DEPARTMENT OF NATIONAL DEVELOPMENT AND ENERGY
Secretary: A. J. Woods

DIVISION OF NATIONAL MAPPING
Director: A. G. Bomford

TECHNICAL REPORT 31

EXPEDITION TO THE AUSTRALIAN TERRITORY OF HEARD ISLAND AND McDONALD ISLANDS 1980

by

C. Veenstra, J. Manning
and other members of the expedition

CANBERRA AUSTRALIA
1982

NMP/82/007

FOREWORD

A number of expeditioners from the Division of National Mapping (Natmap) contributed to this report. In addition the report contains contributions by experts from outside Natmap.

It was a great pleasure to be associated with such a fine team of enthusiasts, from both inside and outside Natmap. The final success and quantity of work performed during the short period of the 1980 Expedition were due entirely to the dedication of all the expedition members, the magnificent work by the Captain, officers and crew of the MV Cape Pillar, and not least to the excellent and untiring performance of the helicopter pilot and engineer.

C. Veenstra
Assistant Director, Division of National Mapping
Expedition Leader

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THE EXPEDITION

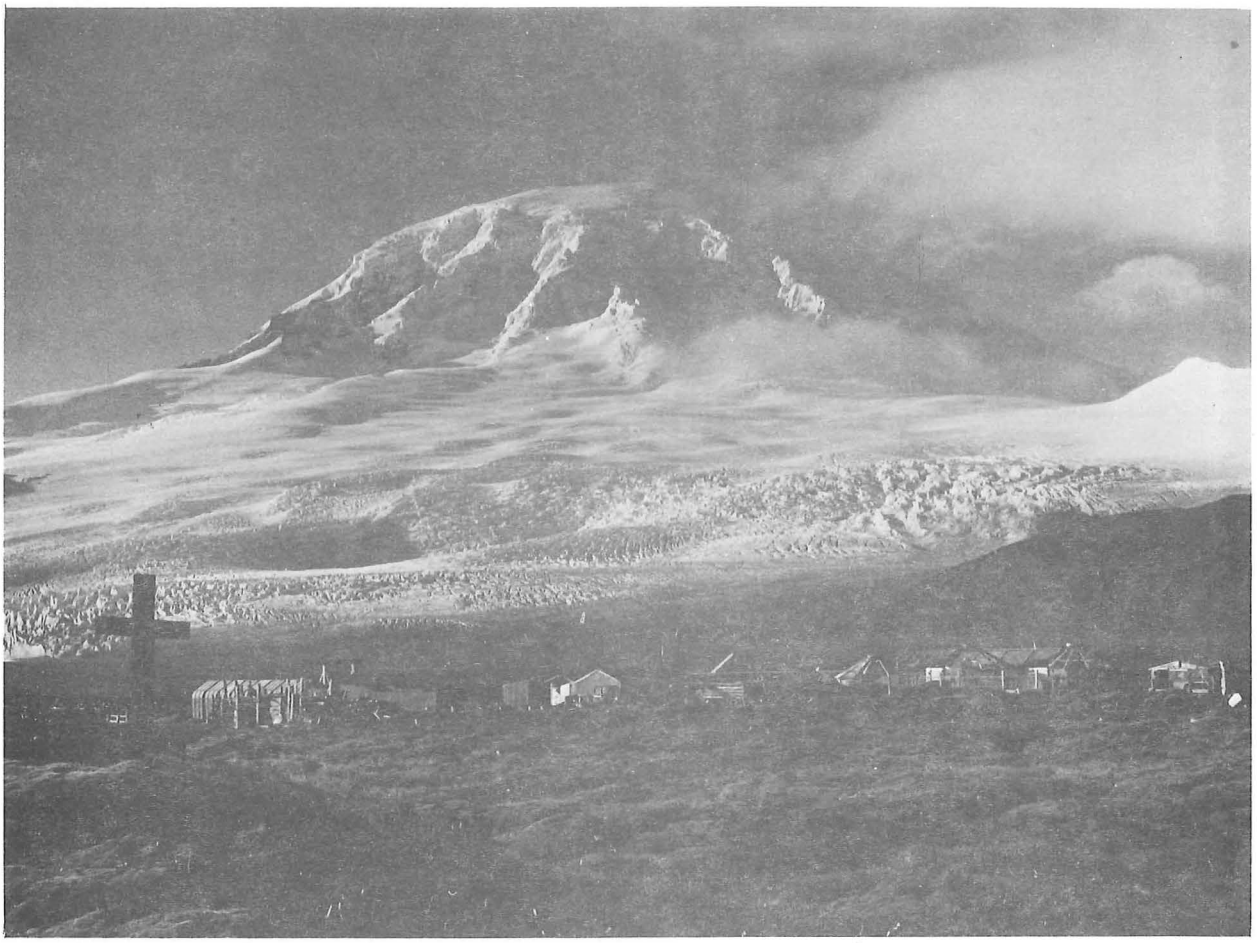


Figure 1. Heard Island. The great domed mass of Big Ben rises majestically behind the ANARE Station. The cross marks the graves of Hoseason and Forbes who died on the island in 1952. (Photo: G.W. Johnstone, Antarctic Division)

The Division of National Mapping as part of its topographic and bathymetric mapping programs mounted an expedition in March 1980 to the Australian Territory of Heard Island and McDonald Islands and the offshore areas under Australian jurisdiction in the vicinity of these islands.

The expedition travelled on the MV Cape Pillar , owned and operated by the Department of Transport. A Hughes 500D helicopter was hired from Central Australian Helicopters, Alice Springs, for survey work on the islands.

The normal cooperative arrangement with the Bureau of Mineral Resources (BMR) on marine data gathering was maintained during this project.

Berths were made available to the Department of Science and the Environment (as it then was) which supported the Antarctic Division's contingent of four scientists on the expedition. These scientists were selected on the scientific merit of the programs to be undertaken, following submissions to the Australian Academy of Science.

The Antarctic Division provided field equipment, clothing and rations for the shore parties at both McDonald Island and Heard Island, as well as radios and a 16 mm Bolex camera.

Details of the project are in Project Instruction NMP/80-015 - at Annex C to the report.

Interim reports on all aspects of the expedition are contained in this report. However, more detailed scientific reports are likely to be prepared in due course.

The main events are summarised in Table 1.

Table 1. Summary of main events

Day	Date - 1980	Remarks - all times are UT + 6 hours
Fri	29 February	Departed Fremantle 1415 hours for Heard and McDonald Islands. Sounding on passage.
Tue	11 March	Anchored at McDonald Island. Shore party disembarked by LARC amphibian. Helicopter used to carry out mapping and scientific work.
Wed	12 March	Weighed anchor 0940 hours and commenced sounding.
Sat	15 March	Anchored at McDonald Island 0045 hours; embarked shore party; weighed anchor at 1300 hours and departed for Heard Island. Sounding on passage. Anchored Atlas Cove, Heard Island, at 1730 hours.
Sun	16 March	Disembarked Heard Island party. Set up camp ashore.
Mon	17 March	At Heard Island. Bathymetric survey at Atlas Cove. Completed unloading of equipment. Shore party commenced mapping and scientific work.
Tue	18 March	Weighed anchor at 1307 hours for sounding operations.
Tue	25 March	Anchored Atlas Cove 1800 hours.
Wed	26 March	Loaded stores and equipment.
Thu	27 March	Recovered wreck of Walrus aircraft, embarked shore party and weighed anchor at 1545 hours. Set course for Iles Kerguelen for medical assistance. Sounding on passage.
Sat	29 March	Anchored at Port aux Francais at 1330 hours.
Sun	30 March	Weighed anchor at 1327 hours and departed for Fremantle. Sounding on passage.
Mon	7 April	Arrived Fremantle 1800 hours.

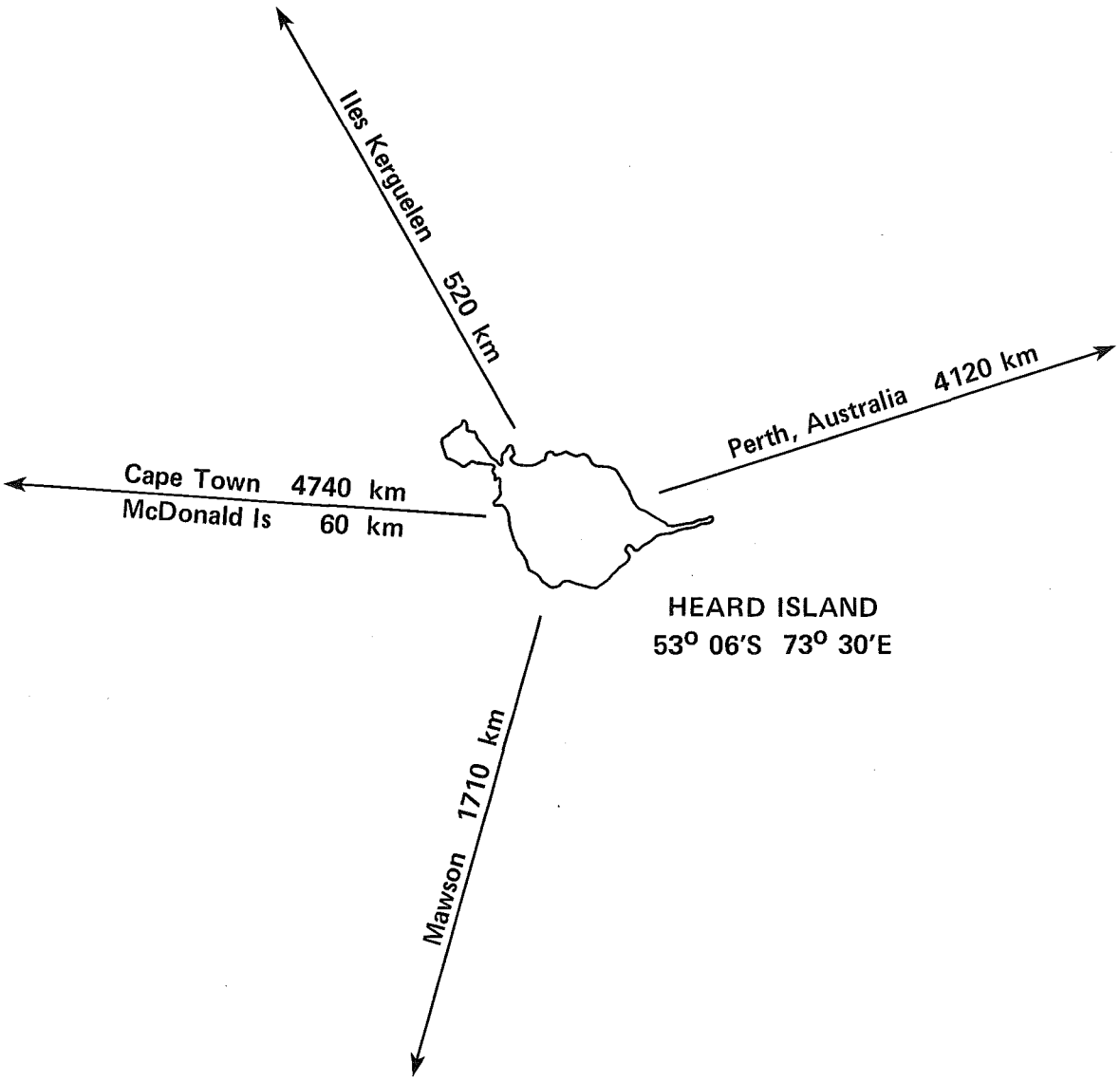


Figure 2. Location of Heard and McDonald Islands

Part Two

MAPPING AND MARINE GEOPHYSICAL REPORTS

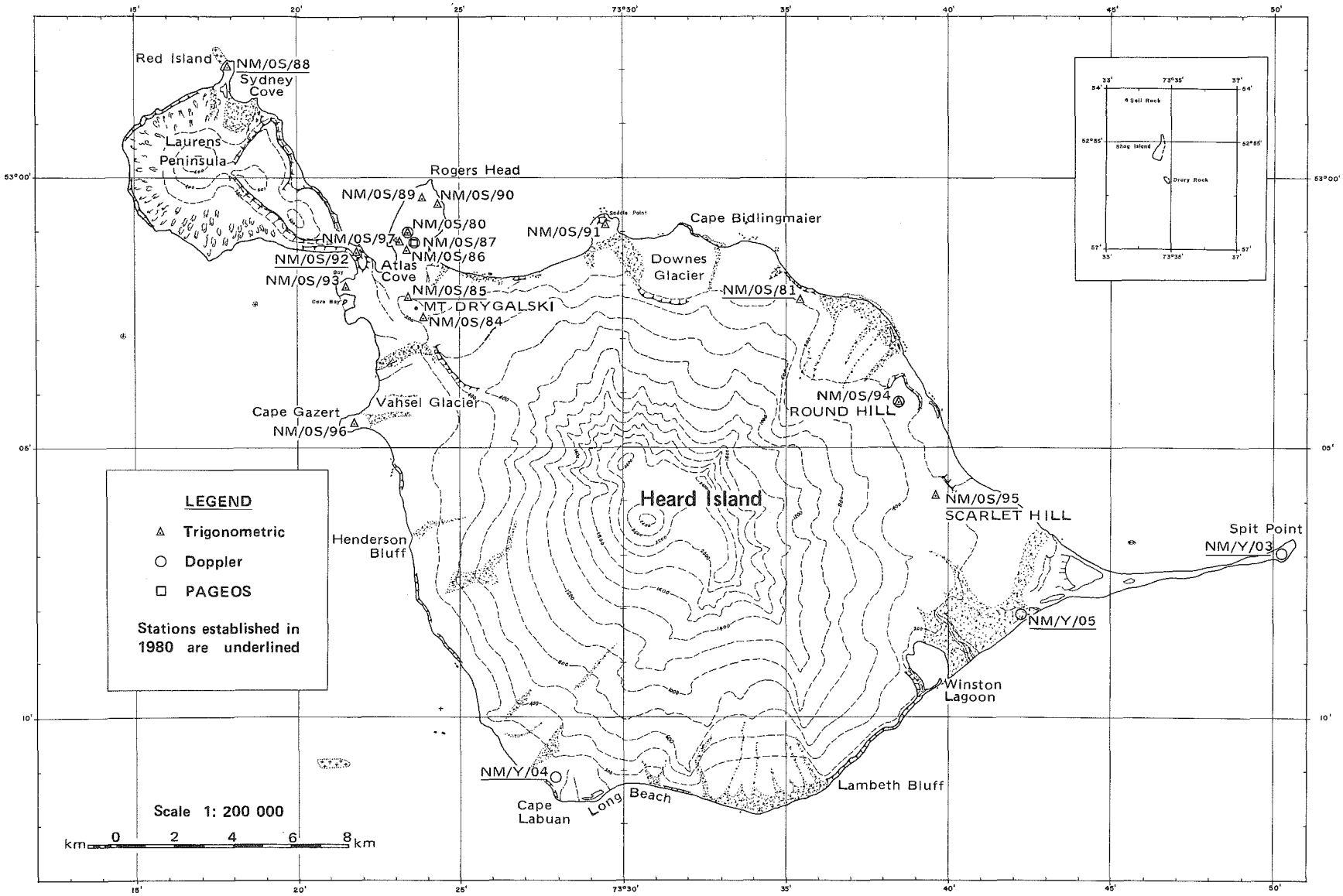


Figure 3. Heard Island, showing survey control points

2.1 SURVEY AND MAPPING OF HEARD ISLAND

2.1.1 History

During sealing operations in 1855 the coastline of Heard Island was explored and roughly charted by the Rogers family but these early maps do not seem to have survived. In 1874 during the voyage of the Challenger a brief visit was made to the island and in June 1874 the first British Admiralty chart of the island was published. This chart was probably based on an earlier map of the American sealers and other information gathered during the visit by the master of the Challenger, Captain G. Nares.

All charts prior to Australian AUS 08 chart in 1949 were sketchy and incomplete. The chart was based on the work of Bob Dovers, surveyor with the 1948 ANARE expedition to the island. To that time the island was thought to be about 6000 ft high but Dovers's survey showed the height of the ice-covered volcanic dome to be 9000 ft. The survey was a priority task for the 1948 expedition and survey control was established around the Laurens Peninsula and along the north-east coast to Round Hill. The inaccessible south and west coasts of the island were not visited. A tide gauge was installed at Atlas Cove.

The best map of the island is at present the 1:50 000 map produced by the Division of National Mapping in 1964, based on Dovers's survey along the north coast; radar plots and photos from ships along the south-west coast; terrestrial photos from mountaineering parties; reports from ANARE scientific parties and oblique photos from the flight of a Walrus seaplane in 1947. The position of the island was determined by star observations by Dovers at Atlas Cove in 1948 using indistinct radio time signals.

In 1969 an American team wintered on the island as part of the worldwide Pageos project. First order astronomical observations were carried out together with tide observations. The position of the satellite camera was permanently marked at Atlas Cove in the vicinity of Dovers's initial survey point. No connection between the two survey positions was made at that time due to misidentification of Dovers's astronomical point.

2.1.2 1980 survey program

The primary purpose of the 1980 shore survey was to fix the points of Heard Island and the Shag Islands lying closest to the French Territory of Iles Kerguelen, to assist in the calculation of a median line.

The secondary task was to take as much aerial photography of the islands as possible using a 70 mm Hasselblad camera, mounted vertically in a Hughes 500D helicopter. Complete photography of the coastline was needed to provide a scientific inventory of coastal features and glacier snouts.

A Doppler position fix was to be made at the American Pageos camera site and a connection between it and the origin of Dovers's 1948 triangulation.

It was clear there would be insufficient time to coordinate enough points to provide adequate control for the coastal photography, let alone to map the entire island.

2.1.3 Doppler survey

JMR observations were made at six stations on Heard Island. Two of these were in Atlas Cove, near the ANARE base. The others were at Spit Point, the eastern extremity of the island; at Cape Labuan on the south coast; at Round Hill, the terminal point for Dovers's 1948 triangulation, near Fairchild Beach; and north-east of Winston Lagoon.

The JMR sets at the Atlas Cove stations were frequently inspected. At the other sites they were checked daily when weather permitted. Due to the failure of a pre-amplifier on McDonald Island it was possible to fit a pre-amplifier to only one set on Heard Island. In the cold weather, signal strengths were lower than normal without the pre-amplifier, although the short antenna cables were used. There was no practical alternative to leaving the sets unattended but it involved some risk to the equipment and the quality of data recorded. At Red Island a JMR unit was run for four days without obtaining any data despite daily visits and attempts to bring it into operation. The position of this station was subsequently fixed by Tellurometer measurements.

In the field, solid wooden boxes were used to give further protection to the JMR sets housed inside their insulated carrying cases. Waterproof sheeting was then nailed over the box as protection against sand, rain and snow.

Spit Point was the habitat of many hundreds of elephant seals. It was swept by driving spray and black volcanic sand. After 24 hours operation, the JMR was covered by half a metre of drifting sand. Twenty-four hours later eight elephant seals had taken possession of the site, knocking a connection off the spare battery and breaking two ground-plane reflector arms. Waves rolled across the spit and it was not a suitable camping site for a party to look after the JMR set.

At Round Hill, the JMR was secured in its carrying case in a plastic covered wooden box and well secured behind a rock wall. Two days later when the weather allowed the site to be revisited, it was a scene of devastation. The protective wooden box and the orange padded protective outer case of the JMR had both gone. The JMR was on its side some six metres away held only by the connecting cable to the antenna, which was anchored by rocks. The wind had probably gusted at over 120 knots. The station is at an elevation of 382 metres but has a vertical drop of nearly 300 metres to Fairchild Beach below. No sign of the missing transit case was found on the hill or the beach. The fate of any party camped at the JMR site to monitor the satellite data collection can only be a matter for conjecture, but it would certainly have been a difficult period.

A complete malfunction in the tape drive on the 'ruggedised' JMR cassette reader negated attempts to use the JMR microprocessor at the Atlas Cove base-camp to verify and prove satellite data. Previous experience on McDonald Island had shown that it was not practicable to link the microprocessor for real-time data manipulation in these extreme field conditions. Thus, in these circumstances it was not possible to verify the collected satellite data at either the point of collection or at the base camp.

