 1961, a geological reconnaissance was made from the M/S "Thala Dan", during which three localities in western Enderby Land were visited:

(A) Coast and islands west of Casey Bay in the vicinity of 67°39'S, 45°50'E, close to the western boundary of the Australian Antarctic Territory.

(B) Kitchenside Rookery, a peninsula at 67°17'S, 47°00'E, on the western coast of Casey Bay.

(C) Adams Fiord Rookery in Amundsen Bay at 66°47'S, 50°28'E.

On the coast west of Casey Bay eight rock exposures occur. Two are islands, 2 miles off the coast, each approximately 1 mile long, 1500 feet wide and 200 feet high (Figs. 34 and 35). The remainder are peninsulas or isolated monoliths protruding from the edge of the ice sheet. The peninsulas are on the average half a mile long, 1500 feet wide and 100 feet high. The topography is dominated by a peninsula rising to an estimated 900 feet above sea level and covering 1 square mile.

The country rock in this area is quartz-feldspar-pyroxene gneiss grading into and interbedded with gneissic charnockite. (Figs. 30 and 32). It is intersected by pegmatitic dykes and numerous veins of blue quartz (Fig. 33). (Samples R 8867, R 8868, R 8869, R 8870, R 8871, R 8872, R 8873).

The quartz-feldspar-pyroxene gneiss is a grey, medium grained, laminated or well-bedded rock in the west, and coarse-grained, with an augen-gneiss structure, in the eastern outcrops (Fig. 31). In places, dark bands of amphibolite alternate with quartzitic horizons (Fig. 28), Weathering has formed a red patina of metallic hydroxides on the exposed surfaces.

In the west the country rock is intersected by numerous dykes of pegmatite containing crystals of pink orthoclase, plagioclase, biotite, minor muscovite and quartz. Clusters of magnetite crystals up to 2 inches in diameter are abundant. The dykes are vertical and range from 2 inches to 20 feet in thickness. The thicker dykes contain in places lenses up to 6 feet in diameter of fine to medium grained granite. Associated with the pegmatite dykes is a closely spaced network of veins of blue quartz, ranging in thickness from 1 inch to 10 feet. The rock adjacent to the dykes has been altered, in places over a width of 1 foot. (Fig. 29). The feldspars have been largely replaced by quartz.

Neither the pegmatite dykes nor the quartz veins show a preferential orientation.

The rocks have been intensely folded, faulted and jointed. The general strike is 310° and the dip from vertical to 30° to the west.

Glacial erosion is evident in land forms close to sea level but polishing and striation occur only above the 400 feet level. This feature indicates the former presence of the sea up to this level (Fig.34).

Very little moraine was found in the area and rocks in it are restricted to two types : white garnet granulite and grey, fine-grained and foliated sericitic schist interbedded with thin layers of sugary quartz.

Kitchenside Rookery (proposed name), is a peninsula rising 150 feet above sea level, 600' long and 500 feet wide (Fig. 36). It consists of a massive and coarse-grained biotite-hornblende-quartz-feldspar amphibolite (Sample R8874). The rock is grey and the schistosity illdefined. Jointing on several systems is widespread. A vertical pegmatite dyke, 15 feet thick, crosses the outcrop and consists of big crystals of orthoclase, plagioclase, biotite and quartz. Close to the walls of the dyke the intruded rock is metamorphosed to a quartz-biotite hornfels.

Adams Fiord Rookery is part of the coastal outcrops of the Mount Riiser Larsen area.

The country rock is hypersthene-quartz-antiperthite charnockite interbedded with quartz-feldspar granulite. Samples (R 8875 and R8876). The beds are from 6 inches to 1 foot thick. Biotite rich bands occur in places. The general strike is 30° - 70°. and the dip is south-westwards. Evidence of major folding and faulting was observed. The rock is intruded by pyroxene-magnetite-quartz dykes up to 20 feet thick (Sample R 8877).

SOUTHERN PRINCE CHARLES MOUNTAINS

Binders Nunataks

The base camp in the southern Prince Charles Mountains was established close to Binders Nunataks at 72°35'S, 62°58'E. The largest nunatak is 2 miles long, half a mile wide and rises 200 feet above the plateau level. Two small outcrops, not shown on the map, are present about one mile to the north-west and west.

The large nunatak is almost entirely covered with moraine. A few square yards of quartz-feldspar-biotite gneiss were found in situ (Sample R 8832). It is a distinctly schistose rock, medium to fine-grained and banded. Banding is due to concentration of biotite and hornblende. Quartz veins up to one foot thick intersect the rock. Amphibolite dykes containing labradorite, quartz and biotite occur in two places (Samples R 8833). In hand specimen this amphibolite is a black, hard, fine-grained rock with no evident schistosity.

The moraines are formed into mounds or polygons (see Fig.10). They contain high grade metamorphic rocks of varied nature: granitic gneisses, quartz-garnet gneiss, amphibolite, gneiss with large staurolite and apatite crystals, silicified breccia-sandstone, and granite.

Mount Creswell(72°47'S; 64°17'E)

This flat-topped mountain with steep moraine-covered slopes is approximately four square miles in area. On the northern side is an amphitheatre shaped valley with six rows of lateral moraine. The flat top of the mountain represents the old erosion surface covered with "mounded" moraine. The feature is dominated by a peak rising 300 feet above the general plateau surface.

Finely banded quartz-feldspar-biotite gneiss forms this mountain (Sample R 8849). The rock is the same as that at Binders Nunataks. It is intersected by numerous pegmatite dykes up to 20 feet thick. Quartz veins and a few amphibolite bands (Sample R 8850) are present. The pegmatite is composed mainly of feldspar, quartz and muscovite, the latter in crystals up to 4 inches wide. Subordinate garnet and ferromagnesian minerals are concentrated in places.

The general strike of gneissosity is east and the dip 30° to 70° to the north. A number of minor faults occur.

Morainic fragments are a few inches in diameter, angular and similar to the bedrock. A few allochthonous boulders of quartz-feldspar-garnet gneiss and quartzite were found in the lateral moraine on the north side of the mountain.

Mount Rymill

This mountain is part of a range bordering the Fisher Glacier. It extends for 11 miles from north-east to south-west and is divided by an ice covered saddle. The general plateau level in the area is 2700 feet and the mountain rises 1200 feet above it. It features the flat-topped morphology characteristic of the southern Prince Charles Mountains (Fig. 3).

The rock is black, grey and green greenschist in alternating bands (Sample R 8838). It is a fine-grained, hard rock, slightly schistose and showing remnants of former bedding .. In addition to quartz it contains biotite and lesser sphene and apatite.

The general strike of the bedding and schistosity is east with dips of 30° to 60° to the north. Faults with a small throw, striking north-east, were observed in the north-eastern part of the mountain.

The outcrop is surrounded by lateral moraine which terminates in a morainic "tail" towards the north-east. Among the materials constituting the moraine, of particular interest are sandy siltstone (R 8848) containing numerous remnants of Glossopteris and other plants (White, 1962). The siltstone is brick-red, soft and fissile. Some boulders contain bands of sandstone. The original formation is therefore thought to be a sandstone-shale assemblage. The sandstone does not contain fossil remnants. Numerous fragments of grey and pale purple marble (Sample R 8847) with a sugary texture were found. The occurrence of siltstone with Glossopteris and marble are restricted to the moraine at the base of the mountain at the north-western end of the saddle. The moraine on the upper slopes contains only high grade metamorphic rocks and detritus produced by nivation of local rock.

Mount Bloomfield

The low-lying hill 3 miles north-west of Mount Rymill which covers approximately 4 square miles , is composed of quartz-feldspar augen gneiss (Sample R 8836). The rock is coarse-grained, closely jointed and intersected by numerous veins of medium-grained, pink pegmatite. The pegmatite is composed of quartz and orthoclase with minor garnet and muscovite. Numerous pebbles of sugary, white, fine-grained quartz occur in the moraine, which covers most of the outcrop and ends towards the north-east in a long morainic "tail".

Mount Seddon

Mount Seddon is situated 13 miles west of Mount Rubin and consists of three rounded peaks separated by snow covered saddles. The highest peak rises approximately 900 feet above the plateau(Fig. 12).

The mountain is composed of calcite-sericite-quartz greenschist. (Samples R 8839 and R 8840). This rock is hard, fine-grained and well stratified. It is probably a slightly metamorphosed greywacke.

The rock on the north-eastern side of the mountain is intruded by an amphibolite dyke several dozen feet wide. Veins of amphibolite extend out from the dyke and intersect or follow the bedding planes. The structure is regular and the strike on the eastern side of the outcrop is east with an average dip of 60° towards the north.

Mount Dummett

This flat-topped ridge is 7 miles long and is dominated in the east by a peak rising a few hundred feet above the ice plateau (Fig. 13).

The eastern half of the mountain is composed of quartz-feldspar schist similar to the low grade metasediments found at Mount Seddon and Mount Rymill (Sample R 8841).

The western part of the mountain is granite. This rock contains muscovite,biotite and locally concentrated small crystals of garnet. Veins of quartz and coarse-grained pegmatite containing feldspars, quartz and muscovite, extend out from the granitic mass. An isolated outcrop of yellow, coarse-grained marble (Sample R 8842) was found in the vicinity of the granite intrusion. Under the microscope it is seen to contain crystals of calcite, quartz, muscovite and kyanite and probably originated by contact metamorphism.

Mount McCauley and Mount Scherger

These two outcrops are the most prominent topographic features in the western part of the mountains north of the Fisher Glacier. They rise approximately 1000 feet above the plateau and are separated by a valley of stagnant ice.

Both are topped by flat, moraine covered terraces. In the north-eastern part of Mount McCauley the terrace has been lowered a few hundred feet by faulting.

Quartz-feldspar schist similar to the rock found at Mount Rymill, Mount Seddon and Mount Dummett forms the major part of the outcrops. The south-western part of Mount McCauley is granite (Figs. 19 and 20). It is a medium-grained rock containing quartz, feldspar, biotite, muscovite and local concentrations of garnet. Numerous veins of quartz extend from the granitic mass of quartz and follow joints or bedding planes. Black vein-like and dyke-like bodies of contact metamorphosed sediment containing biotite and chlorite are also very numerous in the quartz-feldspar schist (Sample R 8846). In a wide area around the granitic intrusion the metasediments have lost their original texture and structure and are now represented by hornfels and migmatite, (Figs. 15 and 16).

