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1960/40

PRELIMINARY REPORT ON GEOLOGICAL WORK DURING THE RELIEF VOYAGE OF THE M.V. "MAGGA DAN", JANUARY - MARCH, 1960.

by

I.R. McLeod

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INTRODUCTION

Ever since Mawson was first established in 1954 on the Antarctic continent by the Australian National Antarctic Research Expedition, it has been the custom to extend the relief voyage beyond the immediate requirements of changing personnel and landing stores at the various stations, to allow exploration of various accessible parts of the coastline. Normally this scientific work was done by members of the parties involved.

In 1958, several supernumeraries, including a surveyor but not a geologist, accompanied the Wilkes relief voyage and carried out special investigations.

An extensive exploration programme was planned for the Wilkes-Davis relief voyage early in 1960, and a geologist and surveyor were carried as supernumeraries. To increase their mobility, two Hiller helicopters, operated by Trans-Australia Airlines, were carried. A De Havilland Beaver, operated by De Havilland (Aust.) was to be used for trimetrogon photography.

At the end of 1959, the two aircraft at Mawson were irreparably damaged during a violent wind storm. This meant that the DC-3 which was to be taken to Mawson early in 1960 would be the only aircraft there. A second aircraft must be available for search and rescue operations, and the Beaver which was to have remained with the Wilkes-Davis relief vessel for the whole voyage was the only aircraft available. Consequently, plans for the relief voyage had to be revised so that this aircraft could carry out some photography before it was taken to Davis and thence flown to Mawson.

As a result, although a considerable amount of geological work was eventually done, the two areas of greatest geological interest on the original itinerary, viz. the Bunger Oasis and Oates Land areas, were not visited.

Places mentioned in the following account are shown on the accompanying map.

NARRATIVE

The M.V. "Magga Dan" (Captain H.M. Pederson) sailed from Melbourne on 5th January, 1960, to relieve the Australian National Antarctic Research Expedition stations at Wilkes and Davis, and, after a comparatively smooth voyage, reached the edge of the pack-ice early on 12th January. After almost a day had been spent forcing a way through increasingly heavy pack, in an effort to reach the coast near the Mertz Glacier, the attempt was abandoned, the heavy pack cleared, and course set for a giant iceberg on the Virik Bank. The dead-reckoning positions found for this berg in 1958 and 1959 differed by 20 miles, and an attempt was to be made to accurately fix its position, and to investigate the reported occurrence of rock on this berg. Unfortunately, a heavy swell near the berg made helicopter operations impossible, so the ship headed for the French station, Dumont D'Urville, which was reached on the morning of 14th January. Here I met Professor Bellair, professor of geology at Paris University, who, during the relief operations (which would take a month) was studying the geology of the islands and coastal outcrops near the station. He spent several hours showing me various

aspects of the local geology, and we spent some time discussing Antarctic geological work in general. An account of the geology as described by him is given later.

The "Magga Dan" left Dumont D'Urville the next day and reached Lewis Island (66°06', 134°22'E), the site of an automatic weather station, on the 17th January. An account of the geological work done here is given later.

The ship sailed on 19th, and after forcing a way through pack-ice, reached the open sea the next day.

An attempt to reach the coast in Porpoise Bay (66°40'S, 128°E) was abandoned because heavy pack was again encountered before the ship was within helicopter range of the coast.

North of Henry Bay (66°50'S, 121°15'E), the next objective, the ship was forced to remain hove-to by high winds for 2½ days, and then set course for Davis, which was reached on the afternoon of 30th January.

At Davis, the following geological work was done:

An aerial examination of the Vestfold Hills, using the Beaver aircraft.

An aerial examination by helicopter of the Rauer Group of islands, and landings at three points.

A landing on the southern side of Ellis Fiord and at Clear Lake in the Vestfold Hills.

Collection of water samples from various lakes.

A series of soundings of Deep Lake.

Brief examination and barometric heighting of raised beaches around the coast and salt lakes, and collection of soil samples from around Deep Lake for salinity tests.

On 1st February, Mr. Law had flown from Davis to Mawson in the Beaver aircraft which was to be handed over to the R.A.A.F. at Mawson. On 4th February the ship left Davis, and next afternoon the Beaver was flown out to meet the "Magga Dan", 70 miles E.N.E. of Mawson, and Messrs. Law, Creswell and Stinear transferred to the ship.