2.1.4 Control survey

CA 1000 Tellurometers were used to measure a section of Dovers's triangulation around Atlas Cove, to verify the accuracy of the 1948 survey and to provide a base for future geodetic or topographic mapping control on the island. Twelve single-direction lines were measured and angles were read with Wild T2 theodolites at six stations to verify and supplement the original triangulation.

Directions were read to Sail Rock, Shag Island and Drury Rock to check their position by intersection.

The site of Dovers's initial survey point was located and connections made between this point and the US Pageos station. A new station was established nearby and marked with a concrete pillar. A message capsule was cemented into the top of the monument to record the visit of the expedition.

A Bristol tide gauge was set up at Wharf Point in Atlas Cove and run for seven days. Level connections were made between the gauge and the previous mean sea level datums of the US Pageos team and Dovers's 1948 survey.

All stations including the JMR points and Dovers's stations were marked and spot-photographed. Their locations are shown in Figure 3.

Natmap station numbers were allocated to new stations and to all marks relocated from the 1948 survey:

- NM/OS/80 Natmap Monument, Atlas Cove (new station)
- NM/OS/81 Streeter Bluff (Dovers)
- NM/OS/84 Drygalski 2 (Veenstra Peak)
- NM/OS/85 Drygalski 1 (Dovers trig point)
- NM/OS/86 Initial Point 1948 Survey (Dovers)
- NM/OS/87 Pageos site 0044 (US)
- NM/OS/88 Red Island (new station)
- NM/OS/89 Crater Trig (Dovers)
- NM/OS/90 Corinth (Dovers)
- NM/OS/91 Saddle Point (Dovers)
- NM/OS/92 Mt Aubert de la Rue (Dovers)
- NM/OS/93 Mt Andree (Dovers)
- NM/OS/94 Round Hill (Dovers)
- NM/OS/95 Scarlet Hill (Dovers)
- NM/OS/96 Cape Gazert (Dovers)
- NM/OS/97 Railway Station, Atlas Cove (new station)
- NM/Y /03 JMR site, Spit Point (new station)
- NM/Y /04 JMR site, Holmes Hill, Cape Labuan (new station)
- NM/Y /05 JMR site, Doppler Hill, NE of Winston Lagoon (new station)

2.1.5 Monumentation of Dovers's stations

In addition to the above survey points a search was carried out for original 1948 survey stations along the north-east coast between Saddle Point and Spit Bay. All points occupied were marked with sub-surface metal markers and rock cairns:

. Mechanics Point No 2

This was a trig station on a crater above Cape Bidlingmaier. The whole top of the crater of red volcanic scoria has collapsed on the western side and seems to have taken the 1948 station with it. No sign was found of the eccentric station, which was the highest point of the three morains south of the crater.

. Trig station above Gilchrist Beach - now NM/OS/81

A star picket was placed in the old cairn and photographed from the air.

. Round Hill - Dovers's Mt Scholes

A small cairn presumed to be Dovers's station was found on the north-west side of the highest point. A new station, NM/OS/94, was established on the highest point and connected to the old cairn. A broken thermometer in a copper tubing case was found near the cairn. The station was marked and photographed from the air.

. Scarlet Hill - now NM/OS/95

A small cairn was found on the summit. The station was marked with a star picket and cairn and photographed from the air.

2.1.6 Atlas Cove survey points

Four main survey stations were established in the vicinity of the ANARE base at Atlas Cove:

. NM/OS/80

A brass mushroom station mark was set in concrete at ground level and a concrete pillar erected over it. A bronze Australian offshore station mark was set into the top of the pillar.

. NM/OS/87

This is the 1969 Pageos camera site. The mark is a brass plaque set in bedrock.

. NM/OS/86

The remnants of Dovers's survey pedestal were located and removed. A brass mushroom marker was cemented into bedrock in its place.

. NM/OS/97

This is the astronomical observation station established by the Pageos team. It is the site of the meterological Dynes Mast established by the 1948 ANARE wintering party. A brass mushroom plaque was set in cement in the centre of the concrete slab. During the 1980 expedition, the automatic weather station, supplied by the Bureau of Meteorology, was erected on the Dynes Mast foundations directly above the survey mark.

2.1.7 Aerial photography

Vertical aerial photographs of the whole coastline of Heard Island were completed in four flying days with a vertically mounted 70 mm format Hasselblad camera using a 50 mm f 1.4 Zeiss Distagon lens.

For the coastal section, from Cape Gazert clockwise to Lambeth Bluff, both colour and monochrome photographs were taken from 3050 metres. The remaining section between Lambeth Bluff and Cape Gazert was flown in colour from 1300 metres in difficult conditions under cloud. The section from Cape Labuan to Lambeth Bluff was reflown in black and white. Vertical photographs of Sail Rock, Shag Island and Drury Rock were taken in both monochrome and colour.

Oblique photographs of Big Ben and other parts of the island were taken with a hand-held Hasselblad camera with a 40 mm Distagon wide angle lens. Difficulties in setting the correct exposure were encountered due to the extreme variation in spectral reflectance from the black volcanic rocks, the sea, the glaciers and the ice cap.

Strong cross winds, often over 50 knots, made photography along a predetermined straight flight path difficult. Turbulence constantly affected the helicopter altitude. The crew did well to achieve so much photography in the time available.

2.2 SURVEY AND MAPPING OF McDONALD ISLANDS

2.2.1 History

Although discovered as early as 1854 by Captain McDonald of the brig Samarang, the islands had never been adequately mapped. They were positioned by sightings from Heard Island in 1948 and were shown as five separate islands on chart AUS 08 published in 1949.

In October 1971 a sketch map of the islands was drawn by the Division of National Mapping following the visit of the French ship Gallieni to the area. The map was compiled from hand-held oblique photography by H. Thelander and G. Budd from a French helicopter during the first recorded landing on the islands in January 1971. This map showed that only three islands existed in the group: McDonald Island, Meyer Rock, and Flat Island.

2.2.2 1980 survey program

The purpose of the 1980 field survey was:

- To obtain aerial photography of the whole group using a 70 mm format Hasselblad camera mounted vertically in the Hughes 500D helicopter.

- To fix sufficient control points to compile the photographs into an accurate map.

2.2.3 Aerial photography

Vertical air photography of the three islands was obtained as planned on 11 March. There was no cloud but a strong 60-70 knot wind was blowing from the west. The temperature at 3000 metres altitude was -22°C.

Photographs were taken from three flying heights:

- 3050 metres - only one flight line needed; flown once in colour and repeated in black and white.
- 1650 metres - only one flight line; flown twice in colour as the monochrome magazine jammed in operation.
- 980 metres - two parallel flight lines, in colour, about 500 metres apart; two control points were also photographed at that time on the colour film.

Kodak 2448 Ektachrome was used for colour; Kodak 2403 for black and white.

Photographs from 150 and 300 metres were taken of the first recorded sea-borne landing on McDonald Island by the LARC amphibian from MV Cape Pillar at 12 o'clock on Tuesday 11 March 1980.

During evacuation of the shore party on 15 March, the islands were shrouded in low mist which prevented further photography of control stations or areas of scientific interest. More details of the aerial photography are given in Part Four.

2.2.4 Control survey

Strong winds on 11 March prevented the helicopter from landing on the sites selected for control stations, so the JMR sets, batteries and other equipment were back-packed to these stations.

One JMR with a microprocessor was positioned on top of the northern hill - Samarang Hill - at 112 metres and the other established on the prominent southern high point - Maxwell Hill - a little below the peak at an elevation of 186 metres. The strong westerly winds and intermittent driving snow and rain made survey work difficult. Low signal strengths were received on both the JMR sets and could not be improved even with the short antenna cables. The microprocessor did not function, the pre-amplifier on one set proved faulty and some satellites were not recorded.

The bare cliffs below Maxwell Hill gave large signal reflections and made CA 1000 Tellurometer readings difficult or impossible. Some lines across windblown wet tussock grass and the ocean also had large signal reflection. Four Tellurometer lines were successfully measured and theodolite angles read at each of the four control stations.

A survey station was established on Flat Island - NM/OS/79 - by helicopter on 11 March. This station was intersected from stations in the main survey network. The highest spire on Meyer Rock was also intersected from all four control stations.

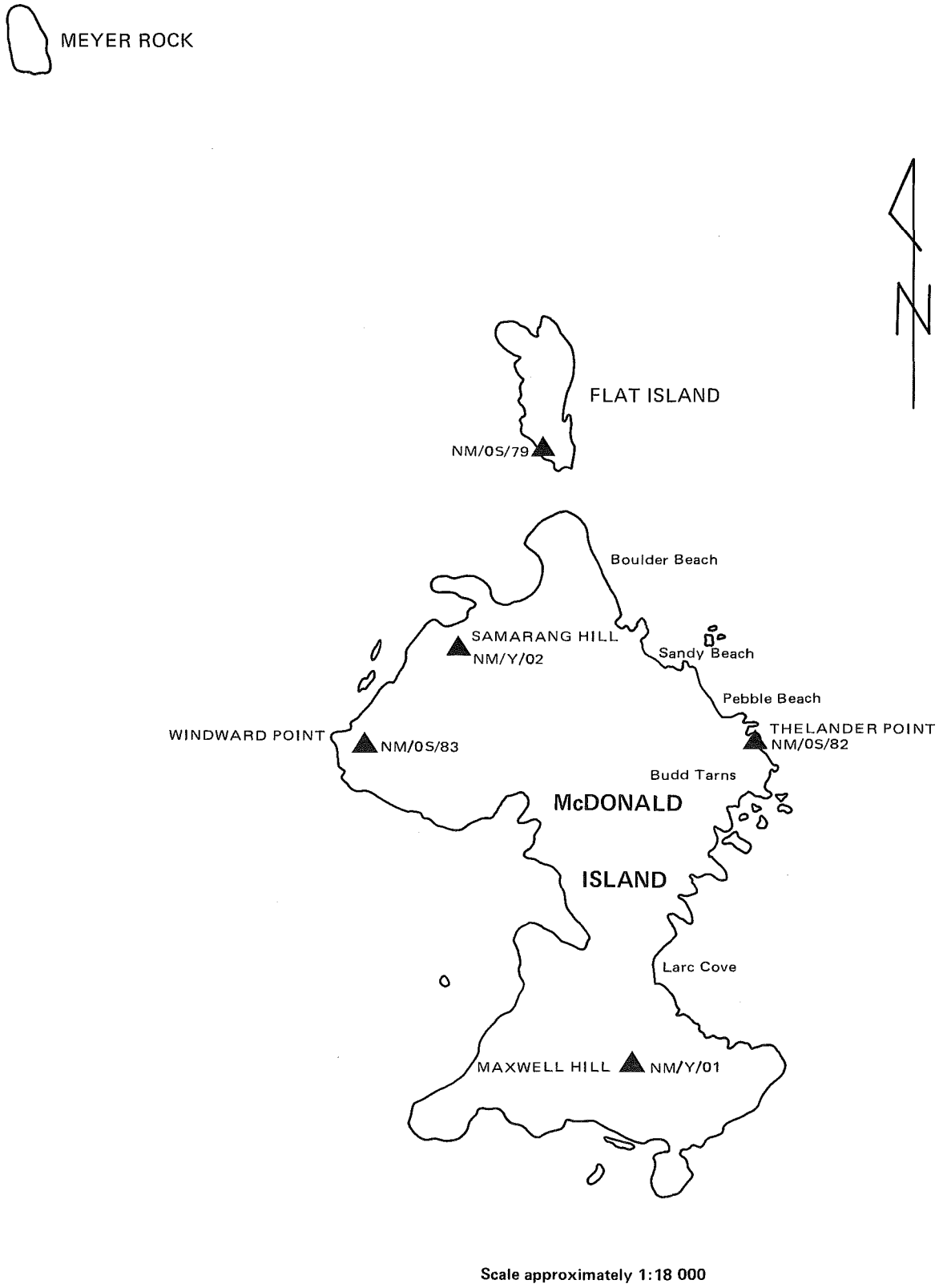


Figure 4. McDonald Islands, showing survey control points

An approximate connection to sea level was made at NM/OS/82 by measuring with a steel band vertically down a cliff face to the sea. A further spot elevation was established at the camp site near the middle of the island to provide height information for the expedition's botanist.

The control stations are shown in Figure 4.

2.2.5 Monuments

The following survey stations were established:

. NM/Y/01

A JMR site at an elevation of 186 metres on a penguin rookery ledge on the highest hill on the island. A bronze rod was driven to ground level and a concrete block with an inset JMR plaque established over it. A small 50 cm high rock cairn was built over the mark.

. NM/Y/02

A JMR site on the summit of the northern hill - Samarang Hill - at an elevation of 112 metres. A JMR plaque was set in a concrete block over a star picket. A substantial 1.5 metre rock cairn visible from seaward was built over the mark.

. NM/OS/82

A Tellurometer station on the east coast - Thelander Point - at an elevation of 24 metres. A bronze rod was driven firmly into bedrock and a circular bronze plaque, NM/OS/82,set in concrete around it. A rock-filled galvanised garbage tin was placed over the ground mark as a beacon. This monument is clearly visible from the south-east side of the island.

. NM/OS/83

A Tellurometer station on the north-west point of the island - Windward Point - at an elevation of 68 metres. A bronze rod was driven into volcanic bedrock and set in a concrete block. A one-metre cairn was built over the mark.

. NM/OS/79

Located on the south-western end of Flat Island. A star picket was driven into rock and a bronze plaque, NM/OS/79, set in concrete.

A spot height was established at the camp site. This was marked by a stainless steel ground mark with a star picket driven alongside it. A brief note of the occupation by the shore party was left in a tin at this site.

2.2.6 Magnetic observations

Third order magnetic observations for field strength and declination were made at Windward Point - NM/OS/83 - on 13 March. The reference object for the declination observations was NM/Y/01. Sun observations for azimuth were made later.

2.2.7 Access

Access to the island is difficult and probably best by helicopter if wind and visibility permit. The high points of the island are windy and turbulent for helicopter landings. The best sites for landings are in the waist of the island on the gravelly sites just to the west of the tarns.

The LARC landing beach is small at low tide: it is below water at high tide. Access from it to the island is by means of a safe, smelly, Macaroni penguin ramp some 3 metres in width. This is the only proven landing with access to the island plateau.

Other possible sea landings are at the south end of Sandy Beach where there appears to be a good straight channel through the reefs. This could only be used in the right weather. Access from this beach to Boulder Beach appears to be difficult due to the rocky bar separating these beaches. No access to the plateau from Sandy Beach exists: the cliffs are vertical, rotten and about 50 metres high.

Boulder Beach is not considered to be a possibility for landings. The high northern cliffs present a barrier to access from Boulder Beach to the plateau necessitating a vertical climb of 6-10 metres. There is access to the south part of Little Pebble Beach* from a Macaroni penguin rookery but there is no access northwards along the foreshore past Thelander Point.

The high southern parts of the island can be reached from the waist of the island up through the eroded gullies of the Macaroni penguin rookery. A small cairn was built on the highest point of the island - Maxwell Hill. Access is then possible from this high area to the south-west headland past several rock spires on to the south bluffs of the island.

There is no possibility of sea landings on the southern, western or northern sides of the island. Access to Flat Island is by helicopter only, where a windswept landing can be made. There appears to be no possibility of landings on Meyer Rock.

2.3 BATHYMETRIC SURVEYS IN THE VICINITY OF HEARD AND McDONALD ISLANDS by B.Obst

On 22 February 1980 Brown and Pittar joined the Cape Pillar in Melbourne to prepare the Magnavox Satellite Navigation System for the Heard Island expedition. All electrical wiring had recently been placed in shielded ducting to prevent interference from radio transmissions. The system functioned well between Melbourne and Fremantle.

Obst and Spellacy joined the Cape Pillar on 29 February to complete the National Mapping bathymetric party. The ship sailed from Fremantle at 1615 hours on Friday 29 February.

During the trip to Heard Island navigation data was supplied to BMR's data acquisition system. Bathythermographs were launched every three hours.

* The beach to the south of Thelander Point.

Natmap's Atlas Deso-10 echosounder was used to record depths to 1400 metres. BMR's Raytheon bathymetric system was used in deeper water. When surveying in depths of less than 300 metres, Natmap's Doppler sonar was able to receive return signals from the seabed and better positional accuracy was possible.

The Kerguelen Plateau was almost covered by a 30-mile sounding grid - see Figure 6 - but large gaps remain to the south of Heard Island. Lines HD17, HD18 and HD20 were not part of the regular pattern but rough seas forced soundings to be carried out in this direction.

While the ship was at anchor in Atlas Cove a detailed bathymetric survey of a strip 400 metres wide between the 30 metre and 5 metre bathymetric contours was carried out using the survey launch and Miniranger positioning system.

Miniranger transponders were placed on stations Drygalski and Dovers Crater. Lines at 20 metre spacing were sounded at constant ranges from the Dovers Crater station. Squalls, snow and choppy water made control of the launch a difficult task. The soundings indicated a regular seabed with no obstructions. A wooden leading mark was placed on the shore of Atlas Cove which when aligned with Mt Drygalski indicates the centre of the surveyed area in Atlas Cove.

An Aanderaa bottom-mounted tide recorder was placed in 19 metres of water in Atlas Cove. Ten days good records from this allowed tide corrections to be applied to the shallow water soundings.

A Bristol tide recorder was established on a small jetty at Atlas Cove. However, the first low tide left the jetty high and dry and the sensor had to be moved into deeper water making it vulnerable to seals. Good records were obtained to supplement the Aanderaa information.

Meyer, Drury and Seal Rocks and Shag Island were positioned from the ship using satellite fixes with short radar radiations from ship to shore.

After a visit to Iles Kerguelen the Cape Pillar left for Fremantle on Sunday 30 March 1980.

Throughout the trip the bathymetric equipment worked well with only occasional malfunctioning of the satellite navigation system teletype unit due to the ship's radio transmissions. This improvement on previous levels of interference is no doubt due to the extra shielding installed prior to the expedition. Failure of the AC power supply caused the greatest loss of records during the bathymetric survey.

A faulty teletype board was the only equipment malfunction.

During rough weather the ship's autopilot often jumped 14 degrees. An off-course warning could be fitted to guard against this.

2.4 MARINE GEOPHYSICAL OPERATIONS IN THE VICINITY OF HEARD AND McDONALD ISLANDS - by L.A. Tilbury

2.4.1 Introduction

The BMR geophysics operation collected magnetic and bathymetric data using a computer-based Data Acquisition System - DAS (Figure 7). Data were collected continuously while the ship was underway, both over the deep ocean basins and over the Kerguelen Plateau, the large oceanic ridge on which the islands of Heard and Kerguelen are situated.

The geophysical equipment consisted of a proton precession magnetometer, to measure the total intensity of the earth's magnetic field, and a deep-sounding Raytheon echosounder designed to measure water depths down to 5000 metres - the conventional echosounders on MV Cape Pillar did not have sufficient range for the deep ocean basins.

The Heard Island Expedition provided BMR's first opportunity since 1973 to use the Raytheon bathymetric system, and it was the first time that a new array of nine transducers was used with the system. Overall, the records were good, and up to 200 milliseconds of sub-bottom penetration were obtained.