The structure of the intruded rock is complicated by folding, jointing and faulting (Fig. 18) and the strike and dip shown on the map are local features which do not express a structural trend.

On the north side the two mountains are joined by lateral moraine and and a morainic 'tail' 8 miles long (Fig. 17) extends from the eastern corner of Mount McCauley. The mountain's slopes are also covered with moraine. The lateral moraine on the south side and in the valley between Mount Scherger and Mount McCauley contains high grade metamorphic rocks of igneous and sedimentary origin. The moraine which joins the north sides of the mountains and the moraine on the northern and eastern slopes of Mount McCauley is different in that it contains a great quantity of sedimentary rocks of low metamorphic grade. Sandstone breccia (Sample R 8843) and silicified sandstone (Sample R 8844) are common. In this type of moraine were found boulders of hematite (Sample R 8845) several feet in diameter. The boulders are very well rounded and are found high up the slope of the mountain. Well-rounded fragments of jaspilite are also present. This rock is fissile and strongly lineated and has a high content of hematite. Provenance of these erratics cannot be suggested. The present direction of ice flow would indicate the Goodspeed Nunataks as the likely area of origin but aerial observation does not support this hypothesis.

Mawson Escarpment

This scarp is on the east side of the Lambert Glacier between 72°30'S and 73°40'S. It is composed of a series of steep rock faces 700 feet high topped by the flat, moraine covered Law Plateau. The rock faces are dissected by cirque glaciers and short glaciers draining from the plateau into the Lambert Glacier (Figs. 23 to 26).

The escarpment was visited close to the southern end in the vicinity of 72°33'S, 68°15'E. In this area the country rock is a hornblende-feldspar-quartz gneiss. (Sample R 8855). It is a medium to coarse-grained rock with bands rich in amphibole. A closely-spaced network of amphibolite bands (Sample R 8856) intersects the rock along two preferential directions, east-north-east and north-north-east. In the vicinity of the bands, the intruded rock is metamorphosed to a garnetiferous hornfels (Sample R 8854). In one locality the hornfels has attained a thickness of 50 feet and a dark red scree is developed on the slope.

The rocks are intensely folded but a general strike towards the north-north-east dominates, with dips from 40° to 60° towards the west. At the foot of the Mawson Escarpment a wide lateral moraine is carried by the Lambert Glacier. Local rocks contribute most of the material but well-rounded boulders of pegmatite and granite were also found.

Aerial Observations

The Goodspeed Nunataks, Mount Menzies and Mount Rubin were examined during route reconnaissance flights in the southern Prince Charles Mountains.

The Goodspeed Nunataks are formed by a number of hills rising a few hundred feet above the plateau surface. In places a group of hills encircles areas of stagnant ice which are considered safe for landing and travelling.

The outcrops appear to be formed by rock similar to the quartz-feldspar-biotite gneiss found at Binders Nunataks. Aerial observation does not suggest the presence of sedimentary rocks in this area.

Extensive moraine deposits form long serpentine patterns between the outcrops. The quantity of moraine compared with the relatively small areas of rock in situ is a striking feature (Fig. 22).

Mount Menzies is the highest mountain in the Australian sector of Antarctica. It rises to a height of 11000 feet above sea level, at least 5000 feet above the surrounding plateau. It is formed by numerous rugged peaks and from the north side two mountain glaciers flow into the Fisher Glacier. The northern side of the mountain was examined from the air. It is probably composed of metamorphic rocks, banded light grey, pink and black (Fig. 21). A few dark coloured dykes intersect the bedding. Some of the light coloured rocks in the upper part of the mountain could be sediments. Viewed from the north, the bedding appears nearly horizontal but the strike could be east with dips to the south.

Mount Rubin is situated along the south side of the Fisher Glacier between 65°E and 66°E. It is a long, flat-topped mountain rising several hundred feet above the glacier and is covered with mounded moraine.

The rocks are dark coloured and well bedded, similar to low grade metasediments of the greywacke-sandstone suite found in outcrops north of Fisher Glacier. In some places the strike is east with dips to the north.

Mount Maguire and Blake Peaks are situated between the Mellor and Lambert Glaciers. The interpretation of the air photographs taken in 1960 reveals a textural and tonal pattern substantially different from the neighbouring outcrops. Horizontal bedding is clearly outlined and the morphology of the steep slopes is rugged. The mountains may be formed by sedimentary rocks. With the present transport facilities it is impossible to reach the mountains but ground examination by helicopter would be necessary to complete the reconnaissance knowledge of the area.

CONCLUSIONS

The extensive field activity of the ANARE party manning Mawson in 1960 has contributed to the reconnaissance knowledge of areas which have not been visited before by ground parties. The geological information which was collected is part of a general plan of reconnaissance activity for the compilation of a geological map of the Australian sector of Antarctica at a scale of 1:250,000. As such it is the the continuation of the work done by B. Stinear, I.R. McLeod and P.W. Crohn. The contributions in the geological field are here summarized:

1. The reconnaissance knowledge of the mountains in the interior of Enderby Land completes the geological reconnaissance of this part of Antarctic territory.

2. Geological and route information concerning the mountains north of Fisher Glacier has been collected for the first time by a ground Party.

3. Mawson Escarpment has been examined from the ground.

4. Siltstone with *Glossopteris* has been found in moraine in the southern Prince Charles Mountains although the place of origin is undetermined; it is the first time that macrofossils have been found in this sector of Australia.

5. Hematite has been found in moraine at Mount McCauley but the place of origin is unknown.

6. The presence of low-grade metasediments intruded by a granite batholith has been recorded in the mountains north of Fisher Glacier.

In addition to geological results, the expedition has collected information on route possibilities in the southern Prince Charles Mountains and has proved that travel is possible early in the season, under very low temperatures, giving full use of the daylight hours.

This year's work suggested that in planning future geological reconnaissance work first priority be given to the exploration of the mountains south of Fisher Glacier.

ACKNOWLEDGEMENTS

ANARE organisation has made this work possible and has provided excellent equipment for field activity. I want to acknowledge in particular the enthusiastic assistance of the Officer in Charge at Mawson in 1960 - Mr. Hendrik Geysen who has given full support to field activity at all times and led the journey to the southern Prince Charles Mountains . Without his drive the results achieved would not have been possible. Sgd.Ldr. J. Kitchenside and his crew and ground staff spent much of their effort in supporting the ground exploration. S. Kirkby and N. Collins were valued members of the exploratory parties and their contribution of previous experience in Antarctic travel proved indispensable. I. Bird, D. Machin, and Ken Bennett as radio operators contributed to the success of field activities.

I wish to acknowledge the assistance in advice and suggestions offerred to me by I. McLeod, P.W. Crohn and B. Stinear of the Bureau of Mineral Resources. Moreover I want to mention the assistance of the Officer in Charge of the Antarctic Mapping Centre D.T. Gale, and N. Harding of his staff for the assistance with maps and aerial photographs.

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APPENDIX I

PETROGRAPHIC DESCRIPTIONS BY THE AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES OF ROCK SAMPLES COLLECTED BY A.N.A.R.E., 1960-61.

by

W.R. McCarthy

ENDERBY LAND PENINSULA

Cape Batterbee

R.8858: T.S. 7264.

This is garnet-pyroxene-feldspar dolerite, with diabasic texture. It has undergone a retrogressive alteration - hornblende, green and uralitic appearing now occurs as partial rims around much of the pyroxene; this is probably a deuteric alteration. Plagioclase is calcic andesine and is present as lath-like and blocky crystals which are cloudy appearing in plain light. Pyroxene is primarily hypersthene with some augite and present as subhedral crystals or aggregates of finer crystals. Quartz is present as rare, interstitial patches.

Opaques occur as skeletal aggregates intergrown with feldspar and often rimmed by myrmekitic appearing garnet. Garnet also rims some of the pyroxene. Garnet appears to be primary because of its intergrowth with opaques and its presence as rims around pyroxene. A portion of the pyroxene is altered to antigorite.

Mount Bennett.

R.8859: T.S. 7265.

This is a feldspar-quartz granulite and assigned to the granulite facies. Texture is xenoblastic with feldspar grains ranging from 2.3 mm to 0.16 mm and averaging 1.7 mm; quartz has approximately the same grain range. Perthite is the most common feldspar; perthitic microcline, antiperthite, and plagioclase also occur. Myrmekitic intergrowths interstitial to plagioclase and perthite are common.

Biotite and hornblende are rare, interstitial accessories. Apatite and opaques are present in accessory amounts.

Mount Armstrong

R.8860: T.S. 7266

This is a coarse-grained, hornblende-quartz-feldspar granulite and assigned to the hornblende granulite subfacies. The rock has xenoblastic texture with extremely large porphyroblasts of perthitic microcline - one has a diameter of 17 mm.; quartz, plagioclase, opaques, apatite, and ferromagnesians all occur as finer/porphyroblasts; quartz forms about 20 percent of the specimen. Ferromagnesians are hornblende and biotite which form 5-10 percent of the specimen; hornblende is the most common, and occurs as large xenoblastic porphyroblasts which commonly have inclusions of apatite and zircon. Myrmekitic intergrowths between quartz and microcline are common.

Accessories are apatite, zircon, sphene, and opaques. Apatite, zircon, and sphene all occur as subhedral to euhedral crystals as inclusions within feldspar or hornblende.

Martin Island

R.8861: T.S. 7267

This is a hypersthene-quartz-feldspar charnockite and assigned to the pyroxene granulite subfacies. No structure is apparent and the rock has a sub-granoblastic texture. Major constituents are calcic oligoclase, perthite, antiperthite and quartz; quartz forms about 10 percent of the rock. The average grain size is 0.56 mm, but some crystals, generally with xenoblastic habit, of quartz and antiperthite reach a diameter of 1.12 mm. Pyroxene is hypersthene, appears as corroded appearing grains generally finer grained than 0.4 mm, and forms 3-5 percent of the specimen.