Wilkes was reached on 11th February, and during change-over operations here, the geology of a number of islands of the Windmill Group was examined, as well as the Balaena Islands 20 miles to the north. Specimens for palaeomagnetic determination were collected.

On 13th a flight was made by the two helicopters in company to the Hatch Islands area, 50 miles S.S.W. of Wilkes. While investigating landing possibilities on an outcrop a few miles west of the Hatch Islands, one of the helicopters, carrying the surveyor as passenger, was caught in a violent down-current and crashed near the edge of the plateau, with, fortunately, only minor injuries to the occupants. The second aircraft was landed safely on the outcrop, and subsequent rescue work occupied most of the time until the arrival of the ship, but a brief examination of the geology was made.

The "Magga Dan" sailed from Wilkes early on the morning of 19th February, and that afternoon a landing was again made on the rock outcrop near the scene of the crash, and the geology examined in more detail. Later that night, the largest island of the nearby Davis group was visited, and again the next morning; in addition, an aerial examination was made of the other islands of the group.

The ship then sailed east, turning south into Henry Bay and reaching Chick Island on 22nd February. Two days were spent here awaiting

suitable weather for an astrofix; during this time, the geology of Chick Island and the Henry Islands, 15 miles to the west, was examined.

Because of extensive areas of new ice, the original plan to sail along the coast to Lewis Island was abandoned, and a route outside the pack-ice chosen. Lewis Island was reached early on 28th February, and a day spent rechecking the automatic weather station.

For a number of reasons, plans for further exploration work in the Oates Land area had to be abandoned, and on 29th February, the "Magga Dan" sailed for Australia, calling at Macquarie Island for a few hours on 5th March, and reaching Melbourne on the morning of 11th March.

GEOLOGICAL WORK

VESTFOLD HILLS.

Various parts of these have been examined by B.H. Stinear, and the writer examined only two areas.

Ellis Fiord at 68°36'S,78°15'E. The rocks here are closely alternating garnetiferous quartzites, quartz-feldspar-pyroxene gneiss, and feldspar-quartz-biotite gneiss. The various types, especially the first, show a considerable variation in their texture and proportions of minerals. The rocks display small folds, but have a general strike of 070° and dip of 70° to the north.

Several medium to coarse grained quartz-feldspar veins cut sharply across the banding of the gneisses. Vertical bands of mylonite, a foot or so wide, strike N.N.E. Copper staining occurs both in the more feldspathic varieties of gneiss and in the large dolerite dykes.

Clear Lake. Here light brown feldspar-biotite gneiss occurs, with some quartz and, rarely, garnet; the biotite appears to be a replacement of another mineral. The strike is about east-west and dip 70° north.

Geomorphology. A number of soundings were made in Deep Lake. Beyond a couple of hundred yards from the shore, the depth is roughly constant, between 105 and 115 feet.

Raised beaches, 30 feet above the present sea level, can be recognised near Davis station. A beautiful example occurs near the small lake south-east of Lake Stinear, at a height of approximately 50 feet above sea level. The terrace around the southern side of Lake Stinear is 20 to 25 feet above sea level; the terrace along the northern side of the Lake is possibly higher than this.

Water samples collected during the year have been submitted to the laboratory for analysis. Records were also kept of the ice cover on the lakes and of the water level during the latter part of the year, when melting of the snow cover was most intense.

RAUER GROUP

The rocks at the western end of Filla Island (68°48'S,77°47'E) are migmatites, consisting of pink and white granite veins up to a couple of feet wide, and thin quartz-feldspar veins, invading quartz-feldspar-biotite gneiss, quartz-feldspar-garnet gneiss, and biotite-feldspar gneiss. In places the country rock is rich in garnets. Small tight folds are common, but the general strike is 100° and the dip north at 60° to 80°.

Most of the islands in the group appear to consist of migmatite like that described, and most display a general east-west strike, except in the northern part of the group, where trends are more northerly and irregular. However, on the mainland north of the Brown Glacier (i.e. in the south-eastern part of the group), the rock is fine to medium grained

quartz-feldspar gneiss, with a faint foliation striking 060° and dipping south at 70°. In places a trace of a lineation pitches vertically in this plane. Much of the rock is lightly permeated by limonite, giving it a pale brown colour, and parts of exposed surfaces have a film resembling "desert varnish".

The dolerite dykes which are so characteristic of the nearby Vestfold Hills are completely absent from the Bauer Group, pointing to a major structural discontinuity between the two areas.