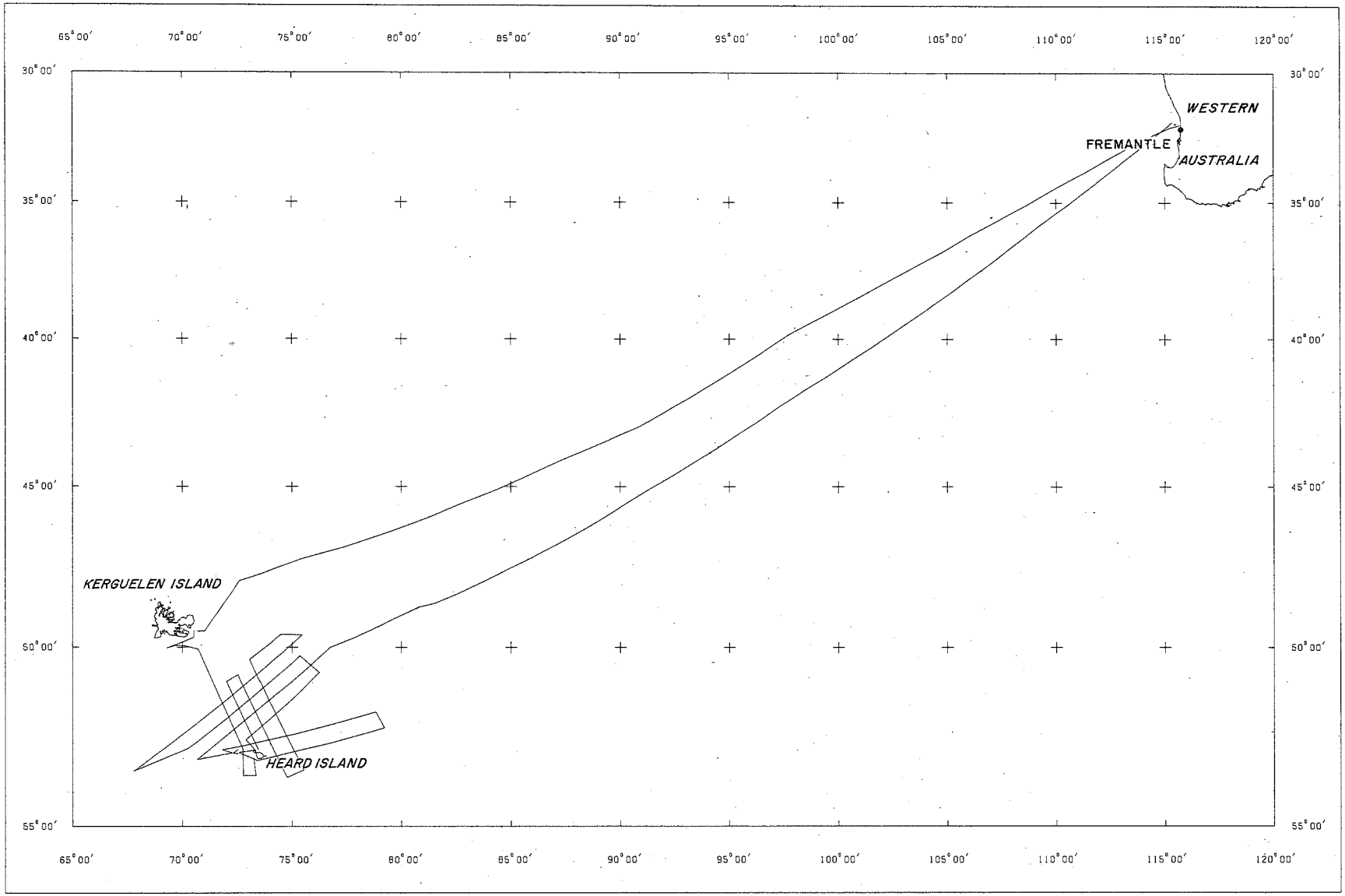
The BMR marine geophysical program was carried out successfully and almost complete bathymetric and magnetic coverage was obtained for the 7000 nautical miles traversed - see Figure 5. This consisted of about 3000 miles over the Kerguelen Plateau and a further 4000 miles in the two transit lines between Fremantle and Heard Island. An additional 1000 nautical miles of data were collected on the test cruise from Melbourne to Fremantle.

The proposed traverse plan over the Kerguelen Plateau was followed - see Figure 6 - except that two north-south lines were deleted because of time constraints and the two southernmost east-west lines were rotated 45° because of the prevailing weather. A total of 2907 nautical miles was surveyed over the Kerguelen Plateau. All traverses extended into deep water beyond the major increase in slope that occurs at about 1000 metres and most extend to regions with depths greater than 3000 metres. Four north-south tie lines, one of which extends to Iles Kerguelen, completed the traverse network. This new network complements the existing French survey tracks to give a fairly comprehensive magnetic and bathymetric coverage of the Kerguelen Plateau around Heard Island.

Bathymetric data obtained during the expedition further defined the morphology of the Heard-Kerguelen region, which is the shallowest part of the Kerguelen Plateau and is defined approximately by the 1000 metre isobath.

Magnetic anomalies over the Heard-Kerguelen region are highly disturbed due to the shallow basement and abundant volcanics.

The two transit lines between the Kerguelen Plateau and Fremantle fill a gap in the existing traverse network and have allowed the magnetic anomaly pattern to be better defined. The most significant result is the identification of an anomaly immediately adjacent to the northeast margin of the plateau. This anomaly, previously identified in the south, is now known to extend along most of the eastern margin of the Kerguelen Plateau. Several previously



Record 1981/16

W/B8-167A

Figure 5. Expedition track map (from BMR Record 1981/16)

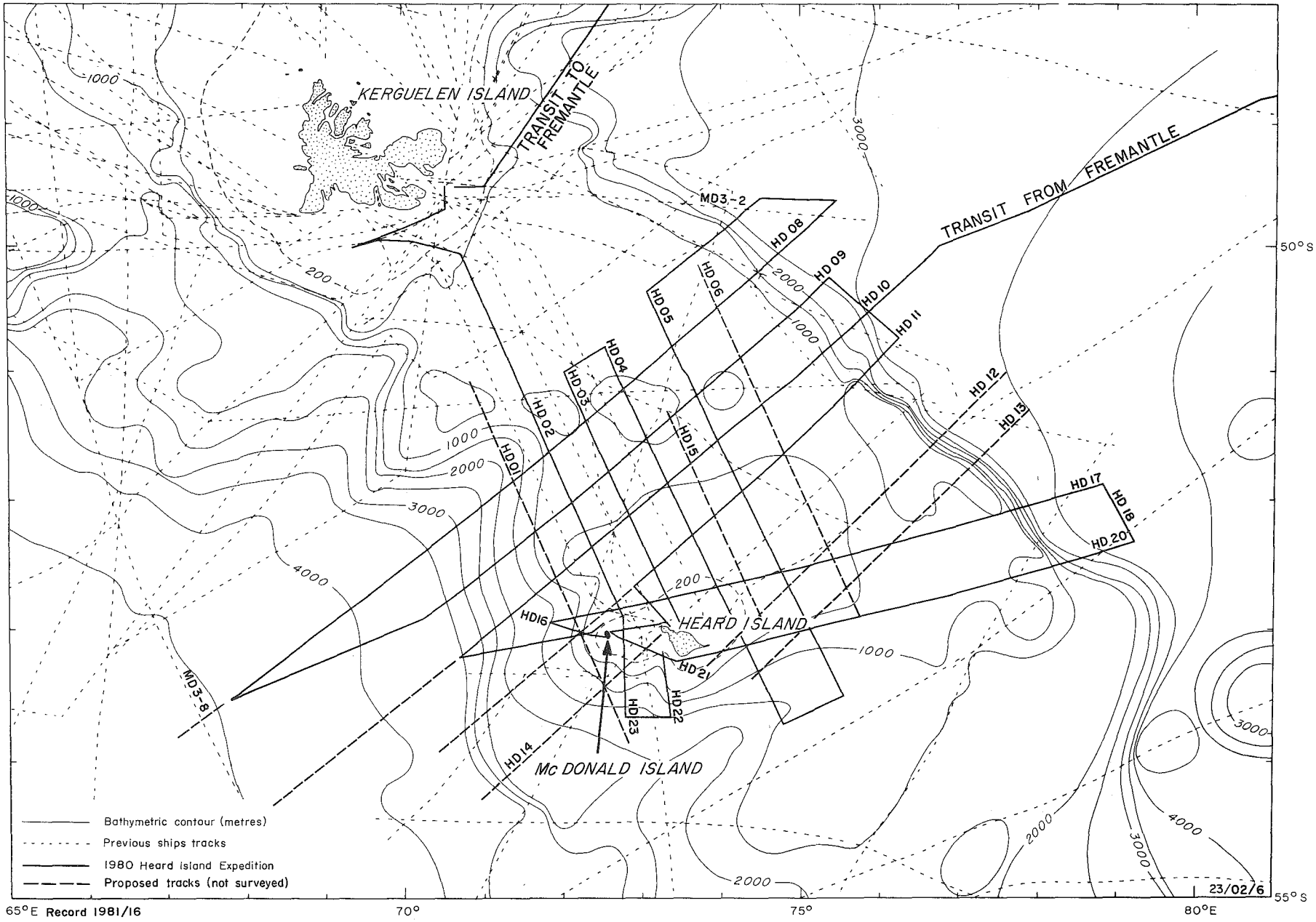


Figure 6. Proposed and actual tracks over the Kerguelen Plateau (from BMR Record 1981/16)

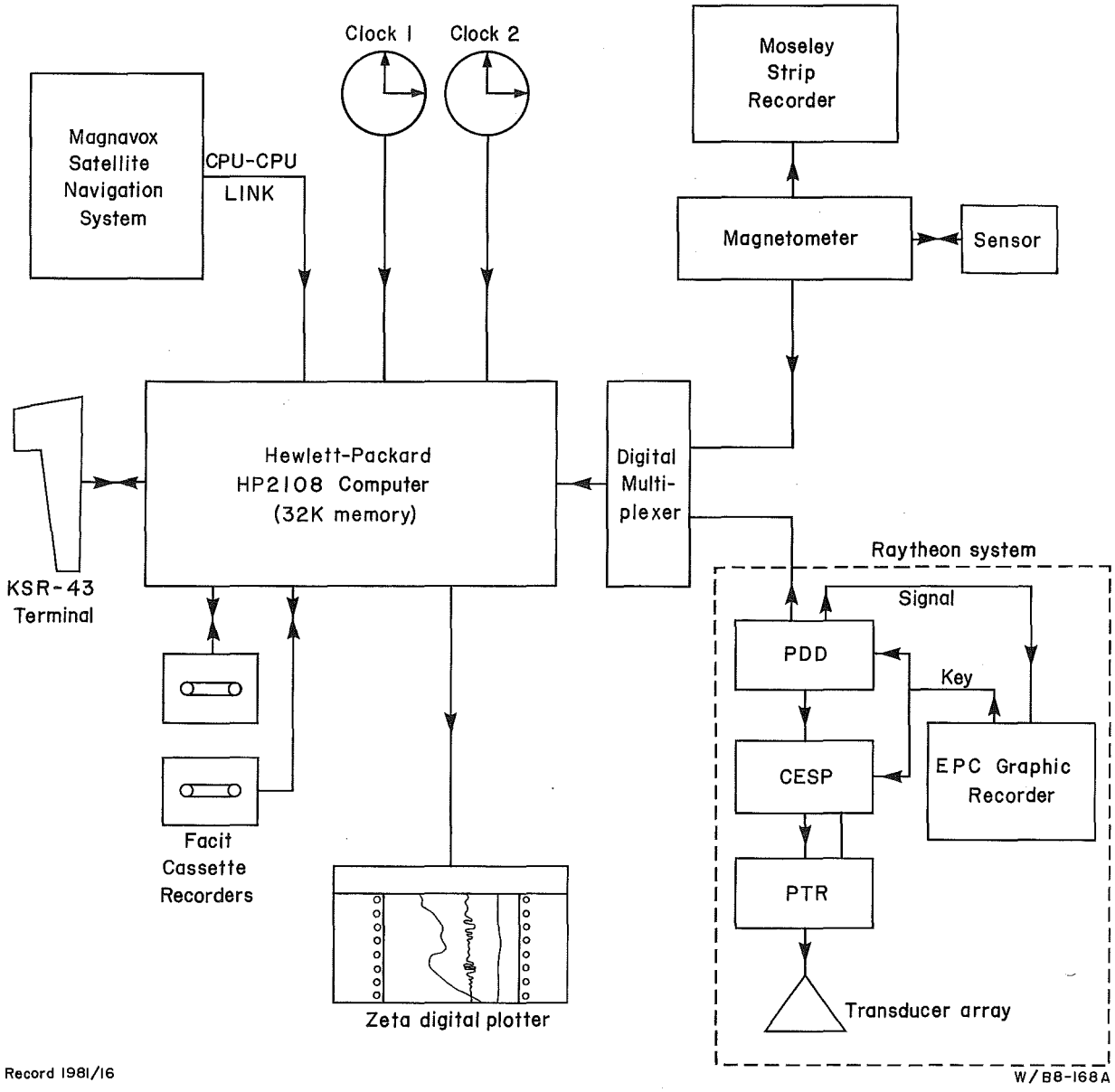


Figure 7. Schematic of the Data Acquisition System used on MV Cape Pillar (from BMR Record 1981/16)

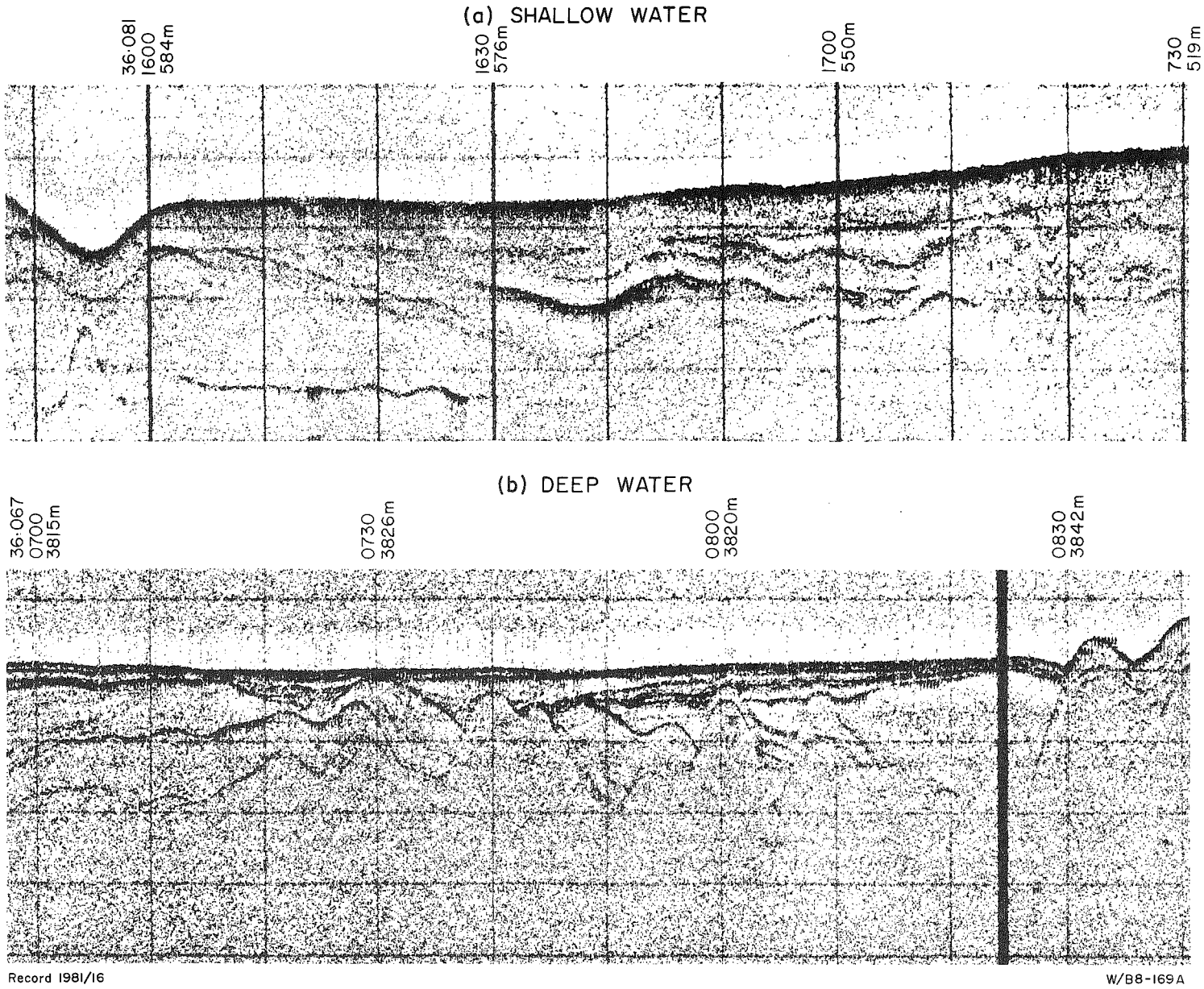


Figure 8. Raytheon bathymetric system - example of 'penetration' (from BMR Record 1981/16)

identified feature zones are also now known to extend southwesterly, almost to the plateau margin.

The preliminary results of the 1980 Heard Island expedition are based on monitor sections produced on board the ship and preliminary one-minute values extracted from data files that have been only partly cleaned and reduced. Only minor errors are present in the line profile and the navigation data have been fully adjusted.

The north-eastern margin of the plateau is a steep scarp which drops from 1000 metres to the deep ocean floor at about 3500 metres. Bathymetric profiles show this scarp in detail and support the conclusions of Houtz and others (1977) that this margin is fault controlled. Associated with the margin is a rugged bottom topography presumably caused by numerous volcanic extrusions. The steep scarp is broken by a small terrace that occurs midway down the slope on the southern profiles.

In contrast, the western margin is not as steep, deepening gradually from the plateau edge at 1000 metres to the ocean floor at about 4500 metres. This ocean basin is significantly deeper than the south-east Indian Ocean basin adjoining the eastern margin, leading to the speculation that it is much older. Several block structures trend north-westerly along the inner edge of the plateau.

South of Heard Island there is an easterly-trending scarp, with relief of about 500 metres which forms a topographic boundary between the northern and southern portions of the Kerguelen Plateau. The scarp may also be an expression of a structural boundary. Profiles from the voyages on USS Eltanin reproduced in Houtz and others (1977) show a distinct change in basement from a volcanic/igneous intrusive complex in the north to a more subdued basement topography in the south. The southern portion, defined approximately by the 2000 metre isobath, is much deeper than its northern counterpart and contains no island groups. A zone of high amplitude, short wave length anomalies along the eastern margin of the Plateau is probably related to the same volcanic/igneous complex. The anomalies within this zone have amplitudes up to 2000 nanoteslas. The amplitude and frequency of the magnetics decrease westwards, reflecting the change to a more subdued basement topography.

Near Heard and McDonald Islands, short wavelength anomalies of less than 0.5 km reflect the shallow volcanic basement existing around these islands. In fact the rugged seafloor topography apparent on the echosounder records suggests that the magnetic anomalies arise from sources within the seafloor or very close to it.

The block structures along the western margin all have large, high frequency magnetic anomalies associated with them, and are probably volcanic/igneous rocks formed as upthrown fault blocks or emplaced by normal extrusive processes. As several of these structures are flat-topped and lie at consistent water depths of about 260 metres, that have probably been subjected to subaerial erosion in the recent geological past. The Raytheon echosounding system, which normally gave 100-200 milliseconds penetration in sedimentary areas, gave no penetration over these block structures and very little penetration in the Heard-McDonald area in general.

2.4.2 Test Cruise, Melbourne to Perth, 21 February 1980 to 26 February 1980

The Raytheon and Data Acquisition System equipment was installed at Melbourne during the outfitting of the ship for the Heard Island expedition. For easier installation the nine transducers of the Raytheon system were mounted within the ship's double hull, in the starboard freshwater tank. The concrete lining of the tank was removed from the hull plate and the mounting brackets for the transducers welded into place. An eight metre high steel pipe was mounted in the top of the tank to provide a pressure head for the transducers. The pipe was 8.5 cm in diameter and protruded through the lower hold. Its top was exposed in the tween-decks for inspection and to allow for topping up to maintain the pressure head. The DAS equipment was installed in three racks in the VIP cabin on the bridge deck. The racks were reinforced and braced laterally to the bulkhead.

The transit from Melbourne to Perth was used to test the DAS and Raytheon equipment under operational conditions and some 1000 nautical miles of data were collected between Cape Otway, Victoria and Albany, Western Australia. Surveying was then suspended as the ship's alternating current system required modifications. In the Great Australian Bight about 20 hours of data were not recorded as the DAS Hewlett-Packard HP2107 minicomputer was being used in tests involving the Magnavox satellite navigation system.

During the test cruise, several problems were encountered with the noise level on magnetic records using the new magnetometer sensor being higher than normal. The fluid in the sensor was replaced but the high noise level remained. A check of the system revealed that the output signal from the sensor was only about 30 percent of the expected signal and this probably contributed to the relatively high noise level encountered in this survey.

The magnetometer winch motor had insufficient starting torque to commence rewinding the magnetometer cable and three seamen were required to pull on the cable to enable the winch to get started. The problem was solved in Fremantle by electrical contractors who rewired the starting mechanism of the winch motor.

The Raytheon digital echosounding system was tested at sea to determine the optimum operational settings.