Apatite and opaques are common accessories; zircon is less abundant and many appear as rounded crystals.

R.8862: T.S. 7268

The genesis of the rock is uncertain from thin section examination, but it is most likely igneous - a pyroxenite. Mineral constituents are hypersthene (about 50 percent) hornblende (about 10 percent) biotite (about 5 percent) and plagioclase (about 35 percent).

Hypersthene occurs in two general size fractions; large anhedral grains which average 1.8 mm. in diameter, fine anhedral to subhedral grains which are generally clustered about the larger pyroxene and have an average diameter of 0.2 mm. Hornblende is found between or rimming pyroxene crystals and at least a portion of it appears to be retrogressive; biotite has the same association and most of it is probably retrogressive. Plagioclase is calcic bytownite, occurs as patch-like aggregates of subhedral, equant, poorly twinned crystals or in the interstices. Apatite, zircon, and opaques are rare accessories.

Cape Gotley

R.8863: T.S. 7269

This a garnet-pyroxene-quartz-feldspar granulite and assigned to the pyroxene granulite subfacies. No structure is apparent and the rock has a heteroblastic texture. Perthite and antiperthite, of the patch and string type, and quartz are the major constituents. Larger xenoblastic grains, generally with crenulated borders, of the major constituents with an average diameter of 0.74 mm. are surrounded by finer crystals. In the finer crystals myrmekitic intergrowths are common. Pyroxene is very corroded appearing and often occurs in aggregates of rods or semi-connected rods; it appears to be two species - an orthopyroxene (probably hypersthene) and clinopyroxene. Pyroxene forms about 5 percent of the specimen.

Garnet occurs in accessory amounts as fine aggregates of crystals often in association with pyroxene. Opaques are common, occur as fine to coarse globular to elongated bodies scattered through the specimen. Apatite and zircon (some crystals are quite rounded appearing) occur in accessory amounts.

Kloa Point

R.8864: T.S. 7270

The rock is an altered, mica-microcline-quartz gneiss and assigned to the almandine amphibolite facies. It has a poor crystallization foliation; some of the primary meta mica shows a poor foliation. Quartz has an average diameter of 0.67 mm, some grains are elongated due to the crystallization foliation, and most quartz has cryptocrystalline rod-like inclusions. The rock has been altered and most microcline has been sericitized; unaltered microcline is rare and many of the altered porphyroblasts are now aggregates of sericite containing laths of muscovite and biotite. An early generation of muscovite and biotite is apparent, but only forms about 3 percent of the specimen. Before alteration, microcline, with some plagioclase, formed about 40 percent of the sample.

The alteration is ascribed to metasomatism or retrogressive metamorphism; from the thin section examined, the alteration process or processes cannot be further limited.

R.8865: T.S. 7271.

This is a hypersthene-quartz-feldspar gneissic charnockite and assigned to the pyroxene granulite subfacies. Structure is excellent and shown by parallel lenses of quartz and quartz grains, and crystallization foliation of the feldspar; hypersthene shows little preferred orientation. Quartz occurs primarily as lens-like bodies or as finer grains scattered through feldspar, and forms about 30 percent of the rock. Feldspar is calcic andesine and occurs as lens-like bodies or as grains with an average diameter of 0.6 mm. Hypersthene forms about 7 percent of the specimen and occurs as corroded appearing grains clustered together in varying shaped aggregates. Some biotite is present which appears to have formed by alteration of hypersthene; a little green uralitic hornblende occurs as rims around some of the hypersthene.

Apatite and zircon are uncommon accessories; zircon crystals are rounded.

Coast $67^{o}40'$S., $45^{o}50'$E.

R.8867: T.S. 7273

This is a hornblende-pyroxene-quartz-feldspar gneiss and assigned to the hornblende granulite subfacies. Structure is fair and shown by thin, parallel lines of ferromagnesians and accessories which cut the feldspar-quartz matrix. Quartz forms about 15 percent of the rock, is present as xenoblastic crystals which range from crystals with a diameter of 1.7 mm. to fine interstitial or included crystals in feldspar. Feldspar forms about 80 percent of the rock, most is perthite, antiperthite, or perthitic microcline; plagioclase is also common and is calcic andesine. Feldspar ranges in diameter from 3.5 mm. to 0.37 mm; most grains are xenoblastic and smaller grains of andesine are quite corroded appearing. Pyroxene is hypersthene and clinopyroxene, has an average grain diameter of 0.37 mm. and has anhedral or corroded appearing habit. Hornblende is dark brown, present in equal quantities with pyroxene, and combined with pyroxene forms about 7 percent of the sample.

Accessories are zircon, sphene, apatite, and two types of opaques commonly found in association with the ferromagnesians. Skeletal-like opaques, probably ilmenite, are inclusions in sphene. The other opaque occurs as various sized, globular shaped bodies.

R.8868: T.S. 7274.

This is a quartz-pyroxene-feldspar gneissic charnockite and assigned to the pyroxene granulite subfacies. Structure is fair and shown by elongated pyroxene crystals. Feldspar is mostly antiperthite (patchy type) with plagioclase (Ab50 An50), has xenoblastic habit, forms about 80 percent of the specimen, and has an average diameter of 0.56 mm. Pyroxene is primarily hypersthene and enstatite with some clinopyroxene (most likely clinohypersthene), occurs as anhedral, equant to subhedral grains, and forms approximately 10 percent of the sample.

Apatite is extremely abundant (forms about 1 percent) and occurs as subhedral to euhedral, scattered crystals. Opaques are common (about 3 percent) and occur as globular -shaped bodies.

R.8869: T.S. 7275.

A medium-grained, plagioclase-quartz-microcline granite. The rock has an allotriomorphic texture. Quartz forms about 25 percent of the rock and has an average crystal diameter of 1.5 mm. Feldspar is primarily microcline (about 60 percent) with sodic oligoclase (about 15 percent); microcline generally has equant habit, oligoclase a tabular habit. Microcline has an average diameter of 1.2 mm. and oligoclase 1.0 mm.

Biotite occurs as flakes and forms about 1 percent of the specimen. Apatite and opaques are rare accessories.

Feldspar is cloudy appearing in plain light and has been partially sericitized. Some of the biotite has been partially altered to chlorite.

R.8870: T.S. 7276.

This is a pyroxene-hornblende-feldspar gneiss and assigned to the almandine amphibolite facies. The rock has fair structure which is shown by aligned segregations of ferromagnesians. The texture of the feldspar (andesine Ab50 An50) is granoblastic; andesine has an average grain diameter of 0.56 mm. and most shows twinning. Ferromagnesians form about 40 percent of the sample. Pyroxene is enstatite and a clinopyroxene (probably augite), and is very altered appearing; most occurs as altered grains in hornblende or is rimmed or partially penetrated by hornblende. It is then apparent that most or all hornblende has formed by retrogression from pyroxene. Hornblende is green coloured, occurs as large plates with inclusions of pyroxene and globular shaped opaques.

Apatite and opaques are common accessories; zircon is a rare accessory.

The rock is cut, normal to its structure, by a vein containing quartz and calcite. Considerable alteration of the rock has occurred along and extending 2 cm. beyond vein borders; most hornblende has altered to chlorite. Some biotite has crystallized from hornblende, pyroxene has almost completely altered to hornblende, and calcite occurs in some of the interstices.

R.8871: T.S. 7277

The schistose portion of the rock is thought to be a granitized sediment - a biotite-hornblende-quartz-feldspar gneiss and assigned to the almandine amphibolite facies. Biotite and hornblende give the rock its schistosity. Feldspar is andesine (Ab62 An38), and microcline, has xenoblastic habit, much is antiperthite, and shows myrmekitic intergrowths. Accessories are opaques, apatite and zircon; about half of the zircons are rounded.

The rock does not appear to be a migmatite ("composite rock produced by injection of granitic magma into schist in lit-par-lit manner"). Several features of the rock make this conclusion evident:-

1. No discernible difference between the composition or texture of the feldspar between schistose minerals and the feldspar enclosing schistose minerals is present; it seems most unlikely that injected feldspar and original feldspar would be of the same composition and show similar texture.

2. If granitic material had been injected between schistosity, some type of reaction between schistose minerals and magma would seem most likely; no such changes have occurred and all minerals are unaltered.

A coarsely crystalline vein-like body of andesine, microcline, and quartz with large magnetite porphyroblasts terminates the gneiss along one side of the hand specimen. The writer does not know the size or spatial relation of this body, but because its mineral composition is similar to the gneiss (except for the ferromagnesians and magnetite) and sinee the contact between the two rocks is not sharp when viewed microscopically, a replacement pegmatite genesis of the body is favoured - that is, the body has originated by granitization of a sediment under the same general conditions responsible for the crystallization of the gneiss.

R.8872: T.S. 7278.

The rock is pyroxene-quartz feldspar charnockite and assigned to the granulite facies. It has a poor structure as shown by parallel lens-like crystals of pyroxene and by similarly oriented elongated crystals of feldspar and quartz. Pyroxene forms 3-5 percent of the sample, is primarily hypersthene with some clinohypersthene, and occurs as corroded appearing elongated crystals. Biotite and hornblende occur associated with the pyroxene, appear to be primary metaminerals, and form about 1 percent of the rock. Quartz comprises about 15 percent of the specimen. Feldspar is generally perthitic, shows only moderate twinning, and is within the calcic oligoclase to sodic andesine compositional range. Feldspar shows occasional myrmekitic intergrowths.

Accessories are apatite and opaques which are scattered through the rock and slightly concentrated near the ferromagnesians.

R.8873: T.S.7279

This is a hypersthene-garnet-quartz-feldspar gneissic charnockite and assigned to the pyroxene granulite subfacies. Structure is fair and shown by pyroxene and garnet concentrated in linear zones and lenticular quartz which is oriented parallel to the pyroxene-garnet zones. Garnet is pink coloured in thin section, has xenoblastic to subhedral habit and contains inclusions of feldspar and opaques. Garnet and pyroxene form about 7 percent of the rock, quartz about 30 percent. Feldspar is bytownite, some is antiperthitic, and all have xenoblastic habit.