ROCK OUTCROP NEAR HATCH ISLANDS

This exposure, situated at 66°53'S, 109°07'E, is made up of migmatite, consisting of bands of grey medium-grained biotite granite and fine-grained quartz-feldspar veins, in fine grained banded feldspar-biotite schist. Most of the veins and bands conform to the schistosity, but some do cut across it in several places. Red garnet occurs along some layers in both the granite and the schist. These migmatites strike 100° and dip south at 30° to 40°.

The migmatite is intruded by dykes of fine to medium grained garnetiferous granite, one of which is in turn cut by a dyke of pink pegmatite. A basalt sill, 5 feet wide, was found on the north side of the outcrop.

A well developed shear moraine occurs in the face of the ice cliffs south of the rock exposure, and the narrow isthmus between the two is strewn with moraine. The most common rock in this is a porphyritic biotite granite not seen in situ in the main rock; strangely enough, the medium grained biotite granite of the outcropping migmatite is almost absent from the moraine. A notable rock type in the moraine is a red or purple fine grained indurated sandstone, boulders of which are moderately common. This sandstone occurs also in the moraine at the Davis, Balaena and Windmill Islands, but has not been found in situ. Possibly it is equivalent to ?Cambrian slightly metamorphosed sediments occurring at Mts. Sandow and Amundsen, 200 miles to the west. (Ravich and Vornnov, 1958). A number of fragments of reddish-brown trachyte were also found in the moraine.

DAVIS ISLANDS

The main island of this group (66°39'S, 108°25'E), consists of several varieties of granite; predominant is a pinkish grey porphyritic biotite granite, largely massive, but in places with a foliation striking 110° and dipping 80° south. A common variant is similar mineralogically, but has a much lower proportion of phenocrysts. Other types include hornblende granodiorite and a small elongated body consisting of red feldspar phenocrysts in a biotite-rich matrix. Thin white quartz veins and shear zones rich in epidote strike north-east.

Many of the rock surfaces have been polished by ice movement. Well developed glacial striae indicate iceflow from south to north. Boulders of red indurated sandstone like those on the outcrop west of Hatch Islands occur amongst the moraine, as well as microconglomerate and ?rhyolite.

WINDMILL ISLANDS

Robertson (1959) has given a short account of the geology of this group (66°15'S, 110°31'E). During relief operations at Wilkes base, brief visits were made to several islands of the group, chosen so that representatives of all Robertson's rock types could be examined. Moraine is common on all the islands visited, and raised beaches were evident on several.

Warrington Island. The rock was called granite gneiss by Robertson. It is a medium-grained rock with a slight banding (produced by thin streaks of biotite striking 075° and dipping south at 70°. Thin feldspar-biotite veins and a couple of aplite dykes cut across the banding.

Odbert Island. Robertson refers to the rock here as a quartz diorite. It is a light-coloured porphyritic rock, parallel alignment of the feldspar phenocrysts producing a foliation striking 085° and dipping 85° south. Small biotite segregations are common; two large ones are cut by quartz-feldspar and granite veins.

Ardery Island. This rock also is called quartz-diorite by Robertson. here it appears to have definite charnockitic affinities - the feldspar is brown and some of the quartz has a bluish tinge. Alignment of the feldspar phenocrysts gives a foliation striking 115° and dipping south at 80°. Specimens were collected for palaeomagnetic measurements.

Robinson Ridge. This shows two contacts between quartz-diorite (striking 080° and dipping vertically) and gneiss, which is a fine-grained rock consisting of alternating bands of quartz and feldspar and biotite and feldspar, tightly folded in places, but generally striking about 115° and dipping south at 60°. The contact zone is about ten yards wide; in it, the gneiss is heavily intruded by veins of coarse-grained granite, similar to the granite gneiss on Warrington Island. On the northern side of the ridge, a body of massive amphibolite, 30 feet wide, cuts across the gneiss.

Herring Island is classed as gneiss and granite gneiss by Robertson. The gneiss is a dark fine-grained quartz-feldspar-biotite rock. The granite gneiss is similar to the rock on Warrington Island; along the southern side of the island it has a charnockitic appearance with brown feldspars and lavender quartz. Irregular feldspar-pyroxene veins occur in this rock.

Clarke Island. This consists of migmatite, made up of quartz-feldspar bands a few inches wide in fine to medium-grained biotite schist, garnetiferous in places; parts of the schist contain white feldspar porphyroblasts. Folds occur in a number of places, but the general strike is 075°. Bands of coarse pegmatite, garnetiferous in part, and up to 50 feet wide, are generally concordant with the migmatite, but cut across it in places. A few veins of red coarse-grained granite occur.