The digital water depth from the Raytheon system is greater than the true water depth by an amount equal to the width of the transmission pulse which is 64 milliseconds or 46.4 metres. Rather than use the delay facility in the system to compensate for the transmission pulse width, all depth values are recorded unadjusted. In addition, no corrections are made for the draught of the ship. This ensured that the digital values were consistent with the depths displayed on the graphic recorder which used the start of the transmitted pulse as the zero mark, and avoided recording depth data in different forms with inconsistent datums, which would lead to problems during later editing of the bathymetric data.

True water depths are computed using the formula:

TRUE DEPTH = PDD READING - 46.4m + DRAUGHT
where PDD READING is the digital value from the Precision Depth Digitiser (PDD).

2.4.3 Transit to McDonald Islands, 29 February to 11 March 1980

This transit line across the southern ocean was positioned approximately midway between the existing surveyed lines known as Eltanin 47 and Conrad 08-02. These lines extend from the Australian margin to the Kerguelen Plateau. The new line was continued across the Plateau as line HD10 - see Figure 6 - and then back-tracked to McDonald Island. It was 2005 nautical miles in length, with a further 370 nautical miles surveyed over the Plateau.

The sea was calm for the first three days but then the weather deteriorated rapidly until the wind reached Beaufort Scale Force 9 (BS 9). Large swells developed, and the ship's speed was reduced to 5.2 knots, compared with a normal cruising speed of about 12 knots. In the heavy weather, the Doppler sonar would not work in the automatic water-track mode. On 2 March 1980 it was placed in the manual mode and remained in this mode for most of the survey.

The Raytheon system worked well in calm seas but in rough weather the sea bottom was barely evident in the noise on the output chart record. The record became particularly noisy when the ship was pitching into high seas. In addition, the return echo was weakened in rough seas and consequently the digital tracking of the water bottom tended to fail. The first example of good sub-bottom penetration by the system was obtained on 7 March 1980 - see Figure 8.

Problems were encountered owing to the inadequacy of the ship's alternating current supply. Three failures of the DAS computer and six failures of the Magnavox system were caused by the inconsistent power supply.

The noise level on the magnetic data was dependent on the sea state, with high noise level correlating with rough weather. On 4 March 1980 the first signs of problems in the digital recording equipment appeared but they were corrected at that time.

2.4.4 McDonald Island to McDonald Island 12-14 March 1980

The ship sailed northwest on line HD16, with the intention of running the north-south lines HD01 and HD02. However, rough seas, winds of BS 6-8, and a large swell prevented this, as the seas would have been on the ship's beam. Instead, lines HD17 to HD21 were surveyed. A total of 574 nautical miles of data were collected on these lines.

The noise level on the magnetic data reached a high peak when the ship was pitching into heavy seas on line HD16, but reduced dramatically as the ship ran with the seas on line HD17. An intermittent problem occurred again with the hundred digit on the digital output but the problem disappeared after a thorough check of the magnetometer.

The freshwater tank containing the Raytheon transducers began to leak towards the end of the transit voyage and the pressure head on the transducers could not be maintained. The system could only be run at half normal power output for this portion of the survey but good digital depth recordings were still obtained as the water depths were mostly shallow. However, no sub-bottom penetration was observed because of the reduced power output.

A minor problem arose with the time recording: it was found that the digital output from the clock was different to that shown on the clock face. The problem was not critical because it only affected the tens digit of the day number display, and data acquisition was continued without interruption. The day number was easily adjusted during later processing.

2.4.5 Heard Island to Heard Island 18-25 March 1980

After leaving McDonald Island, the ship sailed north to establish the position of Meyer Rock, the northernmost feature in the McDonald Group. The position of Meyer Rock was determined using several satellite passes, the range and bearing of the rock being obtained at the satellite fix time. A line was then surveyed to Heard Island but only bathymetric and navigation data were recorded.

The ship left Heard Island on 18 March and then sailed some 10 km north to determine the positions of Shag Island, Sail Rock and Drury Rock before marine geophysical operations were commenced.

The sea was remarkably calm for the next three days and the north-south lines, HD03 and HD05, were run without incident - see Figure 6. The weather began to deteriorate during the sailing of line HD08 to the southwest, the longest proposed line across the Kerguelen Plateau, planned to tie to the French lines Marion Dufresne MD3-2 and MD3-8. A tie was made to MD3-2 in the east, but due to loss of time caused by the heavy seas, the line HD08 was cut short and did not tie to MD3-8 in the west. Lines HD09 and HD11 across the Ridge were then surveyed, but line HD11 was terminated prematurely to return to Heard Island to embark the shore party. A total of 1665 nautical miles were traversed over the Kerguelen Plateau during this part of the survey.

The noise level on the magnetic record was again closely correlated with the sea state. The level was mostly 2-3 nanoteslas peak-to-peak, but increased to 10 nanoteslas peak-to-peak when the boat was pitching into heavy seas on line HD08. Again, when the ship turned to run with the seas on line HD09 the noise levels reduced dramatically. Intermittent output errors again occurred with the digital recording of the magnetics. The problem was finally solved on 21 March 1980 when it was found to stem from a loose connection in the magnetometer-to-multiplexer cable.

The Raytheon system worked reasonably well when sea states were low and some very good examples of sub-bottom penetration were observed - see Figure 8. Problems arose with the digital tracking when the underlying reflectors had similar amplitudes to the seabed signal. At these times the digital tracking jumped back and forth at random.

The bottom signal was barely visible on the record when the ship was pitching into heavy seas with high winds - BS 7-8 - on line HD08. The digital tracking was also bad at this time.

Several system crashes occurred, each time resulting in the loss of the DAS program from the computer memory. A large power surge blew the computer fuse and damaged the tube of the storage CRO used to monitor the Raytheon signal. Two further system crashes occurred during severe rolling of the

ship and may possibly have been caused by a loose connector in the power lead or by power surges.

The ship had to stop twice because of engine trouble. Only a few hours were lost and the lines were tied back to the original lines to provide continuity of data.

2.4.6 Heard Island to Iles Kerguelen 27-29 March 1980

Some 460 nautical miles were traversed, including a loop to the southwest of Heard Island - lines HD22 and HD23 - and a northerly line - HD02 - along the strike of the Kerguelen Plateau extending from Heard Island to Iles Kerguelen. Sea states were low.

The first major problems with the Magnavox satellite navigation system were encountered during this section of surveying and line HD22 had to be restarted. Frequency of satellite fixes throughout the survey was normally hourly but on this day a bad configuration of satellite passes - most at low elevations - meant that no satellite fixes were obtained for a period of 6½ hours.

A further problem within the Magnavox DAS system resulted in no positions being automatically recorded by the DAS for the last 16 hours before reaching Iles Kerguelen.

Positional information at five minute intervals, however, was available from the Magnavox printout for later integration with the data recorded for this period. The problem arose because the Magnavox computer would not load and start the small BMR program which is used to extract key navigational data for input to the DAS computer. No explanation was found for this problem. After leaving Iles Kerguelen, the Magnavox system loaded properly, including the small BMR program. The problem disappeared and did not recur.

The first signs of a major problem with the Raytheon system were also encountered at this time. Poor records and poor digital tracking were observed, even though the ship was pitching only slightly in the relatively low sea states. The decrease in draught caused by the lightening of the ship through fuel consumption as the cruise progressed may have led to an increase in aeration beneath the hull resulting in a loss in efficiency of the Raytheon output pulse.

2.4.7 Transit to Fremantle 30 March 1980 to 7 April 1980

This transit line of about 2300 nautical miles was parallel to Eltanin line 47-1 and was located about 60 nautical miles to the north of it.

The noise level on the magnetic data was acceptable as the sea was mostly calm and the ship was running with the seas. The only problem involving the magnetometer system was with the paper speed mechanism of the strip chart recorder which malfunctioned intermittently and resulted in a disjointed magnetic trace.

The Raytheon system worked well for the first three to four days after leaving Kerguelen and good records and reasonable digital tracking down to 3400 metres were obtained. The quality of the records then deteriorated over a day or so until not even the seabed trace was visible on the charts. No electronic fault could be found and the power output from the transducers

was constant. A reduction in the speed of the ship to 10 knots had little effect. The poor quality of the records appears to have been caused by an increase in aeration beneath the hull of the ship. During the first three to four days the ship had sailed with a large swell which probably gave sufficient push to keep the bow of the ship down slightly. The degree of aeration beneath the hull would have been reduced hence enabling good Raytheon records to be obtained. A decrease in the size of the swell and a slight change in course of about 7° coincided with the deterioration in the chart records.

As the water depths began to shoal near the Australian margin the Raytheon record improved and reasonable records and digital depths were once again obtained.

Three hours of surveying were lost when further problems occurred with the ship's engine. However, the continuity of data was maintained because each time the ship returned to tie into the previously surveyed line.

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Part Three

SCIENTIFIC REPORTS

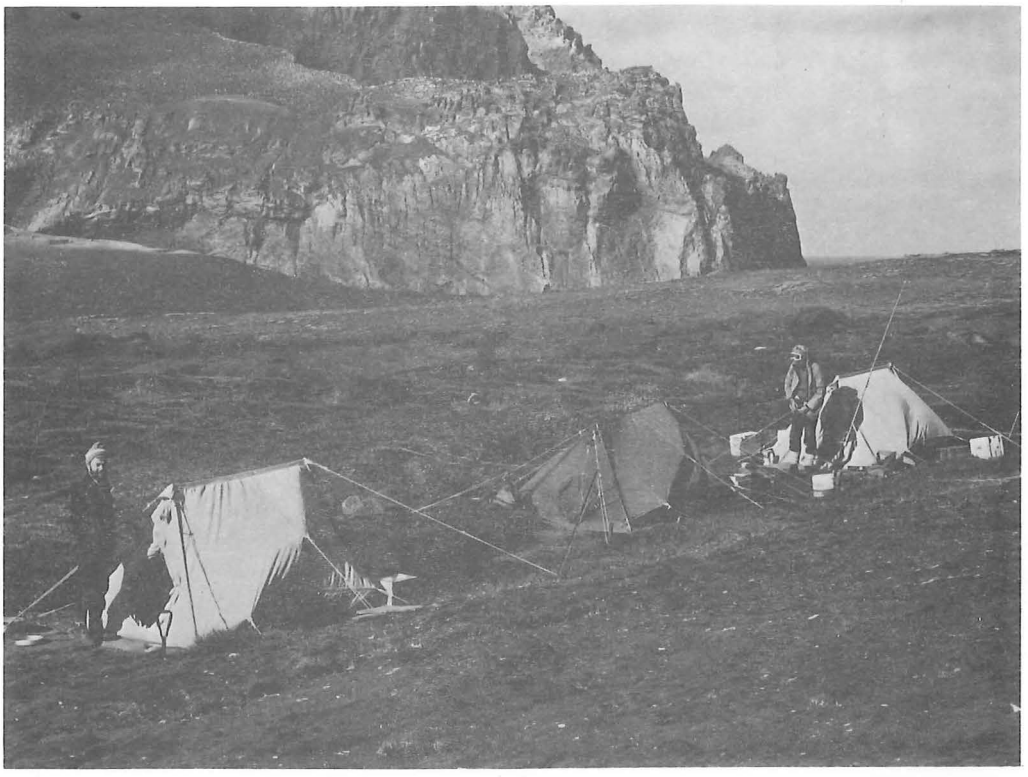

Figure 9. The camp on McDonald Island (Photo: G.W. Johnstone, Antarctic Division)

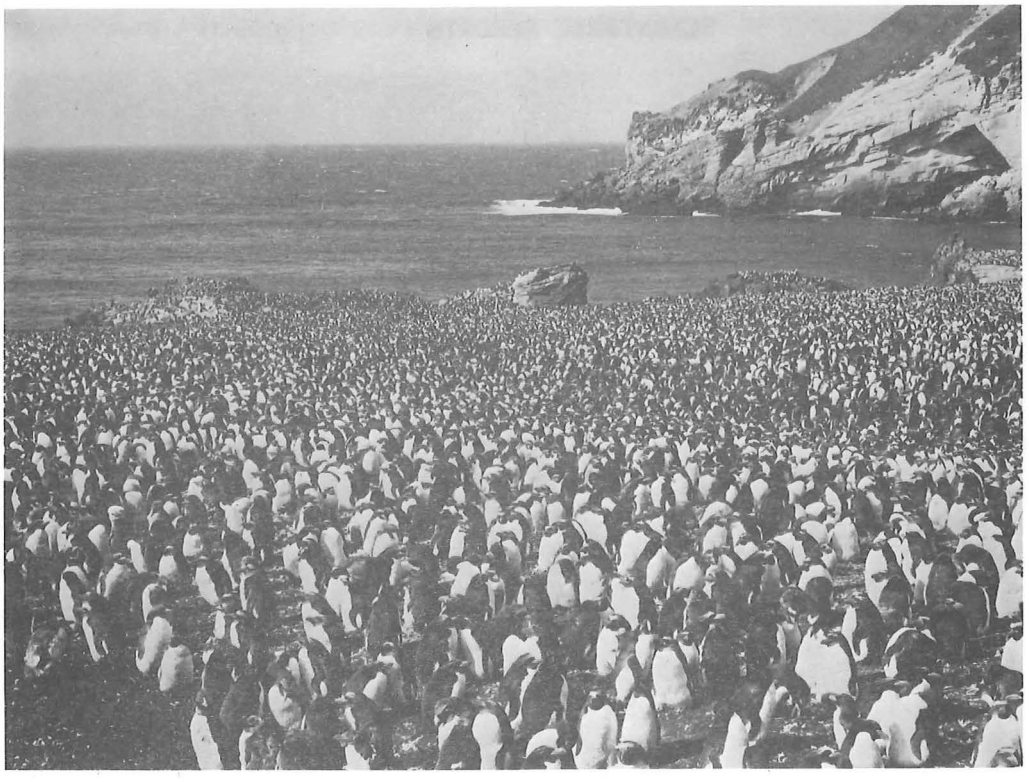

Figure 10. Macaroni Penguins and the south-eastern point of McDonald Island (Photo: G.W. Johnstone, Antarctic Division)

3.1 ZOOLOGY - by G.W. Johnstone

3.1.1 Introduction

The region of the south-eastern Indian Ocean traversed by MV Cape Pillar on this expedition is little known ornithologically and an excellent opportunity was provided for recording the distribution and abundance of birds over this 4000 km landless tract. Similar records have been kept during the annual ANARE voyages to Macquarie Island and the Australian Antarctic stations and this expedition offered the opportunity to extend north-westward the oceanic region covered.

Much information about the birds and seals of Heard Island was assembled and published by members of the successive Australian National Antarctic Research Expeditions in 1947-1955.[2-6] Since then, brief visits in 1963, 1965, 1969 and 1971 have recorded apparent recolonization of the island by King Penguins and Kerguelen Fur Seals.[7-12]

In contrast, the only information for McDonald Islands was collected during a brief reconnaissance in January 1971, including 45 minutes ashore on the main island.[13]

My aims on the 1980 expedition were to:

- Record the distribution and abundance of birds seen from MV Cape Pillar.
- Collect information on the birds and seals of Heard Island that could be compared with the observations made 30 years ago and to continue the documentation of the expanding populations of King Penguins and Fur Seals.
- Conduct a general survey of all species present on the McDonald Islands.

Some ancillary projects were carried out as detailed below.

3.1.2 Fieldwork

During the voyages Fremantle to McDonald Islands, Heard Island to Iles Kerguelen and Iles Kerguelen to Fremantle, a regular watch was maintained to record birds and whales. Numbers of birds seen by species were recorded during a 10 minute period during every hour of daylight, in a form compatible with the Australasian Seabird Mapping Scheme with which they will be deposited.

At McDonald Islands (Figure 9), all accessible parts of the main island and Flat Island were visited to record birds and seals. Meyer Rock was inspected by helicopter. Special attention was paid to the breeding population of Fur Seals and to assessing the size of the breeding populations of Black-browed Albatrosses and Southern Giant Petrels.

On Heard Island, most localities known to be significant sites for breeding birds and seals were visited. Special attention was paid to recording Fur Seal and King Penguin populations as both species had been reported as increasing in numbers since they were first recorded breeding at Heard Island in the 1950s and 1940s respectively. Colonies of Black-browed Albatrosses, Southern Giant Petrels and Blue-eyed Shags were visited to compare their present status with that reported from the early 1950s.

Aerial photographs taken for mapping purposes will be used to estimate the extent of colonies of Macaroni Penguins (Figure 10). This information will be of value to the International Survey of Antarctic Seabirds which aims to carry out a census and subsequently monitor changes in the populations of Macaroni Penguins on sub-Antarctic islands and Adelie Penguins on the Antarctic continent.

Bones and carcases of birds were collected for study by the National Museum of Victoria and a few fresh specimens of eight species were obtained for the same institution.

Small mammal traps were set on both McDonald Island and Heard Island but, in line with previous observations, no evidence of rats or mice was found.

A few terrestrial and freshwater arthropods were collected at McDonald Island and near the ANARE Station on Heard Island.

A representative collection of vegetation was obtained from both islands for a study of the tardigrade fauna - a group of microscopic animals - as requested by Dr D.S. Horning, University of Canterbury, New Zealand.

The logistic support provided by the helicopter and the unexpectedly good weather made it possible to visit numerous localities without the time-consuming and hazardous exercise of crossing the intervening glaciers or, in the case of McDonald Islands, stretches of open water. Without the helicopter the scope of the scientific shore programs, particularly on Heard Island, would have been greatly reduced.

3.1.3 Results

MAMMALS

Whales

Few whales were seen during the voyages. There was one sighting halfway between Fremantle and McDonald Island; a group of four spouts was seen during bathymetric surveys near Heard Island and there were several sightings in the Golfe de Morbihan on departure from Iles Kerguelen. None could be specifically identified. Several small dolphins - identified by French biologist Didier Bazin as Commerson's Dolphin - played around the ship near Balfour Rock during the approach to Iles Kerguelen.

Seals

The status of Southern Elephant Seals and Leopard Seals appeared to be unchanged since previous visits. Only four Elephant Seals were seen ashore at McDonald Island; no doubt the cliff-backed nature of the beaches there makes them unattractive to this species which prefers beaches backed by vegetated ground where they can obtain shelter and the comfort of wallows. At Heard Island, good numbers of Elephant Seals were ashore, mainly first and second year animals and older bulls. The gently sloping sand and pebble beaches of the eight kilometre long spit were particularly favoured.

Two young Elephant Seals bore plastic flipper tags, probably applied by French workers at Iles Kerguelen. Similar Australian tags were applied to eighteen Elephant Seals.

Leopard Seals were recorded only in the Four Bays area at Heard Island, where seven were seen on the western beach of Corinthian Bay and one in Atlas Cove.

The population of Kerguelen Fur Seals has been increasing at Heard Island since the early 1950s and was first recorded breeding there in 1963. In 1971 the summer population was estimated to be at least 3000, the great majority being adolescent males - few pups were seen. In March 1980, noticeable increases were recorded at Skua Beach, Long Beach and a possible increase at Spit Bay but little change was found elsewhere. The total population was about 4500; its composition remained unchanged.

On McDonald Island, nearly 50 pups (Figure 11) and about 150 adults were counted on the eastern beaches from the cliff-top on 27 January 1971. Similar counts on 12 March 1980 gave up to 100 pups and over 200 others. Unfortunately, by this date it was difficult to distinguish pups from second year animals. The apparent increase in numbers may have been a result of better survey being possible with more time available during the 1980 expedition.

The increase in the Fur Seals at Heard Island is in line with similar increases at other sub-Antarctic islands where the original populations were wiped out by sealers last century. A similar situation apparently exists at Iles Kerguelen. The source of the non-breeding males remains unknown.

BIRDS

Shipboard records

Other than coastal birds, twenty species were recorded during the voyages. The only species that could have been expected but which was not recorded was the Grey-backed Storm Petrel. No analysis of the records has been made so far, but preliminary inspection shows that the number of species as well as the total abundance of birds was markedly greater over the Kerguelen Plateau than over the deeper water between there and Australia. This was probably due to the proximity of the breeding islands.

The bright lights of MV Cape Pillar attracted birds at night. Our first night at anchor in Atlas Cove was particularly memorable. There was mist and drizzle and a fresh wind, and large numbers of Antarctic Prions, Diving Petrels and Wilson's Storm Petrels came on board. The birds fluttered down on the deck and were reluctant to leave, seeking the shelter of dark corners. Several became water-logged in the bilges of the ship's boats; they were added to the specimens collected for the National Museum of Victoria.