Biotite and apatite are rare accessories.

R.8878: T.S. 7284.

This is a feldspar-scapolite-augite-actinolite marble of katazonal grade or of the almandine amphibolite facies. Calcite as coarse crystals - some reach a length of 8.0 mm. - forms about 90 percent of the rock. All other minerals occur as rounded to subrounded inclusions within calcite. Scapolite and augite occur in about equal quantities and form about 7 percent of the rock; actinolite is present as a retrogressive alteration of augite.

Quartz occurs rarely as a late fracture filling.

Kitchenside Rookery (67°17'S; 47°00'E)

R.8874: T.S.7280.

This is a biotite-hornblende-quartz-feldspar amphibolite and assigned to the almandine amphibole facies. The rock shows a polymetamorphic history. In an earlier period of metamorphism, the rock may have reached a higher grade - perhaps granulite facies. The last period of metamorphism was accompanied by cataclasis. Large porphyroclasts - some reaching a length of 15.5 mm. - of perthite and oligoclase are surrounded by a mosaic of fine plagioclase and quartz. Perthite and oligoclase show strained extinction, oligoclase has bent lamellae and in several places fractures in the porphyroclasts are filled with fine crystals of quartz, feldspar and hornblende. Both the perthite and oligoclase then were crystallized during the first period of metamorphism; the biotite, hornblende and mosaic quartz and feldspar are retrogressive minerals formed during the last period of metamorphism. Biotite and hornblende are fine-grained and occur with the mosaic quartz and feldspar as rims surrounding the porphyroclasts.

Apatite and zircon are common and occur with the mosaic minerals as euhedral to rounded crystals some of which are broken. Opaques are rare and occur with the ferromagnesians.

Mount Riiser Larsen

R.8875: T.S. 7281.

This is a medium to coarse-grained, hypersthene-quartz-antiperthite charnockite and assigned to the pyroxene granulite subfacies. The antiperthite and quartz are xenoblastic and considerably coarser grained than pyroxene. Oligoclase is the host for the exsolved antiperthite which has string habit. Hypersthene appears as corroded, xenoblastic grains and forms 1-3 percent of the sample.

Rare opaques, as globular shaped bodies, are present and generally associated with pyroxene.

Several microfractures cut the rock along which granulated feldspar and quartz have recrystallized. Some of the pyroxene along the fractures has altered to hornblende.

R.8877: T.S. 7283:

This is an altered metamorphic, pyroxene-magnetite-quartz rock. Originally the rock was composed of euhedral to globular magnetite, anhedral to rounded pyroxene, and coarsely crystalline quartz. Pyroxene ranges in grain diameter from 1.7 mm. to 0.08 mm; magnetite has about the same diameter range. Pyroxene is primarily hypersthene with clinohypersthene and a uniaxial pyroxene (probably a layer of α and β hypersthene). Similar appearing quartz rocks containing kyanite or sillimanite, instead of pyroxene, enclosed by quartz are found in granulite facies rocks of northwestern South Australia and have been described by the writer. The South Australian rocks apparently formed by metamorphism of quartzites under granulite facies conditions. Because of the presence of hypersthene and the proximity of granulite facies rocks 8875 and 8876, it is thought that this rock is a metamorphosed quartzite of granulite facies grade.

The rock has been fractured and magnetite with small amounts of pyrite, chalcopyrite and pyrrhotite have been deposited in fractures. As considerable magnetite is present in the original rock both as individual crystals and as fine specks in quartz, it is thought that the deposited magnetite and sulphides have a local source (i.e. - the metasediments themselves), were concentrated by metamorphic processes and were deposited during a period of fracturing while host rock conditions were still rather dry or anhydrous. The ore minerals comprise about 30 percent of the specimen.

Adams Fiord

R.8876: T.S. 7282.

The rock is a garnet-quartz-feldspar granulite and assigned to the granulite facies. No structure is apparent and most grains are xenoblastic in habit and many of the feldspar grains are poikiloblastic with inclusions of quartz. Feldspar is perthite and antiperthite with string habit, the host feldspar is oligoclase. Quartz forms about 30 percent of the rock and has many cryptocrystalline spindle-like inclusions. Garnet forms about 2 percent of the rock, is present as xenoblastic, poikiloblastic grains with inclusions of quartz and is found in fine bead-like strings.

Opaques as globular-like bodies, and zircon are rare accessories.

SOUTHERN PRINCE CHARLES MOUNTAINS

Binders Nunataks

R.8832: T.S. 7238.

The rock is a garnet-biotite-hornblende-feldspar-quartz gneiss and assigned to the almandine amphibolite facies of Fyfe, Turner and Verhoogen (G.S.A. Memoir 73, 1958, p.228). Foliation is fair and visible both in hand specimen and thin-section. In thin section, the biotite shows foliation and quartz and feldspar have a tendency to be elongated parallel to foliation. Evidence exists for a probable polymetamorphic history of the rock. It is evident that the first period of metamorphiem was synkinematic and reached the biotite grade. A second later period of thermal (regional rather than local) metamorphism is likely for the following reasons:

1. Large garnet porphyroblasts have inclusions of biotite (formed during sykinematic period) and the garnets push aside the foliated biotite.

2. A second, non-aligned, generation of biotite is present.

3. Hornblende shows no preferred orientation and is not present as inclusions in garnet - thus is probably not synkinematic.

Quartz (about 50 percent), labradorite (Ab42 An58 and about 35%), and biotite (about 10 percent) are the major constituents. Green hornblende, and garnet (with inclusions of biotite, feldspar, and quartz) are present in about equal quantities, and form about 5 percent of the rock.

Some biotite has altered to chlorite.

Accessory zircon (many grains are rounded) and apatite are common.

R.8833: T.S. 7239

This is a garnet-hornblende gneissic amphibolite and assigned to the almandine amphibolite facies. Hornblende, the major constituent, (about 60 percent), shows a fair crystal parallelism and gives the rock its structure. Feldspar, andesine and quartz - except for accessories - comprise the remainder of the gneiss. Garnet is present as porphyroblasts with inclusions of hornblende, plagioclase and quartz. The garnet is extremely corroded appearing and often is present only in the centre or side of large circular areas now occupied by finer crystals of feldspar, quartz, hornblende and sometimes sericite and biotite. It is then thought that the garnet once filled a larger portion of the circular areas and because of some disturbance of metamorphic equilibrium (i.e., heat, pressure, metasomatism) that a portion of it has recrystallized into other minerals more conformable with new conditions. Some of the garnet porphyroblasts show alignment with structure.

Sphene occurs associated with skeletal opaques and some crystals show an elongation parallel to structure. Apatite and zircon occur in accessory amounts.

R.8834: T.S. 7240

This is a garnet-hornblende amphibolite with poor foliation and assigned to the almandine amphibolite facies. Hornblende shows a fair crystal parallelism and biotite a fair foliation. The specimen shows a complex metamorphic history; several periods of metamorphism are evident.

During the first period, the rock developed its schistosity with biotite and hornblende giving the foliation, biotite being rather rare at this stage. Porphyroblastic garnet developed at this time. Several quartz vein-like bodies cut the rock parallel to foliation and were formed during the initial metamorphism. Next, a period of fracturing followed - shown by fractures in garnet. A final period of metamorphism, which appears to be primarily thermal, resulted in crystallization of hornblende and biotite within fractures in garnet, new unoriented biotite, and partial conversion of some hornblende to biotite. Another alteration, the sericitization of some of the feldspar, was contemporaneous with the thermal metamorphism or is a late retrograde feature. Hornblende, quartz and garnet are major constituents; biotite and feldspar minor constituents.

Accessories are zircon, apatite, sphene and metallic opaques. Metallic opaques are common, have lath and rod habit, occur in skeletal aggregates, are associated with sphene, and are probably ilmenite.

R.8835: T.S. 7241

This is a feldspar-quartz-amphibole hornfels and assigned to the hornblende hornfels facies. The constituents are hornblende (about 55 percent), plagioclase (about 30 percent) and quartz (about 15 percent). Texture is granoblastic and all minerals have a tendency to develop equant grains and crystal faces and show the following decreasing order of idioblastic habit - hornblende, plagioclase, and quartz. Hornblende has an average diameter of 0.18 mm, and quartz and feldspar average 0.37 mm. No relict igneous textures are visible although the plagioclase (andesine) is generally zoned. Consequently, the rock appears to have formed by regional thermal metamorphism.

Mount Creswell

R.8849: T.S. 7255

This is a biotite-feldspar-quartz gneiss and assigned to the almandine amphibolite facies. The rock has crystallization foliation with both feldspar and quartz showing elongation parallel to foliation. Biotite forms about 7 percent of the rock and gives it a fair foliation. Quartz forms about 50 percent of the rock, is xenoblastic, ranges in grain size from 1.7 mm. to 0.14 mm. and averages 1.2 mm. Feldspar has anhedral to xenoblastic habit, is andesine, and ranges from 0.7 mm. to 0.2 mm. and averages 0.4 mm.

Zircon as fine crystals is a rare accessory.

R.8850: T.S. 7256.

The rock is an epidote-chlorite-hornblende hornfels and assigned to the hornblende hornfels facies. No structure is apparent and the rock has sub-granoblastic texture. The ferromagnesians tend to be concentrated in patch-like bodies with feldspar interstitial to them. The rock is medium to fine-grained and the minerals arranged in decreasing order of idioblastic tendency are: hornblende, epidote, chlorite, and feldspar. Feldspar is very dirty appearing in plain light because of many fine inclusions, shows little twinning and is andesine (Ab68 An32). Chlorite is penninite and generally has spherulitic habit.

The mineral assemblage is apparently unstable and a portion of the epidote and all of the chlorite appear to have formed retrogressively from hornblende.

Sphene is a common accessory and occurs as coarse to fine xenoblastic grains. Opaques and apatite occur as rare accessories.