Several narrow fault zones, mostly filled by pegmatite, strike about north-west. Copper staining is common, and a mass of tephroite, several feet across, with associated rhodonite and spessartite, occurs near the camp. Small rhodonite veinings were found at two other places near the camp.

Beall Island is lithologically similar to Clarke Island, except for a higher proportion of granitic material. The general strike is 075°. Several dykes of basalt, striking about 130°, were seen; specimens for palaeomagnetic measurements were collected from one.

Ford Island is dominantly a red porphyritic garnetiferous granite with a vertical foliation striking north-south. Several textural varieties of the dominant rock occur, but no sign of chilling was seen at contacts of various types.

High scintillometer readings were obtained over this island by an airborne survey in 1956, but no significantly high counts were obtained with a portable ratemeter during this last visit. The high readings were probably due to the mass effect of radioactive accessory minerals in the granite.

Shear Moraine. This forms a line many miles long on the plateau behind the islands of the Windmill Group. It is made up of boulders, many showing little rounding, and mainly from 1 to 3 feet across, although larger, and especially, smaller sizes are not uncommon. Most of the rock types are high grade metamorphic or coarse plutonic varieties, but pieces of greenstone and pink felsitic rhyolite were collected.

FRAZIER ISLANDS.

Nelly Island, the largest of this group several miles north-west of the Windmill Islands, is made up of uniform fine-grained finely crenulated feldspar-quartz-biotite gneiss. In the northern part of the island, dark biotite-rich bands alternate with light-coloured fine-grained quartz-feldspar bands containing rare garnets. Biotite is more abundant in the north-west corner of the island. The general strike of the gneisses is 120° and dip 60° to the south.

Near the north-west corner of the island, two pegmatite lenses up to 8 feet wide and 12 feet long, and containing large feldspars and biotite flakes, cut across the general strike of the gneisses.

BALAENA ISLANDS.

Thompson Island, the main island, is composed of a grey medium-grained biotite granite, with a faint foliation striking 080° and dipping south at 20°. The rock is commonly pyritic, and the feldspar in such rock is saussuritised to some degree.

The granite is cut by numerous pegmatite veins and masses; the feldspar of these is epidotised in places; pyrite and chalco-pyrite are common in some.

High readings were obtained over this island during an air-borne scintillometer survey in 1956. Detailed examination with a portable ratemeter during this latest visit revealed no significantly high counts, and the scintillometer anomaly can be attributed to the mass effect of radioactive accessory minerals in the granite.

The island at the southern end of the group consists of a massive fine to medium-grained gabbro. Copper staining is common towards the western end of the island. Vertical bands of shearing strike 030° and 135°.

Erratics occurring near the top of the island include boulders of pink granite and massive, indurated red or purple sandstone.

HENRY ISLANDS

These are made up of a pinkish-grey medium-grained porphyritic biotite granite, with a poorly defined foliation striking east-west and dipping vertically. Small fine grained biotite-rich inclusions are common; these are not aligned parallel to the foliation. Several thin feldspar veins cut the granite.

The rock has widely spaced joints and a smooth rounded surface. No erratics were found.

CHICK ISLAND

The rock here (66°47'S, 121°00'E) is a dark coarse-grained charnockitic granite containing rare biotite and garnet. Small pyroxene or feldspar-rich inclusions are elongated parallel to a faint foliation which strikes east-west and dips between 80° south and vertical. One thin pink coarse-grained quartz-feldspar vein was found.

LEWIS ISLAND

The geology of this island was examined in 1958 (McLeod,1959) A small flat area of rounded boulders, 85 feet above sea-level, may be the result of wave action during a period of higher sea-level.

A small island 5 miles north-east of Lewis Island consists of pinkish-grey porphyroblastic granite gneiss, striking 020° and dipping 45° west; similar, but more biotite-rich rock occurs on Lewis Island. Several thin pegmatite veins and a few quartz veins cut across these rocks.

DUMONT D'URVILLE

I was shown around the station area by Professor Bellair, of the geology department of Paris University, who was making a study of the local geology during relief operations there.