McDonald Islands

Species known to breed at McDonald Islands were doubled from five to at least ten species, but none of the additions was surprising. Black-browed Albatrosses, a species not previously known to breed in these islands, had at least 78 chicks on the southern cliffs of McDonald Island and another 11 on ledges high on the north-western and southern faces of Meyer Rock, previously reported as 'barren'. About 800-900 Southern Giant Petrel chicks occupied nests in the flatter vegetated parts of McDonald Island, a significant proportion of the total population of the Territory.

Heard Island

At Heard Island, the status of most species of birds was similar to that reported in the 1950s. For example, the colonies of Black-browed Albatrosses at Jacka Valley and Henderson Bluff, which had been reported to contain 102 and 110 pairs, contained 98 and 112 chicks respectively.

The colonies of Blue-eyed Shags in Sydney Cove and at Saddle Point, which had about eight and twenty pairs respectively in the early 1950s, were still the only two places where nests were found. The family groups had already dispersed, but the discovery of 45 old nests at Saddle Point suggests that there may have been an increase at that colony.

On the other hand, the numbers of Southern Giant Petrels breeding successfully seem to have fallen by 50% or more. The numbers of chicks at three localities had decreased from 780 in 1963 to 370 in 1980, and at Long Beach where more than 2500 birds were incubating in November 1951 only 751 chicks were counted in March 1980. This suggests that the total breeding production of this species at Heard Island is now about 1500 chicks, barely twice that of McDonald Island.

The status of the Northern Giant Petrel at these islands remains enigmatic. Photographs show that it was present in the early 1960s but it was not until 1966 that it was realised to be a species distinct from the Southern Giant Petrel.[14] Few were seen during the expedition. If it were breeding, any young would already have flown by early March, but adults normally continue to frequent nesting areas after the young have fledged; there was no sign of this behaviour. It is concluded that this species is unlikely to breed on Heard Island or at McDonald Island, and the few birds that do occur are probably visitors from Iles Kerguelen where it breeds in good numbers.

The steady increase in numbers of breeding King Penguins which has been documented at intervals since they were first found breeding on Heard Island in 1947 has continued. Nearly 600 chicks were counted, compared with 100 or so in 1969. Five colonies are now known, including a new one with three chicks at Red Island (Figure 12).

One of the most exciting events of the expedition was the discovery on 19 March of a Wandering Albatross incubating an egg on a nest on the vegetated high flats of Cape Gazert. This species has not been recorded previously at Heard Island, though it breeds at Iles Kerguelen and on many other sub-Antarctic islands. The bird, a male, bore metal and plastic leg bands of the Australian Bird Banding Scheme. It had been banded as a non-breeding adult at Macquarie Island on 9 April 1967. There were two old nest mounds nearby, indicating that breeding had been attempted in two previous years. When revisited on 25 and 26 March, the egg had hatched and the same adult was brooding the small chick; the female was not seen.

Shag Island

Shag Island was unfortunately not visited but a superficial inspection from the ship - by B. Obst and R. Williams - showed large numbers of Macaroni Penguins with many Cape Petrels over the water. The island appeared to be cliff-bound with no beaches and devoid of vegetation. It is unlikely to support many other bird species and is an improbable site for fur seals.

Figure 11. Kerguelen Fur Seal pups on an eastern beach of McDonald Island (Photo: G.W. Johnstone, Antarctic Division)

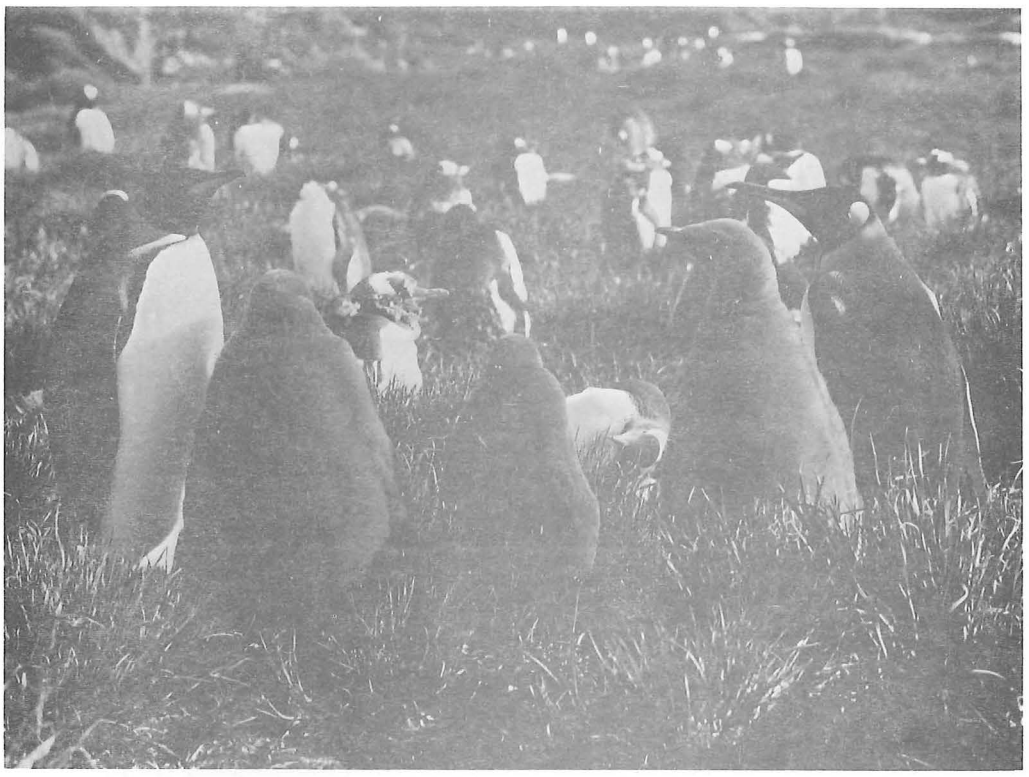

Figure 12. The new breeding colony of King Penguins at Red Island. Gentoo Penguins in background. (Photo: G.W. Johnstone, Antarctic Division)

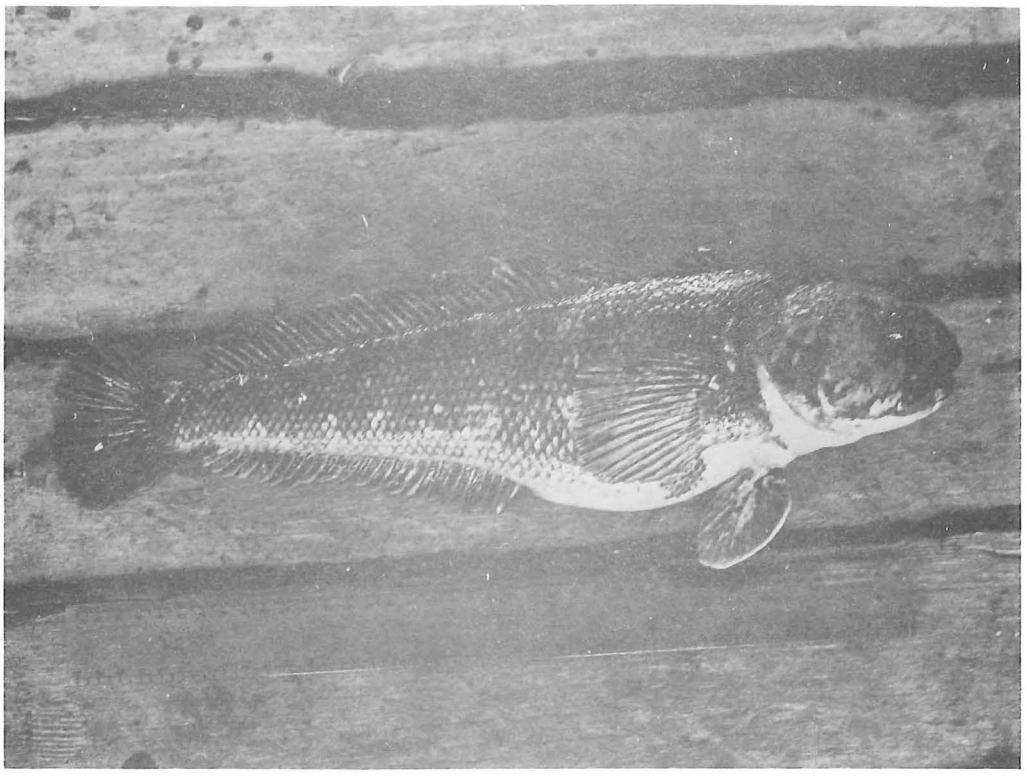

Figure 13. Notothenia coriiceps coriiceps (Photo: G.W. Johnstone, Antarctic Division)

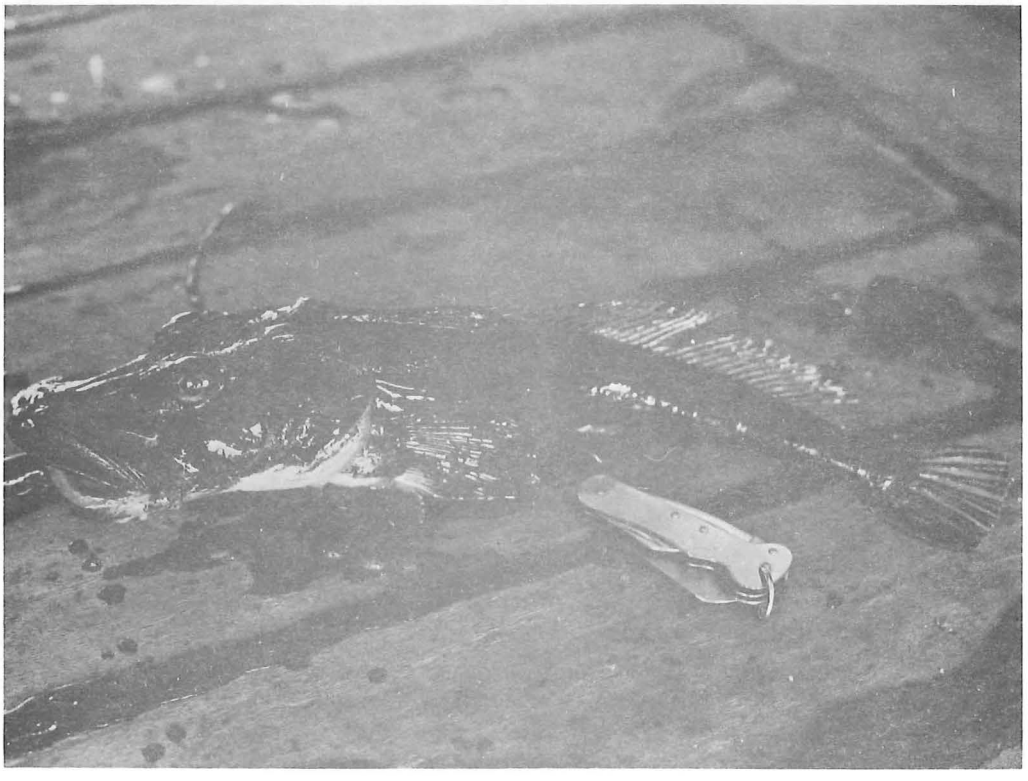

Figure 14. Channicthys rhinoceratus (Photo: G.W. Johnstone, Antarctic Division)

3.1.4 Conclusion

The time spent at McDonald Islands and Heard Island enabled a useful survey of the birds and seals of the Territory to be made. If visits with helicopter support become more frequent in future, flipper-banding of King Penguins would give valuable information on the progress of, and processes involved in, the growth of their population. More detailed study of the Fur Seal population of these islands would be valuable, particularly if parallel studies were undertaken at Iles Kerguelen. Finally, a visit to Shag Island would remove any lingering doubts about its inhabitants.

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3.2 MARINE SCIENCE - by R. Williams

3.2.1 Introduction

The main aim of the program was to investigate the effects of the Kerguelen-Heard Plateau on the structure of the water column of the southern ocean and hence indirectly on the phytoplankton population. Two phenomena were specifically sought - upwelling of deep water as the prevailing westerly ocean current encountered the plateau, and the Antarctic Convergence, which was reputed to occur between Heard Island and Iles Kerguelen.

Consequently, observations were made on water temperature, salinity, chlorophyll concentration, primary production of the ocean and composition of the phytoplankton species encountered while the ship was at sea. During stays at McDonald and Heard Islands, the fish fauna, zooplankton and intertidal zonation were studied.

3.2.2 Water Temperature

Surface water temperature was monitored continuously from the ship's engine cooling water intake. This was calibrated twice daily against the temperature of a water sample taken by bucket over the ship's side, read with a mercury thermometer.

Expendable bathythermographs - XBTs - were dropped at approximately 30-mile intervals along the tracks between Fremantle and the Heard Island area and in the vicinity of Heard Island at the intersections of the grid lines sailed whilst mapping the area. As on previous trips to southern waters, the XBTs proved unreliable - about 35% gave unsatisfactory results. Much of the trouble appeared to be caused by the rough seas encountered - waves or swell up to 9 m high and wind speeds up to 35 knots - but the chart paper drive also gave trouble.

The Antarctic Convergence on both legs of the trip was well marked in the XBT traces, but somewhat masked in the surface data by summer warming of the upper 100 m. It was encountered at approx 47°15'S, 86°15'E on the outward leg and 46°30'S, 79°00'E on the return leg. This places the Convergence well to the north of Iles Kerguelen - at variance with most instances cited in the literature[1 2 3], which place it close to or through the archipelago. The Kerguelen Plateau did not appear to have much influence on the structure of the water column of the ocean. No obvious upwelling or other features associated with submarine ridges was noted. Surface water temperature was consistently about 3.5°C over the plateau, with a minimum of about 1.5°C at a depth of 450 metres.

3.2.3 Salinity

Water samples for determination of salinity on return to Australia were collected at most XBT stations.

3.2.4 Phytoplankton studies

Chlorophyll 'a' concentration in sea water supplied from the cooling water intake was continuously monitored by means of a Turner Design fluorometer. It was difficult at times to maintain the required flow rate of 2 litre/minute because of the height of the fluorometer installation above the

pumping point of the water. Continuous records of the basic fluorescence (FA) were recorded on a chart and each hour a timing device injected a quantity of the herbicide DCMU which inhibits phytoplankton photosynthesis and thus gives a measure of maximum fluorescence (Fm). Fm gives an estimate of phytoplankton biomas and (Fm - FA)/Fm provides an index of metabolic activity of the phytoplankton. Two litres of seawater were filtered 2-4 times daily for later determination of chlorophyll concentration in order to calibrate the fluorometer and some of the filtrate was preserved frozen for later nutrient analysis.

Once daily a triplicate set of seawater in light and dark bottles was incubated with a ^{14}C source to estimate primary production. Incident light levels measured in micro-einsteins/m^2/sec with a Li-Cor 185A quantum radiometer were also recorded.

Apart from normal diurnal variations in fluorescence very little variation in the surface water fluorescence was observed. Preliminary estimates based at this stage on fluorescence values alone gave prevalent chlorophyll 'a' levels of 0.1 to 0.2 mg/m^3, typical of the low nutrient or oligotrophic state of ocean situations. Only in the region of the Antarctic Convergence were higher fluorescence values observed, generally 2-4 times those in other areas.

3.2.5 Studies at Heard and McDonald Islands

FISH

At both islands a gill net - 100 mm stretched mesh 45 m long - and craypots were set and some fishing with hand lines was done. Nothing was caught in craypots at either location, but many fish were netted, especially at McDonald Island. Here a gill net was set for 3½ days in approximately 30 m of water on a fairly flat rock bottom with much weed. The following fish were caught:

Notothenia coriiceps coriiceps	57	specimens, total weight 45 kg
N. rossii rossii	2	specimens)
N. magellanica	1	specimen) total weight 7 kg
N. acuta	1	specimen)
Channichthys rhinoceratus	9	specimens, total weight 5 kg

Hand line fishing was successful from the ship anchored in 28-34 m of water about 400 m offshore. The catch was mainly of Antarctic Cod and consisted of 26 N. c. coriiceps, 2 N. r. rossii, 10 C. rhinoceratus and 1 possible Channichthys rugosus.

At Heard Island the fishing was much poorer. With the hand lines, only a few C. rhinoceratus - ice fish - were caught at the ship's anchorage in 14 m of water over flat sand on Atlas Roads. In the gill net set for 24 hours in 20 m of water about 20 m offshore from Laurens Peninsula in Atlas Roads, 22 N. c. coriiceps, 1 N. r. rossii and 1 C. rhinoceratus were caught. When the net was set in Atlas Cove in 3-4 m of water over bare level sand no fish were caught.

Of the fish caught, only N. c. coriiceps (Figure 13) has been recorded specifically from the Heard-McDonald Area.[4 5] However all other species caught have either a widespread sub-Antarctic distribution (N. r. rossii, N. magellanica) or are known to occur at Iles Kerguelen, approximately 520 km to the north-west of Heard Island and on the same submarine plateau (Channicthys rhinoceratus (Figure 14), N. acuta). The lack of fish species records to date at Heard and McDonald Islands is almost certainly due to the absence of collecting in this area. It would have been no surprise if more species had been found - eg, Harpagiferbispinis, Zanclorhynchus spinifer in-shore, Champsocephalus gunnari and several other Notothenia spp in deeper water, which are common at Iles Kerguelen. If more time had been available for fishing in a wider variety of locations some of these other species might well have been caught. Further fishing in this area would be useful, as the small amount of fishing done showed reasonable catches. A cooperative venture with the French at Iles Kerguelen is an attractive proposition which would enable the relationship of the fish fauna between two island groups, so closely placed and yet so different in nature, to be clarified.

It appears that March-April is the breeding time for both N. c. coriiceps and C. rhinoceratus. Most fish of both species had ripe gonads, and many larval and juvenile fish were seen both in adult fish stomachs and especially at night around the lights used for squid fishing.

ZOOPLANKTON

A half-hour tow with a zooplankton net was made at both McDonald and Heard Islands. On preliminary examination, the bulk of the catch consisted of 1 mm long copepods, with some small salps and medusae.

SQUID

Jigging was done with a light at night while the ship was anchored at Heard Island and at McDonald Island. Nothing was caught and no squid were seen. However, as both these sites were close in-shore, this negative result should not be taken as indicative of the whole area. Cephalopod remains were found in a stomach of N. c. coriiceps at McDonald Island and more may be found when all the stomachs have been examined.

INTERTIDAL ZONATION

At Heard Island a representative collection of intertidal zone organisms exposed in a small bay just west of Rogers Head was made. Zonation was generally poorly developed because the coastline consisted of either flat sand, pebbly beaches or vertical cliffs. The shoreline between Rogers Head and Atlas Cove was the only area within easy reach of the base camp that showed any worthwhile intertidal zonation, due to the presence of small coves separated by small headlands of relatively low relief. Even here the intertidal zone was very compressed and similar to that of most sub-Antarctic islands in that the most striking visual feature was a band of the large kelp Durvillea antarctica in the wash zone, with a zone dominated by red coralline algae below, and a zone dominated by the red alga Porphyra above.

The 'bare zone' between the Porphyra and kelp zones commonly found on other sub-Antarctic islands was not discerned at Heard Island.

OTHER COLLECTIONS

Numerous shallow freshwater pools lie among Azorella-covered hummocks between the ANARE station and Rogers Head. As these are much frequented by skuas, the pools then become rich in organic nutrients to a state of eutrophication from bathing, defecating and the dropping of food. Rich growths of the angiosperm Callitriche antarctica and filamentous and unicellular algae occur, together with large populations of copepods and cladocerans. Samples of all these were collected for later identification.

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3.3 BOTANY - by J.F. Jenkin

Prior to the 1980 expedition, knowledge of the vegetation of Heard and McDonald Islands was very limited. Previous expeditions to Heard Island, dating back to the Challenger expedition in 1874, have made collections, and species lists have been published. The flora of Heard Island was known to include eight vascular, twelve moss and fifty-two lichen species. (Vascular plants have an internal conducting or vascular system and include ferns, conifers and flowering plants.) However, no comprehensive account of the vegetation was available. The only information relating to the vegetation of McDonald Island was a recent report of the occurrence of three vascular species.