Original rock type is not determinable from thin section. However it is more likely that this is a metamorphosed basic igneous rock than a metasediment.

R.8851: T.S. 7257

The rock compares in all regards to R.8834 except for the following differences: garnet of R.8851 is more coarse, no quartz vein-like bodies cut the rock, and the feldspar of R.8851 is little altered.

R.8852: T.S. 7258

This is a garnet-muscovite-tourmaline pegmatite. Tourmaline is present as idioblastic crystals,garnet is subhedral, and quartz and feldspar have fine crenulated borders. Feldspar is microcline and albite-oligoclase; the feldspar has inclusions of quartz and a portion shows incipient sericitization.

Petrogenesis is not determinable from the thin section, but quartz inclusions in feldspar, feldspar with crenulated borders, and the presence of garnet would suggest that a metamorphic genesis be considered.

R.8853: T.S. 7259

This is a feldspar-quartz pegmatite with graphic intergrowths of quartz and feldspar. The feldspar is albite and microcline. Quartz is present as thin laminae-like bodies which parallel the (001) cleavage of the feldspar.

Mount Rymill

R.8838: T.S. 7244

This is a fine-grained, dark coloured, epidote-biotite - feldspar-quartz greenschist and assigned to the greenschist facies. Schistosity is poor - almost incipient - and shown by thin concentrations of biotite. The matrix is quartz and feldspar with an average diameter of 0.051 mm. Several incipient porphyroblasts of partially fused feldspar grains reach a diameter of 0.56 mm. Concentrations of opaques and biotite rimming a core of sphene are common. Epidote minerals are present as minor constituents and occur as extremely fine-grained, disseminated crystals.

Apatite is a common accessory; zircon occurs rarely.

R.8847: T.S. 7253

This is a fine-grained marble. The matrix of the rock is composed of recrystallized calcite and calcite grains which show no apparent recrystallization. Several cross-cutting bodies containing coarsely crystalline calcite occur. Grain size ranges from 0.05 mm. in the matrix to 1.12 mm in the cross-cutting body. Most of the calcite has fine scattered inclusions. A few grains of quartz and flakes of muscovite are the only additional minerals in the rock.

A magnesium test was positive which proves that a portion of the calcite referred to above is dolomite or magnesium rich.

R.8848: T.S. 7254

This is a stilpnomelane-goethite-quartz schist and assigned to the greenschist facies - an iron-magnesium assemblage. All minerals have a grain size of less than 0.0625 mm. Quartz and stilpnomelane are major constituents and interstitial goethite is common. Stilpnomelane and angular quartz grains, with parallel elongation, give the rock its schistosity. Quartz is angular or lens like - a few grains are subrounded - stilpnomelane has acicular habit.

R.8866: T.S. 7272

This is a mica-quartz-feldspar schist and assigned to the almandine amphibolite facies. Schistosity is poor and the rock has an incipient crystallization foliation; quartz and feldspar show a poor grain elongation parallelism. Feldspar is primarily microcline with some oligoclase and forms about 30 percent of the specimen; it has an average diameter of 0.72 mm. Much of the feldspar has been sericitized; the sericitization is thought to result from K metasomatism. Most grains of feldspar and quartz are ringed by coarse-grained sericite which occasionally concentrates in lenses to give a rude foliation to the rock.

Zircon, tourmaline, chlorite, and opaques are accessories. Biotite occurs as sheet-like poikiloblastic crystals in accessory amounts.

Mount Bloomfield

R.8836: T.S. 7242.

This is an epidote-hornblende-biotite-quartz-feldspar augen gneiss and assigned to the almandine amphibolite facies. Schistosity is shown by linear zones of crushed fragments mainly quartz and feldspar with an average diameter of 0.026 mm and by linear zones of ferromagnesians. Often the two zones are distinct, but zones containing a mixture of ferromagnesians, quartz, and feldspar are common. Linear zones of crystalline quartz also are present. The ferromagnesian zones contain fine-grained biotite (generally showing no preferred orientation) green uralitic appearing hornblende, sphene, epidote minerals, and accessory minerals. Two types of augens are evident, one of sericitized and epidotized plagioclase, and the other of microcline. Between augens and linear zoned material, quartz and microcline (with an average diameter of 0.55 mm), scattered ferromagnesians, and accessories are found.

The rock has had a complex evolutionary history. Two generations of minerals are evident; the first: augen plagioclase, epidote (distinguishable from later formed epidote by its pleochroism, low birefringence, and clastic appearing grains), and finer grained biotite and hornblende; the second: microcline, sericite, epidote, green uralitic hornblende, coarser biotite, quartz, and sphene. The second generation of minerals formed during a period of medium-grade dynamic metamorphism accompanied by K metasomatism. Before dynamic metamorphism the rock was probably a granitoid rock and most likely metamorphic as it contained epidote. Thus it appears that two periods of metamorphism have formed the present mineral assemblage.

Potassic metasomatism is thought to have accompanied the second period of metamorphism because the relict plagioclase indicates that it was the stable feldspar of the granitoid rock whereas the only feldspar to form during the last crystallization was microcline. The sericitization of plagioclase was most likely a result of K metasomatism.

Accessory minerals, zircon and apatite, are common; some of the zircon is present as broken crystals; most apatite is euhedral.

Mount Seddon

R.8839: T.S. 7245

The rock is a calcite-sericite-quartz schist and assigned to the greenschist facies. Schistosity is fair and shown by sericite and sub-aligned quartz clasts. Calcite occurs as xenoblastic, poikiloblastic crystals with inclusions of quartz; calcite crystals have an average diameter of 1.12 mm. Rare clastic grains of feldspar are present. Quartz occurs as angular to sub-rounded grains which have an average diameter of 0.13 mm.

Accessories are tourmaline, zircon, sphene, and opaques. Opaques occur as scattered grains which assume a rude parallelism with schistosity and as patchy aggregates. Green biotite is present in accessory amounts.

R.8840: T.S. 7246

This rock can be compared to R.8839 in all regards except for the following differences. Small porphryblasts of quartz which are rimmed by directionless green biotite are scattered through the rock; similar shaped bodies of biotite occur with no quartz centres. No calcite porphyroblasts occur. This rock shows that P/T condition reached during its metamorphism, as compared to R.8839, was slightly higher; this is indicated by its more abundant biotite.

Mount Dummett

R.8841: T.S. 7247

The rock is an epidote-hornblende-quartz-feldspar amphibolite and assigned to the greenschist facies. In previous classifications the rock would have been assigned to the epidote-amphibolite subfacies; now it belongs to the highest portion of the greenschist facies. Structure is shown by parallel zonal concentrations of hornblende and epidote and by parallelism of elongated epidote, hornblende and less frequently microcline. Texture is sub-granoblastic and grains have a range in size from 0.37 mm. to 0.15 mm; quartz shows the complete grain range while the other constituents are coarser than 0.20 mm. Feldspar is generally microcline with some sodic plagioclase.

Sphene, zircon, and apatite are present in accessory amounts. Opaques are scattered through the specimen as anhedral to subhedral grains.

Several vein-like bodies of epidote cut the rock. Some of the feldspar is sericitized especially when near zonal concentrations of epidote.

R.8842: T.S. 7248

This is a tremolite-quartz-calcite marble and assigned to the greenschist facies. The rock has definite structure; quartz, and calcite grains are elongated and show parallel orientation; quartz and calcite grains are concentrated in separate zones which parallel the grain elongation. Both quartz and calcite occur as xenoblastic grains, quartz ranges in size from 1.15 mm. to 0.04 mm. calcite from 1.15 mm. to .06 mm. Quartz and calcite are present in about equal quantities and form approximately 98 percent of the rock. Tremolite occurs as fine acicular crystals with a random distribution.

Mount McCauley

R.8843: T.S. 7249

The rock is a sericite-biotite-quartz schist and assigned to the greenschist facies. Schistosity is good; it is quite wavy as it passes around augen-like quartz grains or crystalline quartz aggregates. Two fractions of quartz form the major portion of the rock, one ranging from 0.75 mm. to 0.08 mm, and the other fraction is less than .0625 mm. Quartz is angular to sub-rounded and occasionally a grain of feldspar occurs with the finer fraction. Sericite and fine, green to brown coloured biotite are present with fine quartz; chlorite occurs rarely in the fine fraction. Fine grains of calcite are scattered through the finer fraction.

Accessory tourmaline, zircon and opaques occur rarely.

R.8844: T.S. 7250

This is a recrystallized feldspathic quartzite. No structure is visible. Altered feldspar (about 35 percent) and quartz (about 65 percent) are the major constituents. Grains are well sorted and have an average diameter of 0.16 mm. Feldspar is microcline and plagioclase; it shows varying degrees of sericitization from unaltered to completely sericitized grains. Secondary overgrowths of silica have destroyed much of the sedimentary texture. Rare biotite with equant habit is present. This would be classified by most petrologists as a metamorphic quartzite.

Accessory apatite and zircon occur as rare crystals.

R.8845: T.S. 7251

The ore minerals of this rock are hematite and magnetite present in 9 to 1 ratio; hematite is the more abundant. Both are finely crystalline and hematite is xenomorphic while magnetite occurs as rounded inclusions in hematite.

Thin section examination reveals that muscovite and quartz, present in fine, parallel laminae, occur as gangue in the ore.

R.8846: T.S. 7252.

The rock is a goethite-tremolite-muscovite-stilpnomelane schist and assigned to the greenschist facies - an iron and magnesium rich assemblage. Banding is apparent and occurs because muscovite and tremolite are present in lighter coloured bands with less stilpnomelane and goethite. Stilpnomelane and muscovite are the most common acicular minerals and show a slight tendency to be elongated normal to the banding. Geothite fills interstitial spaces. All acicular minerals are less than 0.0625 mm.

Euhedral to subhedral opaques are scattered through the matrix and some reach a diameter of 1.12 mm.