The rock is closely jointed migmatite, consisting of quartz-feldspar-biotite- (hornblende or pyroxene) rock, intimately veined by pinkish grey granite, the larger veins of which have a slight foliation. Bands of massive pink granite cut sharply across the migmatite. Professor Bellair plans to make a series of age determinations of the various rock types.

The moraine includes fragments of indurated red quartz sandstone (which has not been found in situ), similar to the sandstone erratics of the Vincennes Bay area, and a reddish rhyolite, possibly related to the pink granite.

Island summits in the area are grouped about two levels at 10 and 40 metres above present sea level.

CONCLUSIONS AND RECOMMENDATIONS

As a result of this voyage, we now have a knowledge of almost every known coastal outcrop area from east of the Bunger Hills (103°E) to the eastern boundary of Wilkes Land (136°E), as well as increased information from the Vestfold Hills and Windmill Islands.

It is quite evident that the scope for geological exploration and survey work is greatly increased by the use of helicopters. Without them, only a small proportion of the work done during the voyage could have been achieved. It was unfortunate that the two regions of most concentrated rock exposures, viz. the Bunger Hills and the Wilson Hills area, were not visited. The operations in the Vestfold Hills and Windmill Islands showed conclusively that a geological reconnaissance can be made of several hundred square miles of territory in a couple of days.

The Hiller 12-C helicopters used were rather small for the job. With the two travelling in company, carrying a surveyor and geologist, the maximum radius of action was about 30 miles; this can, of course, be increased by laying down fuel depots. The radius for one machine, carrying a geologist only, was about 40 miles. A larger type of aircraft would be an advantage, but nevertheless, in a suitable area, much valuable work could be achieved with similar machines.

It is recommended that (providing helicopters are taken on the voyage) a geologist accompany at least one more relief expedition, and that work be concentrated in the Wilson Hills area. A number of astrofixes are also needed in this area. Given good weather and free movement of the ship along the coast, a reasonably good picture of the geology of most of this region (which includes several hundred square miles of exposed rock), could be obtained in a week. Even if the coast were reached in only one place, a large area could be covered by establishing fuel depots.

This area is likely to prove of exceptional interest because rocks of the greenschist facies have been reported, and rocks of such a low grade are known to occur at only a very few other places in East Antarctica. Knowledge of the geology may also be valuable in delineating the junction of the main shield area and the Antarctic Horst, a great uplifted zone of Upper Proterozoic igneous and metamorphic rocks and Palaeozoic sediments, running along the western edge of the Ross Sea and across to the Weddell Sea. At present the position of the western edge of this horst is practically unknown. Also, the possibility of finding representatives of the Upper Palaeozoic Beacon Group cannot be excluded, because coal-bearing Permian sandstones outcrop 100 miles to the west at Horn Bluff.

All in all, the area, which is the only region of extensively exposed rock still to be explored in the Australian Antarctic Territory, is likely to prove one of great petrological variety and structural complexity, with correspondingly enhanced economic possibilities.

The geologist could also do valuable work during changeover operations at Davis and Wilkes, especially the former, as the geologist at present at Mawson is unlikely to spend any time at Davis because of a full summer programme in MacRobertson Land.

At Davis, much information could be gained by a traverse along a north-south line (i.e. across the strike) across the whole eastern part of the Vestfold Hills. Such a traverse would be difficult if only surface transport was available, because of the distance from the station and irregular distribution of sea and land. Further systematic work should be done on the raised beaches, and specimens for palaeomagnetic measurement and age determination could be collected. A nearby area yet to be visited is the Svenner Islands, and more work should be done in the numerous rock exposures at the head of Prydz Bay.

Opportunities for further work at Wilkes are not so great, because the area has been examined by American geologists, and some of the rocks dated. Palaeomagnetic specimens could be collected, a search made for further manganese deposits, and the moraine behind the camp examined in more detail for unusual rock types which may give a clue to the geology of the ice-covered hinterland. Several small nunataks in the southern part of the group, and some of the Frazier Islands, yet remain to be visited.