The aim of the botanical program was to undertake a comprehensive survey of the vegetation of Heard and McDonald Islands. This was intended to overcome a long-standing gap in our botanical knowledge, and to provide the basis for further consideration of factors affecting the distribution of sub-Antarctic vegetation, both locally and geographically.

The basic approach involved an initial ground survey of as much of the vegetation as possible, supplemented by aerial observations. Comprehensive collections of all forms of vegetation were made at all locations visited and those will likely be lodged at the National Herbarium, Melbourne. On the basis of the observations in the initial survey, a subjective classification of the vegetation was developed, followed by more detailed, objective sampling of representative areas of the main vegetation types. In association with this, factors affecting vegetation distribution were subjectively assessed and vegetation distribution was mapped on a broad scale.

The flora of McDonald Island includes five vascular species (two new records), about six bryophytes (mosses and liverworts) and an as yet undetermined number of lichen species. The paucity of the bryophyte flora seems unusual, particularly in view of an abundance of apparently suitable habitats. The vegetation is of two main types - grassland, dominated by Poa cookii, and feldmark or fellfield dominated by Azorella selago. The occurrence of each type seems directly related to wind exposure. The absence of vegetation in the central part of the island is largely due to heavy salt spray being blown from wave impact on the western cliffs - the activities of Macaroni Penguins and the burrow-nesting Antarctic Prions and Diving Petrels also contribute. Biotic influences are also important in the grassland, where nesting colonies of Giant Petrels have modified most of the vegetation.

On Heard Island, in spite of a wide search in all places visited, no new records of vascular plants were added to the eight species already known. Two of these species have a restricted distribution, occurring only in the southern and eastern parts of the island. No naturalised alien species were found. Bryophyte and lichen collections require study before comment is possible. Several previously unrecorded liverwort species are amongst the material collected and other new records are likely.

Five main vegetation types occur on Heard Island, with numerous variations and intergrading forms, - 'pool complex', grassland, meadow, herbfield and feldmark or fellfield. The types identified are largely compatible with those reported in various published summaries of sub-Antarctic vegetation, although some revision of existing schemes seems warranted.

A characteristic type on Heard Island, covering extensive areas, may be designated 'pool complex', and has not been previously considered as a separate entity. This vegetation comprises predominantly Poa cookii and Azorella selago, forming closed communities within a mosaic of pools of varying sizes. The main contributing factor to the development of this vegetation would appear to be a relatively flat, impermeable substratum, notably the widespread lava flows on the island. On other sub-Antarctic islands, a similar situation may develop as the result of the accumulation of relatively impermeable peat over an otherwise more permeable substrate.

Grassland, dominated by Poa cookii, ranges from isolated large tussocks adjacent to the coast, a characteristic sub-Antarctic vegetation type, to relatively uniform, dense swards in some inland areas.

This latter form grades into the meadow type, with localised variations in the component species, notably the occurrence of Deschampsia antarctica as a dominant in some areas in the Spit Bay region.

The herbfield vegetation type is quite variable and of relatively restricted distribution. Two main forms occur: in one, Pringlea antarctica, the 'Kerguelen cabbage', is the dominant species, whereas the other is dominated by Acaena magellanica.

These three vegetation types occur only in areas partly protected from the wind; their further differentiation seems related to local variations in wind exposure and drainage.

The feldmark or fellfield vegetation type is the most widespread on Heard Island and is characteristic of areas exposed to strong winds. The vegetation varies from extensive closed communities of Azorella selago in relatively sheltered areas to very open communities with sparse vegetation cover in areas receiving the full force of the wind. Bryophyte-dominated vegetation occurs locally, ranging from extensive closed communities to isolated cushions.

The occurrence and distribution of vegetation is also influenced by the stability of the substrate, particularly in new moraines and on the extensive bare sands of the 'Nullarbor Plain'. The age of the substrate is also important - the relatively recent lava flows have only sparse vegetation. The limiting effects of salt spray are readily apparent, especially in areas immediately downwind of coastal cliffs. Biotic influences are also important: Elephant and Fur Seals have marked local effects on the vegetation, and burrow-nesting birds are widespread on the island.

The results outlined above are preliminary only, and will doubtless be modified in the light of further work on the data and specimens collected. Nonetheless, they do provide an initial overview of the vegetation of Heard and McDonald Islands, and provide the basis for various comparisons with other sub-Antarctic islands.

There is abundant scope for further botanical work - mainly on Heard Island - concerned with the more precise delineation of the various plant communities and the factors affecting their distribution. Detailed ecological studies on a range of species will be necessary to fully answer the fundamental question concerning the factors contributing to the marked reduction in native vascular species - from twenty-nine on the Kerguelen Islands to eight on Heard Island - in a distance of about 500 km. Similar considerations will apply to other categories of plants once the appropriate floras are adequately documented. An overriding consideration throughout must be to maintain the existing situation wherein alien fauna and flora are absent from both Heard and McDonald Islands.

3.4 GEOLOGY - by I. Clarke

3.4.1 Regional geological setting

The Kerguelen Plateau is a submarine aseismic ridge about 2000 km long trending north-west towards the Gaussberg volcano on the eastern coast of Antarctica, but structurally separated from the Antarctic continent. It is an area of relatively old crust - the oldest magnetic anomaly recognised on the deep ocean floor adjacent to the plateau is about 45 million years old and sediment 90-100 million years old has been sampled from the eastern flank of the plateau. Heard Island, McDonald Island, and the Kerguelen Archipelago lie in the northern part of the plateau.

The Kerguelen Plateau was thought to be a small continental fragment which originated from the old supercontinent of Gondwanaland. More recently, interpretation of geophysical evidence has led to the alternative idea that the plateau is an uplifted part of the ocean basin that existed west of Australia in the Mesozoic era.[1] Furthermore, it has recently been suggested that the uplift and vulcanism which produced the Rajmahal Traps in India, the Ninetyeast Ridge and the Kerguelen Plateau originated by a large scale northward movement of part of the earth's crust over a stationary upwelling convection current - 'hotspot' - in the mantle. Heard Island is thought to be the latest manifestation of this hotspot.[2 3]

3.4.2 Previous geological work on Heard and McDonald Islands

The first significant contribution on the geology of Heard Island was made by Tyrrell[4] who described a collection of rocks brought back by Sir Douglas Mawson on his brief visit in 1929. The basis of our current knowledge of Heard Island geology is due to Lambeth,[5] who spent a year on the island during the establishment of the ANARE station in 1947-48. During the ANARE summer visit to Heard Island in 1963, Stephenson,[6 7] was able to review and augment Lambeth's work, and he subsequently determined the chemistry of some igneous rocks.

The only previous geological account of McDonald Island was based on an examination of oblique aerial photographs taken in colour by Budd in 1971.[8] As much of the account is speculative, a description of the geology of McDonald Island is presented later in this report where the results of recent field work are incorporated.

3.4.3 Geology of Heard Island

The following summary of the geology of Heard Island is based on the work of Lambeth[5] and Stephenson[6], integrated with observations made during the 1980 expedition.

The oldest rocks exposed on Heard Island belong to a unit of limestone with occasional horizons of chert lenticles. These limestones outcrop in cliffs on the coast of Laurens Peninsula south of Mt Olsen and in a cliff behind First Beach in Corinthian Bay. The limestone and chert were formed by accretion in deep water of calcareous and siliceous skeletons of marine organisms. Hence, we have strong evidence that Heard Island was once the site of a deep ocean basin. However, the microfossils found in the limestone have not yet proved sufficiently diagnostic for their age to be

accurately determined.

The limestone is folded and intruded parallel to the folded bedding by numerous igneous sills of basaltic composition. Both the limestone and the igneous sills are overlain by a series of essentially horizontal fragmentary deposits and basaltic lavas, collectively termed the Drygalski Agglomerate by Lambeth.[5] The surface between the folded limestone and sills and the horizontal Drygalski Agglomerate represents a period of time during which the limestone was uplifted and deformed and subsequently eroded. The sills probably intruded just before or during the period of uplift and deformation.

The Drygalski Agglomerate is exposed in cliffs on Laurens Peninsula around Mt Olsen, as well as at Mt Drygalski and North West Cornice and in cliffs along the northern and north-eastern coasts of the main part of the island. This unit represents a period of basaltic volcanic activity that may have taken place partly in a submarine environment and partly in a glacial environment. Some fossils have been found, presumably from this unit, but unfortunately they are not very useful for dating purposes.

The most recent group of rocks are those forming the various volcanic landforms which dominate Heard Island. The bulk of this material makes up the basaltic lava pile of the Big Ben volcano. On Laurens Peninsula, the Drygalski Agglomerate is overlain by trachyte flows which originate at least partly from Mt Olsen. These in turn are overlain by younger basalt flows which make up Mt Dixon. The Cave Bay hills are the remnants of a trachyte volcano which may be of similar age to the Mt Olsen trachyte. There appears to have been a very recent period of sporadic basaltic vulcanism, probably no older than 10 000 years, during which small scoria cones and lava fields appeared around the coast of the island. During this time Mt Dixon was probably still active and the cone of Mawson Peak was built up from the crater of Big Ben.

3.4.4 Objectives of fieldwork

The basic geological structure and history of Heard Island have been previously established, as outlined in 3.4.3. The major objectives of the 1980 project were to test the 'hotspot' hypothesis mentioned in 3.4.1. To do this we required to know:

. the age of the uplift and earliest vulcanism on Heard Island, and

. the chemical characteristics of a representative suite of igneous rocks from Heard Island for comparison with the Kerguelen Archipelago, the Ninetyeast Ridge and the Rajmahal Traps.

A related objective was to investigate in greater detail the genesis of the major rock types on Heard Island.

In the light of these objectives, the specific aims of fieldwork on Heard Island were:

. To critically re-examine the geological sequence.

. To look for and collect microfossils or suitable horizons that may contain microfossils useful for palaeontological dating and environmental analysis.

. To collect chert lenticles for a study of chert formation.

. To collect samples from the sills within the limestone for chemical analysis and radiometric dating. The age of these sills should be approximately equivalent to the time of the uplift and initial stages of vulcanism on Heard Island.

. To examine the Drygalski Agglomerate and collect samples of the fragmental deposits to determine the nature of their source and environment of formation.

. To collect samples of lavas within the Drygalski Agglomerate for chemical analysis and radiometric dating.

. To collect samples of the series of young volcanic rocks for chemical analysis.

. To look for foreign rock fragments - xenoliths - within the igneous units, especially those that may have been brought up from the lower crust or upper mantle and which can therefore be used to determine the nature of these regions beneath Heard Island.

. To make a collection of at least 100 oriented samples from the older units - limestone and sills, and lavas within the Drygalski Agglomerate - for palaeomagnetic direction determination. These data would be used in conjunction with various dating methods to determine the history of movement of the crust in the vicinity of Heard Island.

Since no geological fieldwork had previously been carried out on the McDonald Islands, the primary objectives of geological fieldwork were to outline the nature and distribution of rock units and to make a representative collection of major rock types for laboratory study.

3.4.5 Allocation of fieldwork

Geological fieldwork was carried out in the following areas on Heard Island, roughly in order of decreasing priority or time spent: southern and eastern coasts of Laurens Peninsula, Red Island, Long Beach, First Beach, Rogers Peninsula, Cave Bay, Cape Gazert, Saddle Point, the northern lateral moraine of the Vahsel Glacier, and the western lateral moraine of the Downes Glacier.

A helicopter flight to Spit Bay was undertaken to gain a geological overview of the northern and north-eastern coasts of the main part of the island.

On McDonald Island, the southern hilly part, the bays on the south-eastern coast and the cliff tops around the plateau were investigated. One hour was spent on Flat Island, and the time was evenly divided between erecting a survey monument and rapidly making a collection of rocks. A flight around McDonald Island, Flat Island and Meyer Rock was undertaken to obtain a geological overview of the group.

3.4.6 Results of fieldwork

On Heard Island, the following results were achieved:

. No major modifications to the basic geological structure and history of Heard Island as determined by Lambeth[5] and Stephenson[6] were found to be necessary.

. A sample of mudstone with fragments of unidentifiable bivalves was found on the central crater on Rogers Peninsula. The rock had been brought to the surface by the volcanic activity that produced the scoria cone. Apart from this rock, no other macrofossils were found.

. Three samples of soft sediment from a relatively fine-grained part of the lower section of the Drygalski Agglomerate were collected from extraction of microfossils.

. 10 kg of limestone was collected, initially for palaeomagnetic work, but it will now be used for examination of microfossils.

. Several chert lenticles were collected for studies of lithification of siliceous sediments.

. Samples from ten sills within the limestones were collected for chemical analysis. Most of the sills are partially weathered, but at least three should be suitable for radiometric dating.

. The Drygalski Agglomerate was not examined in as much detail as was hoped, largely due to its tendency to crop out in precipitous cliffs which were capped with glacial ice and hence dangerous to approach. Nevertheless, some observations were made, and samples were taken of clasts and varieties of fragmental rock types. Most clasts are of basalt, with minor trachyte, limestone and chert. The nature of the fragmental rocks is variable and warrants more attention before any conclusive environmental interpretation can be attempted.

. Samples from three basaltic flows within the Drygalski Agglomerate were collected for chemical analysis and radiometric dating.

. Samples of recent lavas from Red Island, Mt Dixon, Mt Olsen, Cave Bay, Mt Andrée, Rogers Peninsula, Saddle Point, Cape Gazert and Long Beach, as well as erratics from moraines of the Downes and Vahsel Glaciers, were collected for chemical analysis.

. Apart from fragments of sedimentary rocks which had previously been recorded, the only foreign rock fragments found within the igneous rocks were nodules of wehrlite. These too had been found on previous expeditions and are considered to be products of partial crystallization of basaltic magma at shallow depth. No mantle or lower crustal material was discovered.

. Owing to the short duration of the expedition, the program of collecting oriented samples for palaeomagnetic direction studies was abandoned.

The expedition enabled a better understanding of the McDonald Islands to be gained. On McDonald Island itself, a unit of laminated tuffs makes up the plateau part of the island. Large scale cross-stratification in the tuffs is a common feature exposed in coastal cliffs. Clasts in the tuffs are mainly of trachyte, but clasts of white chalky limestone are also abundant and chert clasts are present in small amounts. On the east coast, the tuffs are intruded by several trachyte dykes. The southern hilly part of the island is a trachyte dome which has intruded and partly uplifted the tuffs. The trachyte dykes and the dome are characterised by well developed columnar jointing.

South Head, Macaroni Hill and Meyer Rock appear to be similar in nature to the southern hilly part of McDonald Island. Needle Rock has the appearance of a dyke.

Flat Island consists of a series of thin trachyte flows overlying an unsampled basement with vertical columnar jointing.

A collection of rocks was made from the accessible parts of McDonald Island and Flat Island. In view of the fact that trachyte is the dominant igneous rock type found, it is likely that the unsampled units are of similar composition.

3.4.7 Conclusions

It is pleasing to report that the expedition was successful with regard to the geological aspects, since most of the aims formulated before the trip were satisfactorily fulfilled.

From Heard Island a collection of igneous rocks has been obtained which should enable a chemical comparison to be made between Heard Island and similar occurrences in and around the Indian Ocean. Samples of the older rocks will be subjected to palaeontological dating in the case of sedimentary rocks and radiometric dating in the case of igneous rocks. Data obtained will be used to test the 'hotspot' hypothesis outlined in 3.4.1.

The McDonald Islands are the eroded remnants of extensive trachyte vulcanism. The presence of limestone clasts in the tuffs indicates that limestone underlies the volcanics as at Heard Island. Samples collected will be examined microscopically and some chemical analyses and radiometric age determinations will be carried out.

The fieldwork carried out during this expedition is the initial stage of a comprehensive program of study of the geology and origin of the islands on the Kerguelen Plateau. Work on material brought back by the expedition will be carried out in several institutions over the next two or three years.

3.4.8 Recommendations for further geological fieldwork on the Kerguelen Plateau

The availability of helicopter support on this expedition enabled us to carry out in a number of days geological work which would have occupied several months if done on foot. Nevertheless only a relatively small number of areas were investigated. This was intentional, for it was felt that careful work in a few areas would be more profitable than reconnaissance

over a wide area. There remain, however, many important localities which, if examined carefully, will contribute greatly to our understanding of the geology of Heard Island. In particular, the Drygalski Agglomerate still requires further attention and the relationship between this unit and the Big Ben lavas needs to be clarified. Another major gap in our knowledge is the nature of the Big Ben lavas themselves, since they were barely touched on by this expedition, despite their great abundance.

It would be scientifically rewarding if a geologist could spend at least a summer on Heard Island to concentrate on exposures peripheral to Big Ben. It would be preferable to have a field assistant to take a share of sampling. Also, with two people, a program of collecting oriented samples for palaeomagnetic studies would be feasible, especially in the light of results obtained from material brought back on the 1980 expedition.

In the Kerguelen Archipelago, the French have a large research base - Port aux Francais - which could accommodate many more people than it did in 1980. Collaboration with French researchers would enable Australian scientists to undertake some detailed work on Kerguelen. The knowledge thus gained would have important applications to Heard Island problems.

3.4.9 References

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Part Four

GENERAL

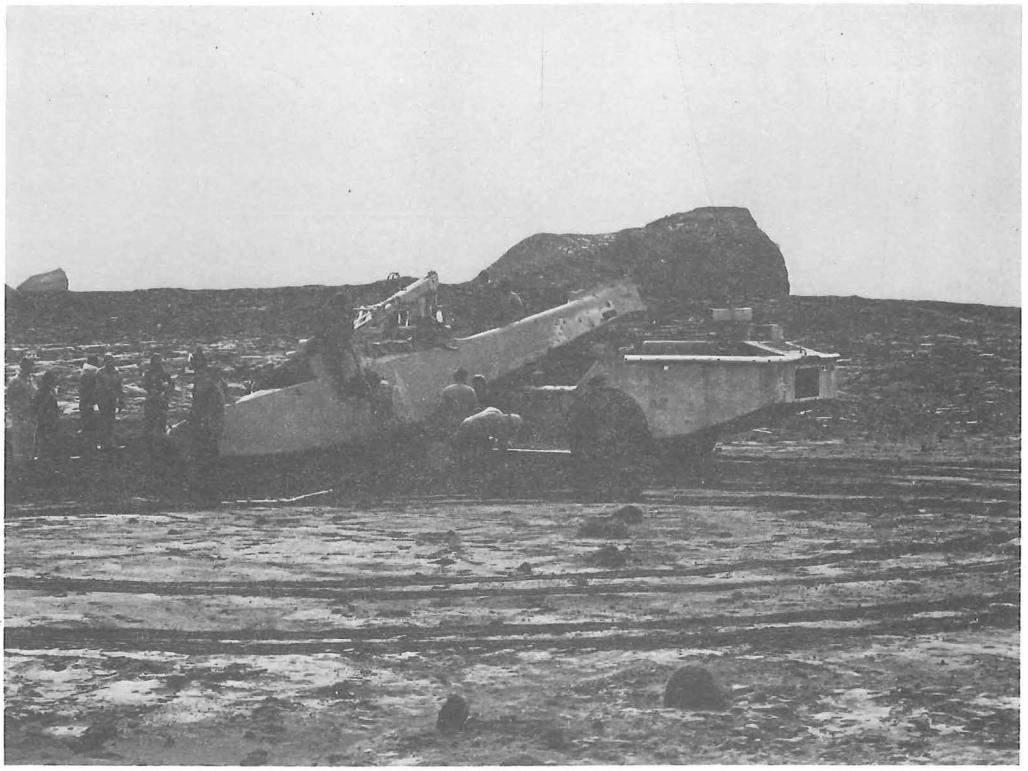

Figure 15. Loading the fuselage of the Walrus aircraft on a LARC (Photo: G.W. Johnstone, Antarctic Division)

Figure 16. The ANARE field hut at Spit Bay (Photo: G.W. Johnstone, Antarctic Division)

4.1 HELICOPTER OPERATIONS - by D.L. Ross and R. Rayner

4.1.1 Pilot's report

The aircraft used was a new Hughes 500D helicopter, registered VH-TIY and chartered from Central Australian Helicopters of Alice Springs. It was flown by their Chief Pilot, Desmond L. Ross, and supported by engineer Roy Rayner. The Hughes 500D was chosen essentially for its 8.1 metre rotor diameter which enabled it to operate safely from the helideck of MV Cape Pillar. Originally the aircraft was to have been fitted with emergency floats, of the 'pop out' type, but after exhaustive and fruitless attempts to obtain them, the expedition had to sail without them. A dispensation to operate without the floats was obtained from the Department of Transport.