Mawson Escarpment ($68^{o}15'$E., $72^{o}33'$S)

R.8855: T.S. 7261

This is a fine-grained, biotite-hornblende-feldspar-quartz gneiss and assigned to the almandine amphibolite facies. Structure is fair and shown by hornblende and biotite generally present in thin linear zones and feldspar and quartz which have poor crystallization foliation. Quartz forms about 45 percent of the specimen and ranges in grain size from 0.72 mm to less than 0.0625 mm. Feldspar is microcline and andesine, has xenoblastic habit, ranges in diameter from 0.72 mm. to less than 0.0625 mm, averages 0.3 mm, and forms about 50 percent of the specimen. Biotite and hornblende form about 5 percent. and are finer than 0.2 mm in grain size.

Apatite and zircon are rare accessories and occur as extremely fine crystals.

R.8856: T.S. 7262

This is a quartz-chlorite-feldspar-hornblende amphibolite. The texture is crystalloblastic and all minerals have an unaltered appearance. No structures, igneous or metamorphic, are present. Sedimentary relict clastic minerals do not occur. The original rock type does not appear to be determinable from thin-section examination. Due to its recrystallized nature original grain size is not determinable. If this was an igneous rock, it would have been an ultrabasic (pyroxenite perhaps) which has recrystallized in situ by a thermal metamorphic retrograde of pyroxene to hornblende and chlorite. Andesine is present in patches between ferromagnesians and forms about 40 percent of the rock. Quartz is present in interstices amongst andesine and as fine grains in the ferromagnesians.

Accessories are opaques - skeletal appearing and associated with sphene - and apatite.

Figure 1: Vertical aerial view of outcrops in the Cape Batterbee area (Enderby Land).

Figure 2: Oblique aerial view of the Kloa Point area, (Enderby Land).

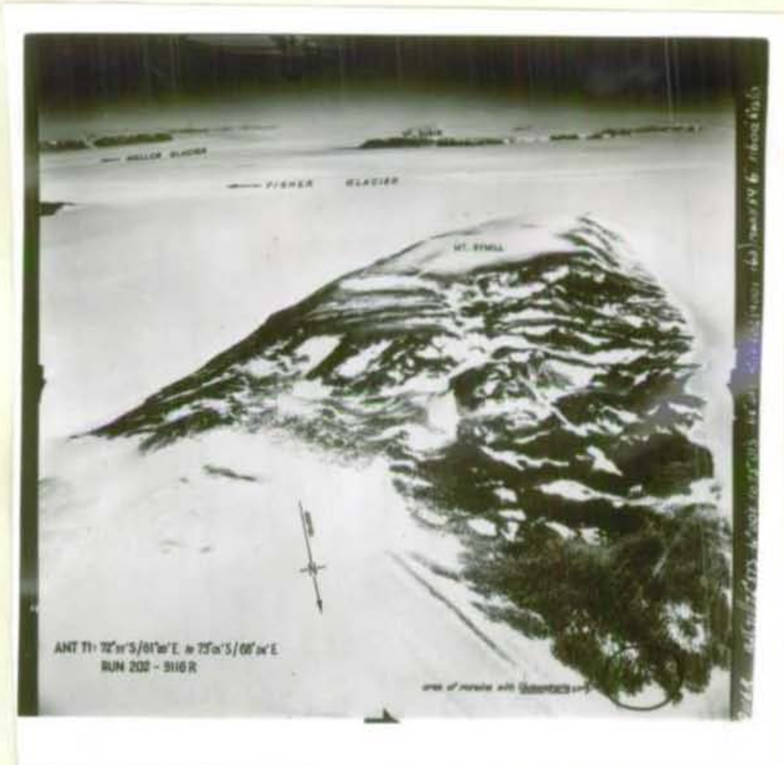


Figure 3: Oblique aerial view of Mount Rymill (southern Prince Charles Mountains). Looking south.

Figure 4; Aerial view of Mawson harbour (centre) with Mount Henderson in the background and Flat Islands in right foreground.

Figure 5: Base camp close to Cape Batterbee on the Enderby Land coast.

Figure 6: Rookery at the base camp in Enderby Land.
Cape Batterbee in the background.

Figure 7: Charnockitic granular gneiss with concentrations of
blue quartz. Cape Batterbee - Enderby Land.

Figure 8: Mount Bennett - Enderby Land ($66^{\circ}32'S, 53^{\circ}29'E$)
Banded quartz-feldspar-biotite gneiss dipping to the west. Looking south.

Figure 9: Recovering the tractor from crevasse, 15 miles north of southern Prince Charles Mountains base camp. Weasel and sleeping caravan in left background.

Figure 10: "Mounded" moraine close to base camp in the southern Prince Charles Mountains.

Figure 11: Mount Stinear and in the foreground heavily crevassed Lambert Glacier. Aerial view toward north-west.

Figure 12: Mount Seddon- southern Prince Charles Mountains. Looking south-west. Fisher Glacier in centre background.

Figure 13; Mount Dummett looking south-west. Crevassed blue ice in the foreground.

Figure 14: Repairing the vehicle at Mount Rymill.

Figure 16: North face of Mount McCauley. Joins Figure 15.

Figure 15: North face of Mount McCauley with Mount Scherger in the background. Quartz and amphibolite veins intersect the metasediments at left. The "mounded" moraine in the foreground extends to Mount Scherger. Looking west.

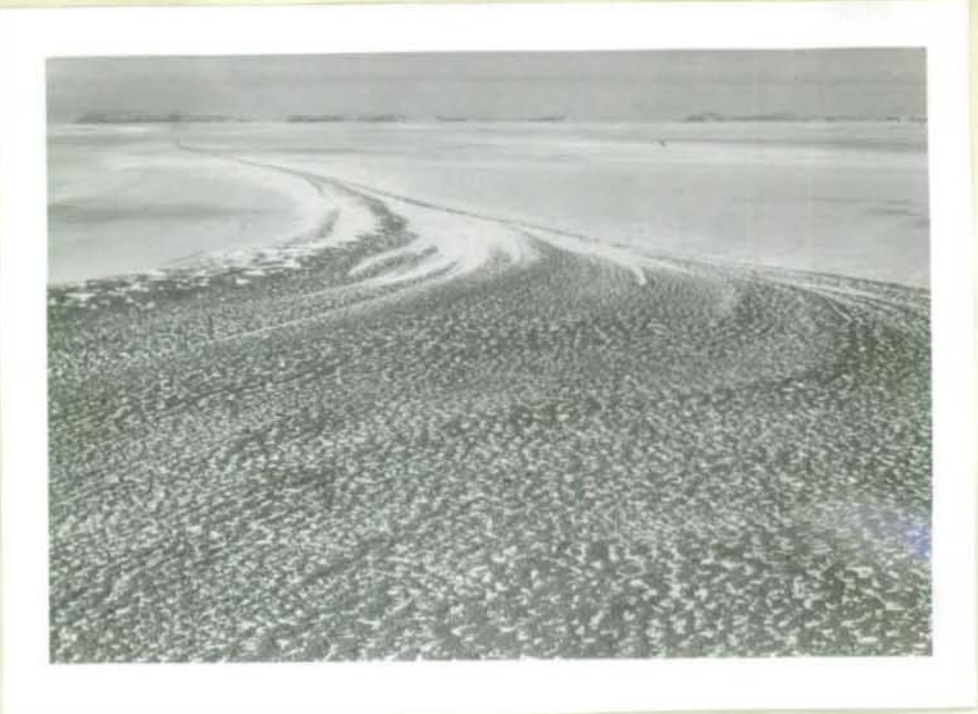


Figure 17: Morainic "tail" at Mount McCauley, looking south-east. Fisher Glacier in centre right and Mount Rubin in background right.

Figure 18: South face of Mount McCauley. Metasediments are intersected by quartz veins. Crevassed blue ice in the foreground.

Figure 19: Mount McCauley looking north-east. Granite in the left foreground. Low grade meta-sediments at right.

Figure 20: Crevass incident at Mount McCauley. The peak right of centre is part of the granite batholith. Right and left background are metasediments.

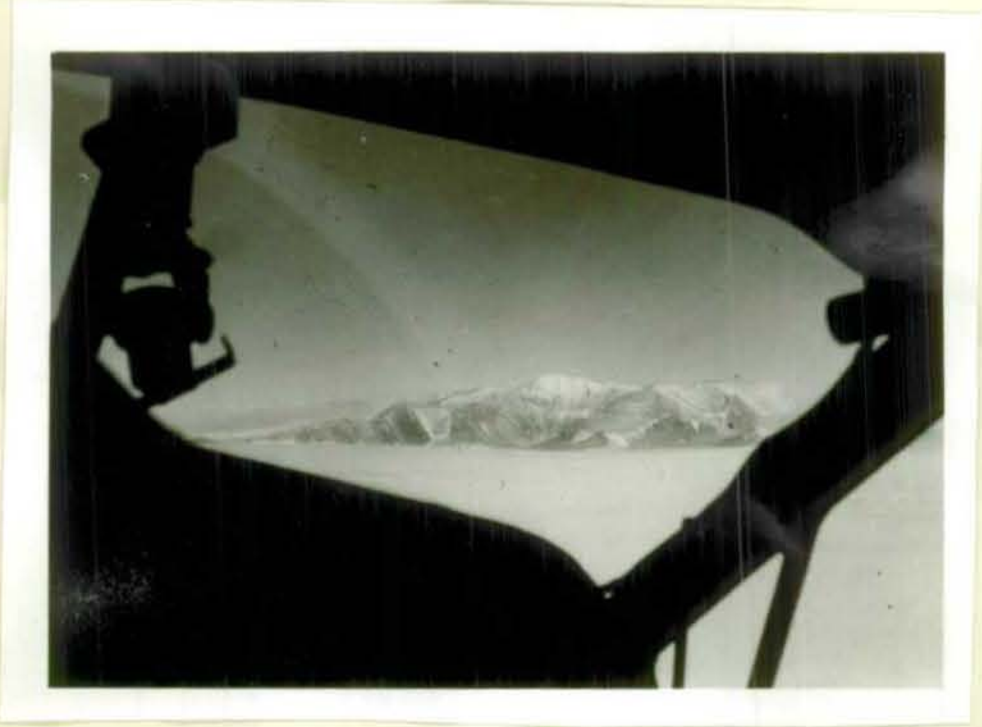


Figure 21: Aerial view of the northern side of Mount Menzies.