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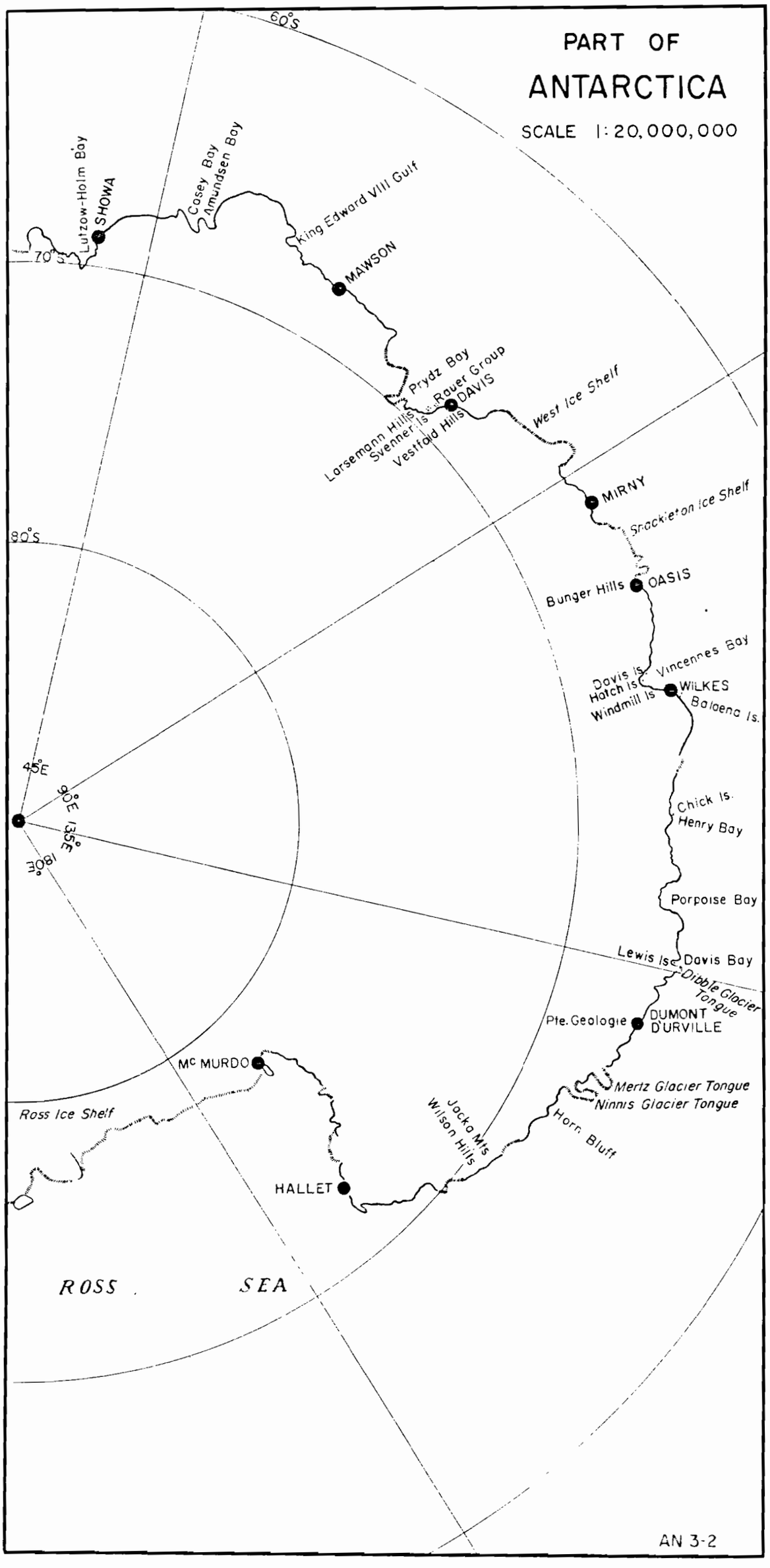
PART OF
ANTARCTICA
SCALE 1: 20,000,000
60°S
70°S
80°S
45°E
90°E
135°E
180°E
Lutzow-Holm Bay
SHOWA
Casey Bay
Amundsen Bay
King Edward VIII Gulf
MAWSON
Prydz Bay
Rauer Group
DAVIS
Larsemann Hills
Svenner Is.
Vestfold Hills
West Ice Shelf
MIRNY
Shackleton Ice Shelf
Bunger Hills
OASIS
Davis Is.
Hatch Is.
Windmill Is.
Vincennes Bay
WILKES
Balaena Is.
Chick Is.
Henry Bay
Porpoise Bay
Lewis Is.
Davis Bay
Dibble Glacier Tongue
Pte. Geologie
DUMONT D'URVILLE
Mertz Glacier Tongue
Ninnis Glacier Tongue
Horn Bluff
Jacka Mts.
Wilson Hills
Mc MURDO
Ross Ice Shelf
HALLET
ROSS SEA
AN 3-2