The intention of fitting floats to the helicopter was to fulfill the normal safety requirements of shipboard operations. However, after the experience of circumnavigating both Heard Island and McDonald Islands several times, it is imperative that they should be fitted for any future operations on the islands. Due to the steep cliffs, boulder covered beaches, steep snow-covered mountains and ice cliffs on the glaciers, there are very few suitable landing pads available for normal operations and it would be most difficult to land in an emergency. The best chance of making a safe forced landing would be to land on the sea close to a beach. This, however, would present the problem of hypothermia from immersion - the water was about 3°C during the visit. Consideration should be given to kitting all crew members with immersion suits. Lifejackets should be worn at all times.

Operations from the Cape Pillar presented no problems. The ship was always able to anchor less than half a mile offshore and the short flights over water were of less concern than the flights over the coastal parts of the islands, in particular the rugged terrain of Heard Island.

The anchorages available were reasonably sheltered and allowed the ship to ride easily with little pitching or rolling.

Normal shipboard procedures were adopted, with the ship's Officer-in-Charge being in control of helideck operations. His attendants were two firemen and a handling party of two or three men from the ship's crew who were responsible for firefighting and rescue, and for securing the helicopter after landing.

The wooden deck was marked with suitable guide lines to indicate clearance limits from the ship's superstructure. A rope cargo net was lashed tightly over the deck to provide a non-slip surface. During flying operations all safety rails and obstructions were removed from the ship's deck.

The take-offs and landings presented no problems. A fair amount of precision was necessary whilst operating on the deck close to the superstructure, but if approaches and take-offs were done in a positive manner and minimum time spent in the hover while the ship was rolling or pitching, no major problems arose. The ship's motion could be difficult to predict but by pausing on the approach near the stern or by making the last part of the approach fairly flat, it was possible to judge the rise and fall of the deck quite accurately. In all the helicopter flew 76 sorties from the ship.

The weather at both islands was very changeable. The expedition was fortunate that flying was not possible on only two days out of the fifteen.

The strong winds and resulting turbulence presented the greatest problems. Turbulence often made it impractical to land close to the objective on the islands.

The nature of the terrain and ice-covered slopes produces many different weather patterns and localised wind directions. It was quite common to leave Atlas Cove in a north-west wind and to arrive at Spit Bay (30 km away) to find a strong southerly blowing.

On 26 March 1980 two unsuccessful attempts were made to fly to Spit Bay from Atlas Cove. The weather at Atlas Cove was overcast with the cloud base at 250 m, but no wind. On each attempt we were stopped at Saddle Point by strong southerly snow squalls and almost nil visibility. On the third attempt we reached Spit Bay successfully but although the weather had not changed at Atlas Cove we found Spit Bay to be in heavy rain from broken stratocumulus cloud at 300 m with a wind of 25 knots from the south.

During some of our vertical photography sorties up to 3000 m the winds were around 80 knots and the turbulence in the lee of 'Big Ben' was severe.

Turbulence was created by the numerous volcanic cones like Crater and Corinth Head. Even in light wind these cones can create violent turbulence like 'mini-cyclones'. On one occasion turbulence caused the rotors to lose speed so badly that the 'engine out' warning came on momentarily. Landings should therefore never be made direct to helipads on Heard or McDonald Islands without a proper high and low reconnaissance to determine wind directions and turbulence patterns, even if the pad has been used recently.

Another good reason for such careful reconnaissance was the wildlife on the islands. The penguins abound in their thousands and are not easily moved from prospective helipads, nor was it desirable to disturb them as disturbance in the breeding season could cause losses of eggs or mortality of young. Elephant Seals can weigh up to 3 tons and are often slumbering and nearly camouflaged as mounds of earth. Landing close to one or a group of these seals could have had disastrous results if they had moved at the wrong moment.

VHF contact was maintained whenever MV Cape Pillar was in the immediate vicinity on 121.1 MHz, while contact with the Heard Island base was maintained, when conditions permitted, on 118 MHz. There were compatible HF frequencies of 5410 and 3008 MHz which strangely enough did not work beyond line of sight on Heard Island and seemed to be less effective than the VHF frequencies.

As a result of poor communications, operations were conducted on a set search and rescue (SARTIME) basis along the predetermined flight plan.

Two dangers mostly likely to cause a forced landing on the islands are bird strikes and airframe icing, which can occur with frightening speed. Rain or sleet squalls can appear suddenly around a cliff or down a valley and can make the Perspex bubble look like frosted glass in seconds.

High winds were our main concern at night, so the helicopter was well secured and 200 litre fuel drums were placed across the skids to prevent any movement. Having seen what happened to the Walrus amphibian in 1948, we were anxious to prevent a recurrence. The main dangers were from building materials such as sheets of tin and wood from the old station blowing about, and the abrasive effect of the blowing sand.

On the couple of clear calm days that we experienced, flying was a real pleasure. The cold air and unlimited visibility allowed the helicopter to operate at its most efficient altitudes with power to spare.

There is no doubt that the use of a helicopter on this expedition was of great importance to the final successful outcome.

4.1.2 Engineer's report

The expedition was a most impressive experience from all aspects. We were fortunate in having a basically new Hughes 500D for this remote and unfamiliar operation, which reduced the chances of unserviceability. Repairs at the Heard Island base camp would have been difficult. Only limited spares were carried to cover defects which experience suggested were essential. Any breakdown of the helicopter away from the base would almost certainly have resulted in a hazardous, costly and time-consuming recovery and would have brought the expedition to a standstill.

Taking the above into account and considering the terrain of the island, there is no doubt that operating with a single helicopter is not really safe. Two helicopters must be the minimum for any further expeditions to the island.

Operation from the ship was uneventful, but as soon as the rotor has stopped, blades had to be secured as violent wind gusts could occur without warning, causing the blades to autorotate at high speeds. This was caused by the wind coming up the side of the ship through the rotor system. All blades needed to be secured as a loose blade could flap violently and might be damaged. The safety precautions on board ship were more than adequate and were diligently performed by members of the crew. Securing of the helicopter on deck for transit was also undertaken by the crew and they are to be thanked for a first class job.

4.2 AERIAL PHOTOGRAPHY OF HEARD AND McDONALD ISLANDS - by E.D. Graham

A Hasselblad camera was mounted vertically inside a Hughes 500D helicopter with the lens partially protruding through a hole cut in the Perspex bubble. The camera mount was constructed in Perth and fitted at sea. The mount could be compensated for tilt and drift, and was situated in front of the passenger seat with communications between the pilot and camera operator by means of the aircraft intercom.

The helicopter cabin was not heated. This was not an operational problem although the camera mechanism slowed noticeably when the outside air temperature was below -15°C. A 10 watt resistance heater bag constructed by the electronics technician and placed over the camera at these temperatures

alleviated this problem. No real discomfort was felt by the pilot or operator even at temperatures of -25°C at an altitude of 3050m over McDonald Island.

The camera batteries were kept fully charged and a spare camera and magazine were carried on all flights. The aperture and focus settings were held in place by masking tape for safety during photography. An intervalometer was initially used but after this failed overlap was determined by stopwatch and the camera fired by remote cable.

We attempted to minimise the effect of unstable conditions by choosing good flying days with clear skies. Winds of 60-70 knots caused severe drift problems and it was virtually impossible to fly along predetermined flight lines. One flight at 1200 m had to be abandoned when severe icing made the helicopter unstable, and made it difficult to see through the bubble. No ice formed on the camera lens.

The survey stations were photographed from the air but flying heights had to be varied to suit cloud base levels.

4.3 AUTOMATIC WEATHER STATIONS - by J. Pittar

Two automatic weather stations were erected on Heard Island under my supervision. Both stations transmitted their information via the ARGOS satellite data collection system. One station was for the Antarctic Division, the other for the Bureau of Meteorology.

4.3.1 ANARE station

The ANARE station consisted of a 6 metre mast holding various sensors, a carbon battery box, and an electronics box which also held the transmitter and aerial. The information collected was average wind speed, peak wind speed, wind direction, temperature, barometric pressure, sun intensity and battery voltage. A site about 50 m behind the old base camp at Atlas Cove was chosen because of its accessability, distance from areas likely to be inhabited by elephant seals and exposure to the prevailing winds.

4.3.2 Metbureau station

The Bureau of Meteorology station was wholly contained in a 60 litre drum and only needed mounting in a metal box on the tower. This station transmitted atmospheric pressure and battery voltage.

4.4 RECOVERY OF WALRUS SEAPLANE

A Vickers Supermarine Walrus amphibian was taken to Heard Island in 1947 for aerial reconnaissance. The bright yellow aircraft was hoisted aboard HMAS Labuan in Sydney Harbour on 15 October and shipped fully assembled and strongly secured to the deck.

The ship left Melbourne on 31 October, refuelled at Fremantle, and anchored off Rottnest Island where the Walrus was lowered into the water for a test flight.

On 28 November HMAS Labuan left for Heard Island, arriving on 11 December. Two days later the Walrus made its first flight. Aboard were: Flt Lt M.D. Smith, pilot; W/O G.C. Dunlop, radio operator; W/O P.G. Swan, photographer; Mr D. Eastman, ANARE photographer.

The plane circled the ship twice and then headed in the direction of Big Ben. One hour later the Walrus landed and was pulled on to the sand at Atlas Cove, where it was tied down to concrete blocks.

On 20-21 December Heard Island was lashed by strong winds. In the early hours of the 21 December the winds tore the Walrus loose from its blocks. The plane was rolled over several times and the wings and tail were smashed.

Over the years the hull filled with wind-blown black volcanic sand. Parts were removed from the aircraft and put to use around the base.

During the 1980 expedition to Heard Island a request was received from the RAAF to recover the remains of the Walrus.

The engine of the Walrus was found in the camp and the sand-filled fuselage 150 metres away. As the fuselage was too heavy to move, as much sand as possible was dug out. The engine created no real problem for the Hyab crane on the LARC, but the long body required the assistance of all available muscle power (Figure 15).

The LARC made a hazardous trip back to the ship with the Walrus aboard - the journey was made difficult by a 20 knot wind. The Walrus was lifted on board the Cape Pillar and stowed between decks. This awkward operation was well handled by the ship's crew.

In Fremantle the fuselage, engine and wing sections were collected at the wharf by the RAAF. They proposed to display the aircraft in their museum at Point Cook.

4.5 LANDING BARGE WRECK

During helicopter operations at Jacka Valley, Laurens Peninsula, a landing barge was found above high water mark.

The registration on the craft was SOU-5 and a notice on the inside, portside near the stern, read:

CAUTION: DO NOT LOWER RAMP WHILE AFLOAT

A brass plate was found on the engine with the following identification:

Gray Marine Diesel Engine Model 64 HN9
Detroit Diesel Engine Division General Motors Corporation
Detroit, Michigan, USA

This barge apparently is one from the USCG Cutter Southwind which visited Heard Island in March 1969 to install the US Pageos observatory team. It was reported that the barge got into difficulties during a mission to gather fresh water from nearby melt streams and was subsequently abandoned.

4.6 NOMENCLATURE

Many places on Heard Island and the McDonald Islands require names and proposals have been put to the Heard Island and McDonald Islands Names Committee of Australia. For convenience, in section 2.2 reference has been made to Maxwell Hill - the highest hill on the southern end of McDonald Island - and to Samarang Hill near the high points of the northern end. These and other names shown have yet to be approved.

4.7 DOCUMENTARY FILM OF THE EXPEDITION - by E.D. Graham

The aim of the film was to record the events of the expedition.

A 16 mm Bolex camera - serial number 76912 - and tripod were borrowed from the Antarctic Division. Mr Pittar and I spent some hours under instruction from Ms Hosel and Mr Brown of the Antarctic Division, and Mr Manning had had experience in Antarctica with this type of camera. One reel of film was exposed in Melbourne, which proved satisfactory when developed.

The film used was Kodak Color Negative 7247. The separate light metre used was a Lunasix 3. Exposures were taken at 24 frames per second on the ground and 50 frames per second from the helicopter.

The filming began in Fremantle with ship loading, helicopter arrival, and the departure of the expedition. Attempts were made during the voyage south to capture on film the routine of shipboard life, the scientific program, and the weather.

The historic landing at McDonald Island was filmed briefly from both ground and air. On Heard Island the work program, the spectacular scenery and the condition of the old ANARE camp were documented on film.

Some shots were taken at Iles Kerguelen with the permission of the Chef de District. The expedition's return to Fremantle concluded the film.

4.8 STATUS OF ANARE STATION AT ATLAS COVE

The buildings at the old Australian base have generally been destroyed by wind and water. Only the three Arbec huts built by the French in 1971 are habitable. The wooden latrine built by the Americans in 1969 is also in a sound but draughty condition. Of the Australian huts, only the old cottage-style Maudheim living and recreation hut is useable. The remainder of the huts and all stores in the station area are of no use.

Specific comments on each building are given in Table 2, and its location shown in Figure 17 by the number used in the table. Figures 18 to 23 illustrate the condition of some of the buildings.

The station area is a mess, with wind-blown building materials widely scattered. All Australian and American huts should be considered to be totally destroyed and all stores, equipment and fuel can also be considered lost. There is no point in trying to patch the huts - they should all be dismantled and removed. All 44-gallon drums of fuel are rusted through

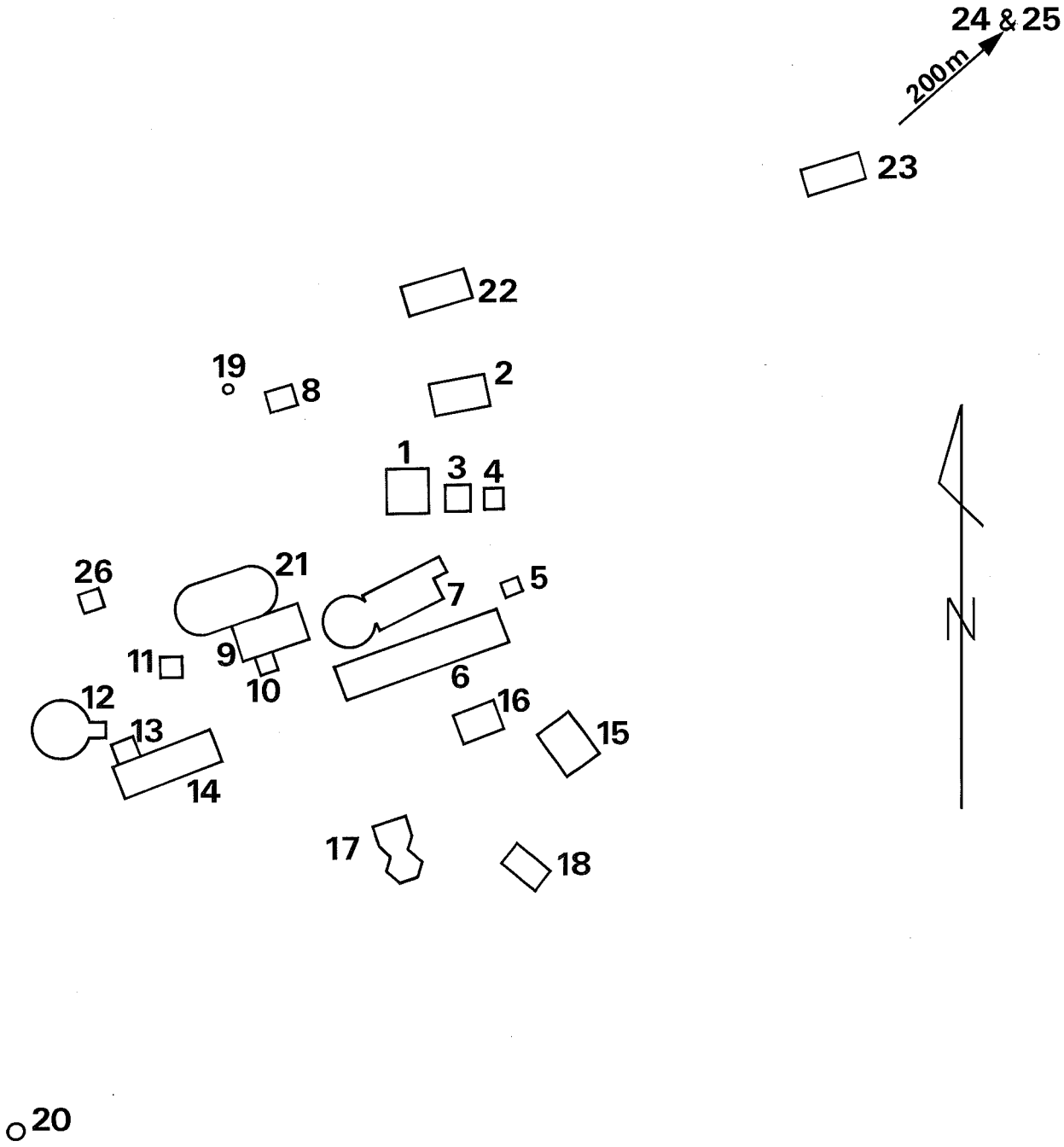

Figure 17. Sketch plan of buildings reported on at the ANARE Station, Heard Island (scale about 1:750)

Figure 18. ANARE living quarters, with small storage shed (left) and Coke Shed (right) in the foreground

Figure 19. US latrine building and French Arbec Hut No. 1

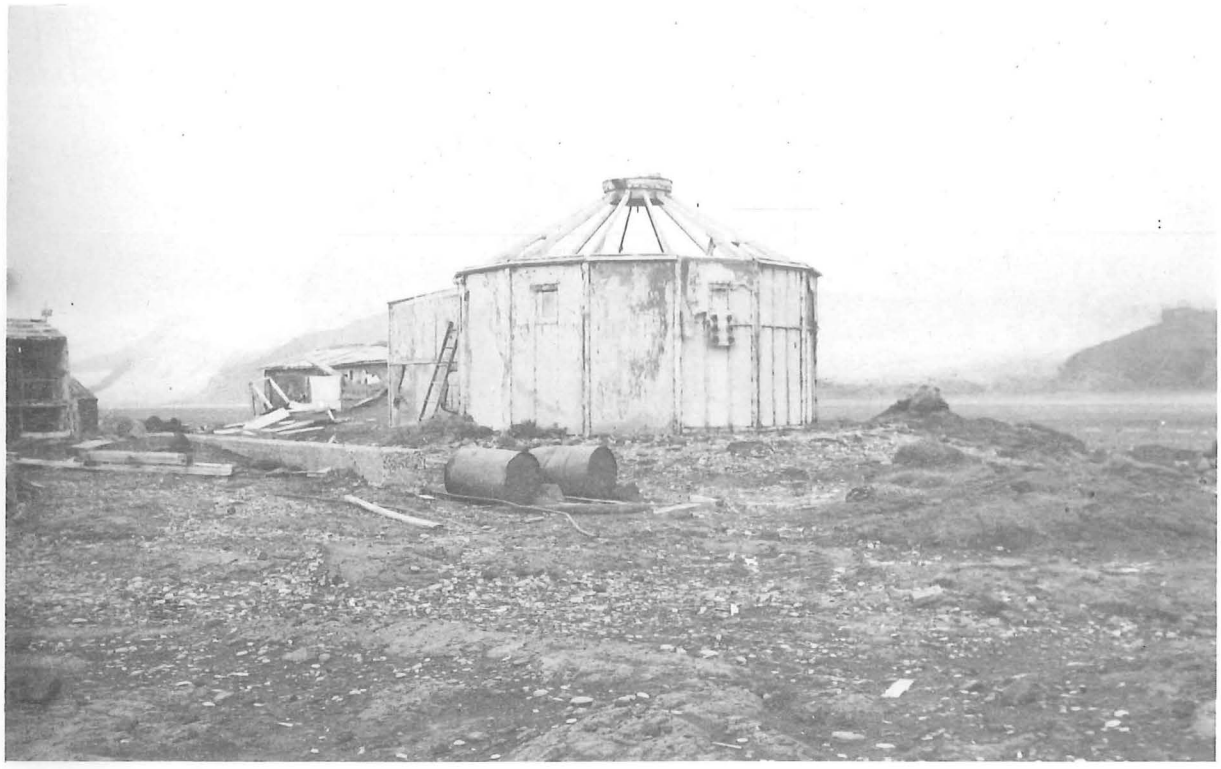

Figure 20. ANARE radio hut (view from NW)