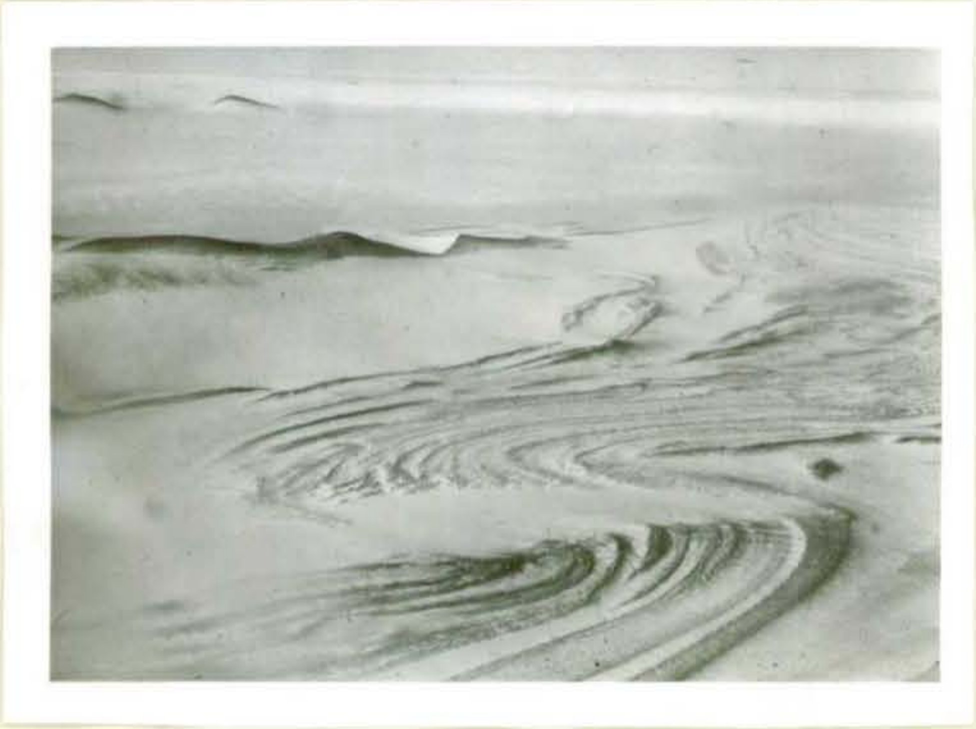


Figure 22: Lateral moraine at Goodspeed Nunataks.
Aerial view looking east.

Figure 23: Mawson Escarpment. Note heavily crevassed areas on Lambert glacier in the foreground. Looking north-north-east.

Figure 24: Mawson Escarpment. Aerial view looking north-east. Cirque glaciers cut the Escarpment; some drain the Law Plateau (in the background) and flow into Lambert Glacier.

Figure 25: Mawson Escarpment in the vicinity of $72^{\circ}33'S$, $68^{\circ}15'E$. Quartz-feldspar-biotite gneiss is intersected by amphibolite. Lambert Glacier in the foreground.

Figure 26: Mawson Escarpment in the vicinity of $72^{\circ}33'S$, $68^{\circ}15'E$. Quartz-feldspar-biotite gneiss is intersected by amphibolite. Lambert Glacier in the foreground.

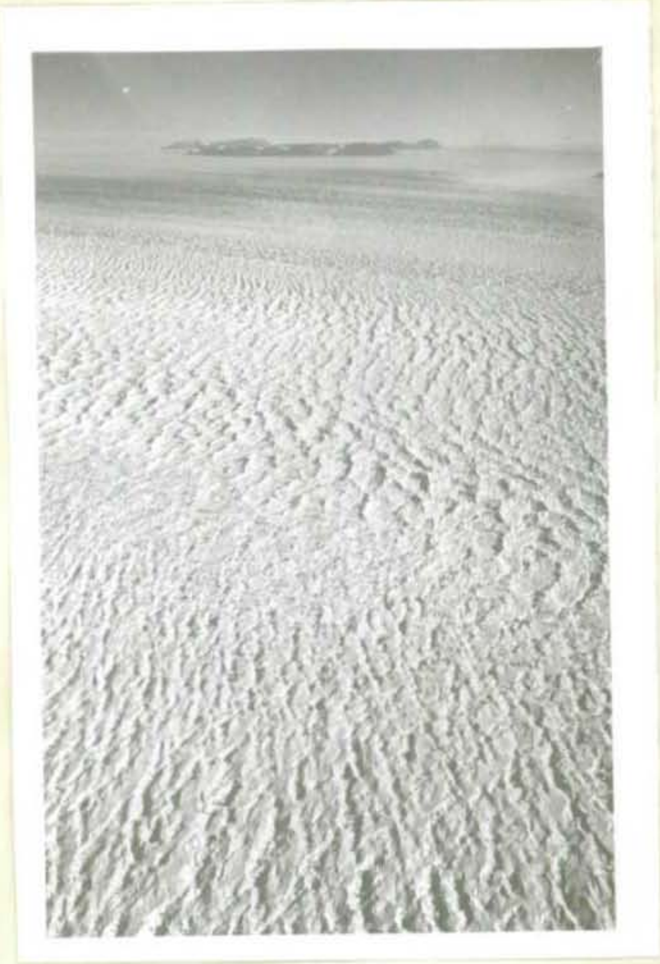


Figure 27: Lambert Glacier looking south, Patrick Point in the background.

Figure 28: Banded charnockitic and pyroxene gneiss typical of the area in the vicinity of 67°34'S, 45°50'E. (West of Casey Bay).

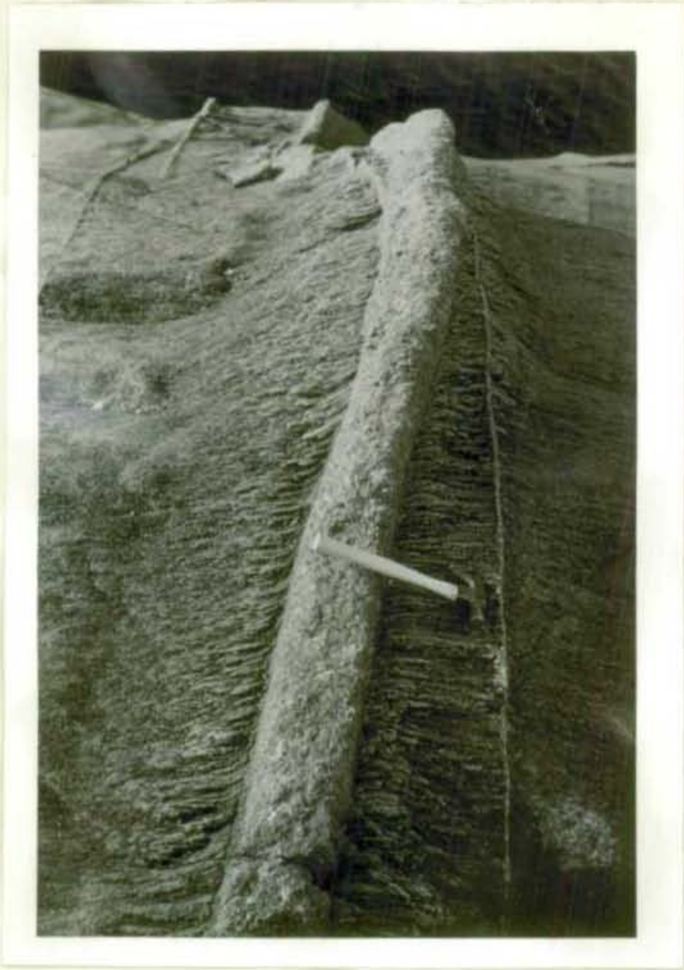


Figure 29: Same Locality, Charnockite gneiss intruded by pegmatite dyke. Contact metamorphosed areas along the Walls.

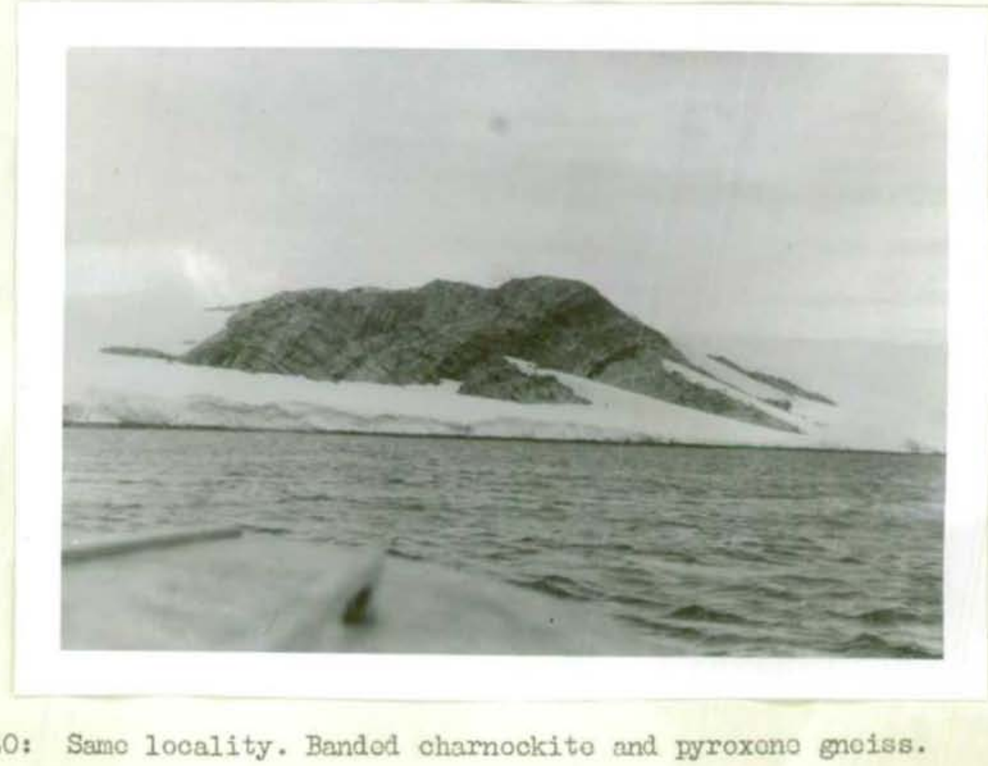


Figure 30: Same locality. Banded charnockite and pyroxene gneiss.

Figure 31: Same locality. Charnockite gneiss intruded by pegmatite dyke. Concentration of biotite and pyroxene along the walls. Quartz vein to the left.

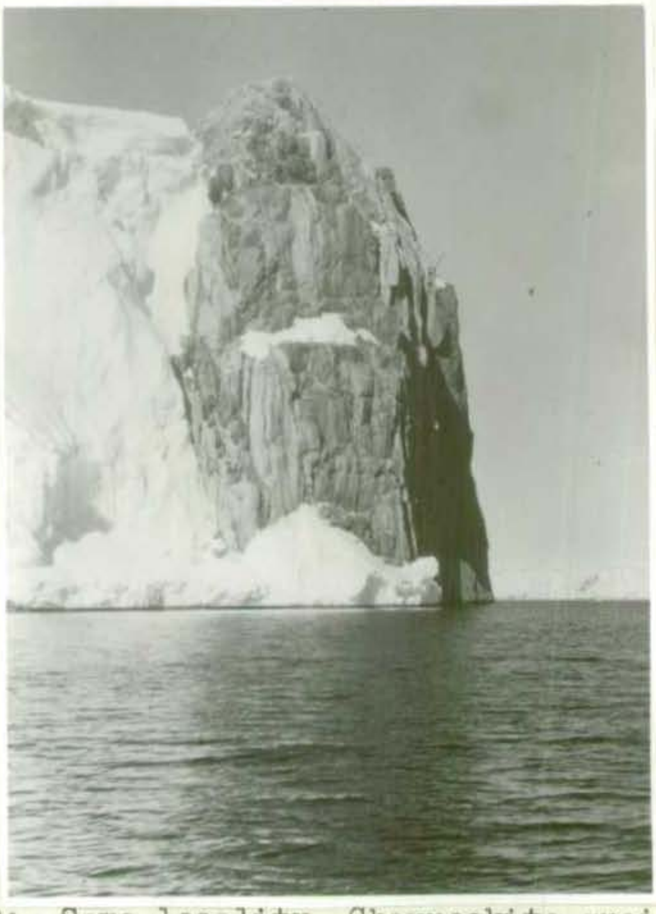


Figure 32: Same locality. Charnockite gneiss with dark bands of pyroxene gneiss. Vertical gneissosity.

Figure 33: Same locality. Two pegmatite dykes intersect charnockite-pyroxene gneiss.

Figure 34: Same locality. Looking south-east from one of the two offshore islands. Charnockite gneiss intersected by quartz veins in the foreground. The peak in the background is glacially polished above a level that meets the horizon.

Figure 35: Same locality. Looking south-west. Charnockite gneiss intersected by quartz veins in the foreground. M/S "Thala Dan" is moored against the edge of the ice sheet in the background.

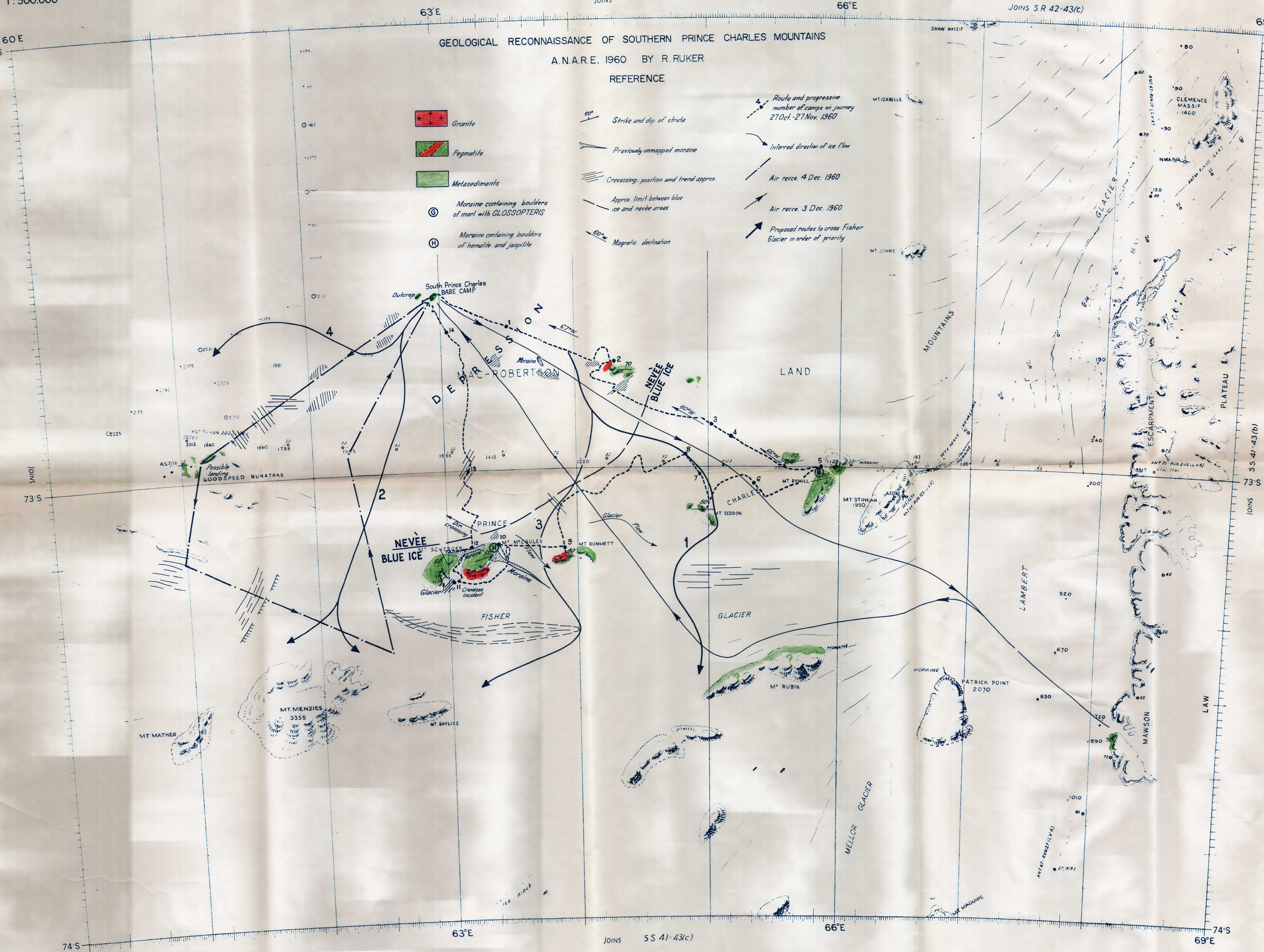
Figure 36: Western coast of Casey Bay. Peninsula at 67°17'S, 47°00'E. Granodiorite gneiss intruded by pegmatite dyke to the right.


ANTARCTICA
AMUNDSEN BAY TO VESTFOLD HILLS
SCALE 1 : 2,000,000.
Altitudes in Metres
Polyconic projection. CM 62° E
Geological information collected by A.N.A.R.E. 1960. R.A. Ruker.
REFERENCE
HIGH GRADE METAMORPHICS
Charnockitic granular gneiss with amphybolite dykes.
Quartz - amphybolite - biotite gneiss
Quartz - feldspar - biotite gneiss
Quartz - feldspar - garnet gneiss with amphybolite and pegmatite dykes
LOW GRADE METAMORPHICS
Undifferentiated quartzites with amphybolite and pegmatite dykes
VOLCANICS
Mt McCauley Granite
Strike and dip of strata
Air traverses
Land traverses
Localities visited from m/s Thala Dan
NOTE: Some features in the Southern Prince Charles Mountains are incorrectly positioned
Proclamation Island
Cape Batterbee
Cape Ann
ENDERBY LAND
MAGNET BAY
Martin Island
KING EDWARD VIII GULF
PENINSULA
TULA RANGE
AMUNDSEN BAY
Beaver Glacier
SCOTT RANGE
CASEY BAY
Wilma Glacier
Robert Glacier
LAW PROMONTORY
STEFANSSON BAY
MAWSON
FRAMNES MOUNTAINS
LECKIE RANGE
HANSEN MOUNTAINS
Cape Darnley
MACKENZIE BAY
PRYDZ BAY
DAVIS
VESTFOLD HILLS
Rauer Group
KEMP LAND
MAC-ROBERTSON LAND
ENDERBY LAND
AMERY ICE SHELF
DEPOT PEAK
STINEAR NUNATAKS
MOUNT MACEY
ANARE NUNATAKS
TRACTOR JOURNEY SEPT.-OCT. 1960
PRINCE CHARLES MOUNTAINS
LARSEMANN HILLS
SANDEFJORD B.
SPAYD OUTLIER
BOUNDARY OF AUSTRALIAN ANTARCTIC TERRITORY
DRONNING MAUD LAND
PRINCESS ELIZABETH LAND
Lambert Glacier
MAWSON ESCARPMENT
NORTH PRINCE CHARLES BASE CAMP
MT RYHILL
MT STINEAR
GOODSPEED NUNATAKS
SOUTHERN PRINCE CHARLES
MT McCAULEY
MT DUMMETT
Fisher Glacier
MT MENZIES
MT RUBIN
PATRICK POINT

AUSTRALIAN ANTARCTIC TERRITORY

BASE COMPILATION

1:500.000



Compiled to Nov. 1959

STATUTE MILES

10 5 0 10 20 30 40 50

10 0 10 20 30 40 50 60 70 80

KILOMETRES

Lambert Conformal Conic Projection
Standard Parallels 72°40' and 75°20'

Division of National Mapping
Department of National Development,
Canberra, A.C.T.

ALL HEIGHTS IN METRES

AN3/7

SHEET
S.S.41-43.(a)