Figure 21. ANARE powerhouse (left) and geology-storage hut (right)

Figure 22. Carpenter's hut, known as 'Chippy's Church' (view from north)

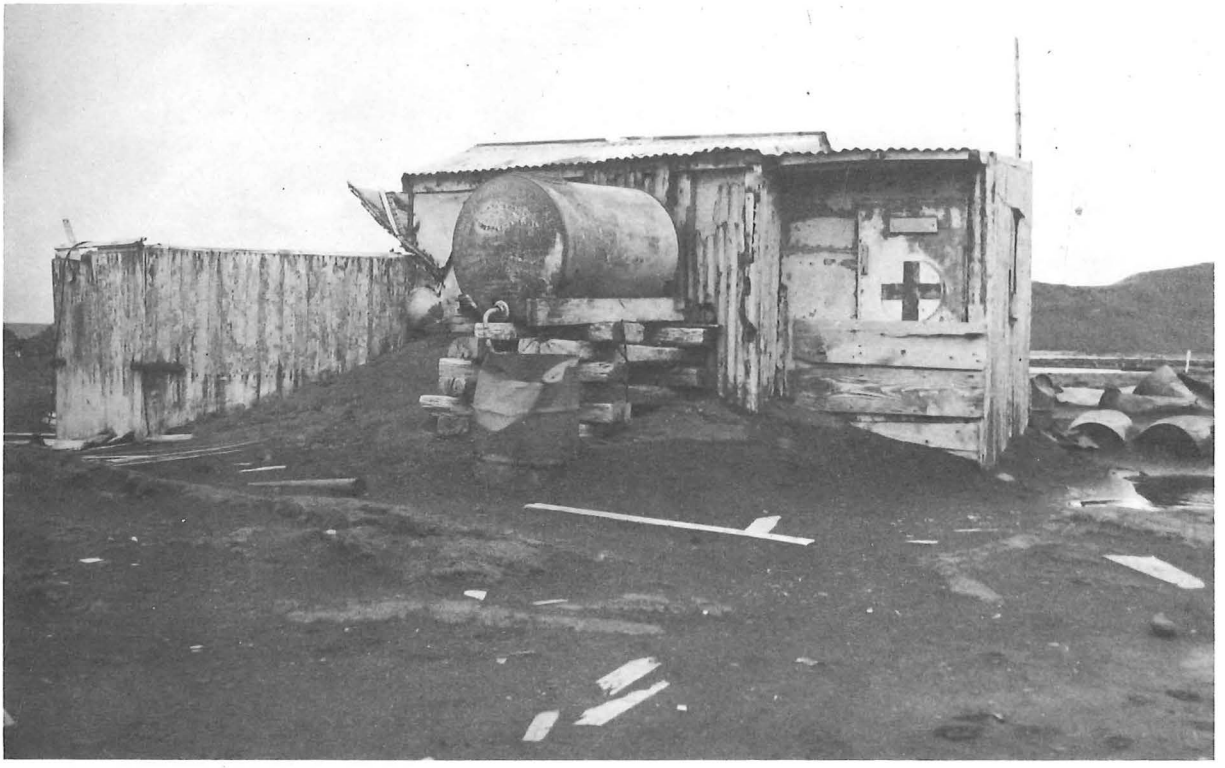

Figure 23. Base hospital. The wooden annex on the left is the Admiralty Hut, built in 1929

and their contents leaking out. They need to be removed from the site.

The wharf at Wharf Point, constructed of railway sleepers, is still in good condition.

Possibly the 1947 Radio Hut, the Maudheim hut and the 1929 Admiralty hut could be rebuilt in the original style, as the most significant historic features, but they would need periodic maintenance.

The French Arbec huts are excellent and it is notable that they have stood since 1971 with no maintenance or attention. Thought should be given to the construction of two strong, low-maintenance refuge buildings when the station is cleaned up.

Information for future expeditions or visitors, willing or unwilling, were left by the 1980 expedition in one of the French huts together with all originals of previous notes found at the ANARE base. The information was sealed in plastic, placed in a green zip-closed mail satchel and suspended from the ceiling of the hut.

The cement base of the cross on the grave shown in Figure 1 had broken and was reconstructed with cement during the 1980 expedition. The cement was still wet on departure, so neither the boxing formwork nor the support guy wires were removed.

Table 2. Condition of buildings at ANARE Station, Atlas Cove

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1. Emergency Generator Building

Rusted galvanised iron construction, with some holes in walls, concrete floor and engine blocks. The large American rubber fuel storage bladder is intact. The hut was originally used by the Pageos team to house three 16 kW generators and it was later used by the French in 1971 to house their alternator. All generators were subsequently removed but the wiring remains.

2. Supply and Clothing Store Building

There are holes in the south and west sides of building. It contains old rusting food storage tins and a quantity of 1970 French Army rations.

3. Emergency Radio Hut

Mainly intact. It contains some old X-ray plates and chemicals. This hut was in the past used as the ham radio centre.

4. Coke Shed

Holes in south and east sides. Floor drifted up with sand. About 20 bags of coke remain.

Table 2. Continued

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5. Small Storage Shed

Mainly intact; used as a gravity station by 1971 expedition.

6. American Living Hut 1969

A large long insulated slab hut of the standard ANARE design erected in 1969. Two side panels near the NW door have been breached allowing wind, sand and water to penetrate. The damage may have been caused by the heavy door section of the heater annex to the old living quarters being blown off in a gale and driven directly into the north wall. The door handle of the NW entry door has also been broken off. The NE section of the hut is wet with water dripping from the roof. The large quantity of food stored in the hut has all decayed and there was one centimetre of water on the floor. Flat roofs are not suitable on Heard Island.

7. Australian Kitchen-Dining Hut

This is a sagging wood and galvanised iron hut, reasonably intact but about to fall apart. That it has stood up for so long is probably due to its location in the lee of other huts and the protection of sand drifts along its walls. The Aga stove and a washing machine (possibly American) remain.

The western annex is an old original ten-sided wooden hut but all roof panels have gone.

8. US Latrine Building

The rectangular plywood construction is sound. The two-holer is in good condition and remains a pleasure to use.

9. Australian Recreational-Living Hut

This cottage-roof wooden building of the Maudheim design has stood up to conditions reasonably well but the special steel heater annex constructed by the Americans in 1969 has been blown apart letting in the weather through the air duct. This has destroyed the contents of the hut including a large quantity of medical stores. This building was cleared and cleaned by the 1980 expedition and could provide a refuge for a number of years. The internal woodwork has rotted somewhat with the entry of water.

10. US Steel Slab Annex

Prefabricated building 2.2 metres square used as a heater room. The door section is missing.

11. Geology-Storage Hut

All walls damaged, contents destroyed.

12. Australian Radio Hut

A ten-sided hut built in 1947. All roof panels were completely destroyed but walls are still intact. Equipment destroyed.

Table 2. Continued

13. Storage Hut

Small store for powerhouse, mainly intact but drifted up with sand.

14. Powerhouse

Doors and sections of west wall destroyed. Rusted old Australian generators still shrouded with remnants of tarpaulin covers. Floor badly drifted in with sand.

15. Carpenter's Hut

The original Chippy's Church. Wooden board sides with high pitched galvanised iron roof. Used for general hardware storage. The galvanised iron is rusting through on the weather side. Frame is intact and could be used as a store if reclad entirely with galvanised iron. The roof will fail soon. The NE clear roofing panel has already gone.

16. Equipment-Storage Hut

Walls totally destroyed. Food, possibly flour in tins, is all totally destroyed.

17. Base Hospital

The south annex to this hut was the Admiralty Hut built by Capt Hansen of the whaler Kildalkey in 1929. The roof has collapsed and the hut is not habitable.

18. Met-Hydrogen Hut

Totally destroyed to floor level.

19. Radio Mast

80-foot mast intact.

20. Radio Mast

40-foot section only, in poor shape.

21. Australian Sleeping Huts

Twin multi-sided wooden huts, with the roofing panels of each hut totally destroyed. Contents totally destroyed.

22. French Arbec Hut No 1

This hut is in excellent condition containing beds and mattresses. Galvanised metal walls with plastic foam inside as insulation, glued directly to the metal.

Table 2. Continued

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23. French Arbec Hut No 2

Excellent condition. This hut has no foam lining but has two excellent Thermolux gas heaters mounted to the walls. It has a concrete pier built from bedrock to the interior of the hut in the NW corner.

24. French Arbec Hut No 3

Excellent condition. No insulated lining.

25. French Arbec Hut No 4

Completely destroyed.

26. Survey Hut

Totally gone, with only the concrete slab and the base of the Dynes Mast remaining. The Bureau of Meteorology automatic weather station has been installed on the base of the Dynes Mast.

4.9 STATUS OF THE SPIT POINT HUT

This hut (Figure 16) is now in poor condition. The flat roof is concave and fills with water which leaks into the hut. The door has blown open since 1971 and both door uprights have rotted badly. The bottom 30 cm of the door was missing and the floor was covered with 2 cm of water.

Penguins shelter in the hut and the plastic and tarpaulins covering the stores were a mess of guano.

Although still a refuge from the howling wind it is a leaking mess. There was no time for effective repair or renovation. New boards were placed on the bottom part of the door and the entrance wired up. No attempt was made to clean the hut out or fix the holes or leaks.

In its time, it has proved to be a very important refuge, particularly in 1963 and 1971. Although it could still be made habitable by cladding the whole exterior of the hut in suitable material sheeting, changing the roof camber and relining the inside, it really needs replacement. For the hut to have survived some 30 years, it must be in a suitable site. It is time the hut was replaced. A replacement could be landed complete or in prefabricated sections.

4.10 VISIT TO ILES KERGUELEN 29-30 MARCH 1980

Before leaving Australia, approval had been obtained through the French Embassy, Canberra, for the MV Cape Pillar to call at Iles Kerguelen in case of medical emergencies.

As the helicopter engineer had suffered a suspected fractured rib caused by a fall on the helicopter deck three weeks previously and pain persisted, it was decided to have the resident doctor at Iles Kerguelen examine him and at the same time attend to two other crew members - one with a damaged phalange and the other with a suspected hernia.

The Expedition Leader and ship's Chief Officer left the ship by helicopter, landed at Port aux Francais and returned with Dr Jacques Richards who attended to the patients.

The Chef de District, Iles Kerguelen, Monsieur Georges Moncot, called on board later from the barge L'Oiseau, on his way back from another part of Iles Kerguelen. Monsieur Moncot warmly welcomed the expedition to Port aux Francais and extended an invitation for all to visit ashore.

The Master, Chief Officer, Expedition Leader and other members returned the Chef de District's call and were shown through the most impressive clean and well-planned establishment.

Monsieur Moncot mentioned that a fishing fleet of eleven ships had recently been fishing in the area: ten Russian and one Polish. They had called at Port aux Francais before leaving and were expected to return in two months' time. Monsieur Moncot is empowered to issue licenses for foreign fishing vessels to operate within the 200-mile fishing zone around Iles Kerguelen.

The party was later entertained to dinner in the 'restaurant' on the island in the warm, though towards the end somewhat rowdy, atmosphere of 'Fraternité'.

The next day, Sunday 30 March 1980, Georges Moncot and the Radio Officer cum Post Master, Jean Zapico called to wish the expedition Bon Voyage and to present philatelic envelopes. The ship brought out a bag of mail from the base.

Annex A

HISTORICAL BACKGROUND OF HEARD ISLAND AND THE McDONALD ISLANDS

Heard Island was first sighted by the British sealer Peter Kemp, master of the brig Magnet on 27 November 1833 whilst on a voyage from Iles Kerguelen to the Antarctic. In 1849 it was rediscovered by Thomas Long, master of the American whaling ship Charles Carroll, who reported he had seen land from the masthead while whaling south of Iles Kerguelen. Neither of these sightings was published and the island was later named after Captain Heard, master of the American barque Oriental who sighted the island on 25 November 1853 during a great circle voyage from Boston to Melbourne.

The first landing on Heard Island was made in March 1855 by Captain Darwin Rogers of the Corinthian, the first of many New England seamen to exploit the seals. He took 400 barrels of elephant seal oil for his employers who quickly despatched another vessel, the Laurens, to join Rogers with four tenders - Atlas, Exile, Franklin and Mechanic. The island was explored, the principal headlands and bays named and some 3000 barrels of elephant seal oil taken.

Although the riches of Heard Island were a jealously guarded secret, sealing camps became established on most beaches along the north-east coast. In 1858 the American monopoly was broken by Dr W.L. Crowther, owner of a large whaling fleet in Hobart, when he despatched Captain Robinson in the Offley, who landed on Heard Island on 29 October 1858. The impact of uncontrolled slaughter of the seals was quick and within twenty years they were almost exterminated. In 1874 when Sir George Nares landed from the Challenger, the industry was in decline and by 1880 the island was abandoned. H.N. Moseley, naturalist with the Challenger expedition, published the first scientific report on Heard Island in 1879, including comments on interviews with the sealers ashore.

In 1902, Baron E. von Drygalski, leader of the German Gauss expedition to Antarctica, called briefly at the island and compiled further scientific reports. In 1908 the British Colonial Office received an enquiry from the Norwegian Government about the sovereignty of Heard Island for whaling purposes. The Colonial Office granted an option to the Sandefjord Whaling Company in 1910 to occupy the island for three years under exclusive licence. However, that company made a private agreement with the South African Whaling Company to send a whaling reconnaissance to the island and share the licence. An expedition was despatched from Durban in the factory-ship Mangoro under Captain A. Eversen who hoisted the British flag on Heard Island on 25 March 1910.

In October 1926 a whaling licence was granted by the British Colonial Office to a South African firm - the Kerguelen Sealing and Whaling Company - and in 1929 one of the company whalers - the Kildalkey - erected a visual navigational beacon and a hut at Atlas Cove and hoisted the British flag. This ship made six visits to the island that year, and the French geologist G. Aubert de la Rue and his wife landed there for eight days to study the geology.

In November 1929 Sir Douglas Mawson's BANZARE Expedition, aboard the Discovery II, spent seven days on the island and carried out a short program of scientific research.

Early in 1947, following the appointment of an Australian Antarctic Planning Committee and discussions with the British Government, it was decided to establish a research station at Heard Island. The Heard Island Expedition left Australia on 28 November 1947 in the World War II landing craft LST 3501 - renamed HMAS Labuan - and arrived at Heard Island on 12 December. On 26 December the Australian flag was raised and the island formally annexed.

Following an exchange of notes between the United Kingdom and Australia on 19 December 1950, the sovereignty of Heard Island was transferred from Great Britain to Australia. In 1953 the Australian Government enacted formal measures providing for the government of Heard Island and its outliers, the McDonald Islands.

The ANARE station was occupied for meteorological and other scientific research for seven years - from 1948 to 1954 - by a party averaging fourteen men. Details of these scientific parties are given in Annex B. In July 1950, HMAS Australia made a mercy dash to the island to repatriate a sick medical officer. HMAS Labuan was replaced in 1952 and 1953 by the chartered Norwegian whaler MV Tottan and this in turn by the MV Kista Dan in 1954. The base was closed on 8 March 1955 following the establishment of Mawson station on the Antarctic mainland.

Several brief visits have since been made by ANARE ships returning from relief voyages to Antarctic stations, to check the condition of the Atlas Cove base. In 1963 an ANARE party spent six weeks on the island and made an unsuccessful attempt to climb to the summit of the central mountain, Big Ben.

[redacted]

In the summer of 1965 a private scientific and mountaineering expedition sailed from Australia in the auxiliary schooner Patanela, and a five man climbing party reached the summit of Mawson Peak on Big Ben on 25 January 1965.

In March 1969 an ANARE party from the USCG Cutter Southwind made a biological and glaciological reconnaissance of the north coast, from Spit Bay to Red Island, while an American survey party was being established at the Atlas Cove station. The American party and a subsequent relief party occupied the station until April 1970 as part of the Pageos satellite observation program.

In 1971 a combined French-Australian expedition from the French ship Gallieni spent the summer based at Atlas Cove making geophysical and auroral observations. One of the party broke a leg on the Gotley glacier and was later rescued by a helicopter from the Nella Dan.

On 1 November 1979 the Australian Government declared a 200 nautical mile fishing zone around Australia and its Territories; this included the Territory of Heard Island and McDonald Islands.

Annex B

PREVIOUS EXPEDITIONS TO THE TERRITORY 1947-1972

1947-48 ANARE

Leader : Group Captain S.A.C. Campbell
Ship : LST 3501 (HMAS Labuan - Lieutenant Commander G. Dixon)

Heard Island Wintering Party (1948)

A.V. Gotley, OIC and Meteorologist
R.G. Dovers, Surveyor
F.J. Jacka, Physicist
J.E. Jelbart, Physicist
A.J. Lambeth, Geologist
A.R. Gilchrist, Medical Officer
L.E. Macey, Radio Supervisor
A.N. Jones, Cook
A. Campbell-Drury, Radio Operator
A.W. Scholes, Radio Operator
G.S. Compton, Radio Operator and Assistant Surveyor
A.T. Carrol, Weather Observer
K.W. York, Weather Observer
J.A. Abbotsmith, Diesel Mechanic

Supernumeraries

N.S. Chamberlain, Magnetician
J. Ivanac, Geologist
F/Lieut M.D. Smith, RAAF Pilot
W/O P.C. Swan, RAAF Photographer
D. Eastman, Photographer
W/O C.C. Dunlop, RAAF Warrant Officer Signals
L.A.C. C.E. Short, RAAF Fitter
L.A.C. G. Melk, RAAF Fitter

1949 ANARE

Leader : P.G. Law
Ship : HMAS Labuan (Lieutenant Commander G. Dixon)

Heard Island Wintering Party

R.W. Allison, OIC & Medical Officer
A. Garriock, Meteorologist
R.G. Chittleborough, Biologist
E.H.M. Ealey, Biologist
R.G. Smith, Weather Observer
O.E. Warden, Weather Observer
R.G. Oatt, Radio Supervisor
H.C. Burnett, Radio Operator
J.H. Paddick, Radio Operator
A.R. Burton, Diesel Mechanic
C.W. Du Toit, Cook

Supernumeraries

Capt E. Troy, RAASC, OIC DUKWs
W/O J. Cunningham, DUKW Driver
W/O K. Jardine-Wallace, DUKW Driver
Kee Hoch Ooi, Biologist
D. Eastman, Photographer
J. Atkinson, Journalist

1950 ANARE

Leader : T.G. Heath
Ship : HMAS Labuan (Lieutenant Commander D. Shaw)
- HMAS Australia visited in July

Heard Island Wintering Party

J.W. McCarthy, OIC & Meteorologist
L.E. Gibbney, Biologist
P.S. Young, Biologist
S. Udovikoff, Medical Officer (until July)
J.H. Gore, Radio Supervisor
L.J. McGarrigle, Radio Operator
J.H. Vause, Radio Operator
M.J. Bruer, Weather Observer
P.J. Marron, Weather Observer
J.E. Walsh, Weather Observer
T.F. Keating, Diesel Mechanic
A.D. Riddell, Carpenter
E.H.J. Thornton, Asst Cook & Storeman
P.R. Wayman, Asst Cook & Storeman
A.M. Gwynn, Biologist and Medical Officer (from July)
O.R. Rec, Medical Officer (from July)

Supernumeraries

Lieut G.L. Thomas, RAASC, OIC DUKWs
W/O K. Jardine-Wallace, DUKW Driver
W/O J. Cunningham, DUKW Driver
E. Schaeffler, Geophysicist
A.R. Martin, Meteorologist
R. Kenny, Biologist

1951 ANARE

Leader : P.G. Law
Ship : HMAS Labuan (Lieutenant Commander I. Cartwright)

Heard Island Wintering Party

F.T. Hannan, OIC and Meteorologist
H. Doyle, Geophysicist
K.G. Brown, Biologist
M.C. Downes, Biologist
O.R. Rec, Medical Officer
N.T. Lied, Radio Supervisor
K.J. Johnston, Radio Operator
D.J. Cheffins, Radio Operator
K.F. Bott, Weather Observer
A.J. Giex, Weather Observer
W.R.J. Dingle, Weather Observer
P. Lawson, Diesel Mechanic
J. Starr, Cook
J.E. Walsh, Day Attendant

Supernumeraries

Capt E. Troy, RAASC, OIC DUKWs
Sgt R. Stanyer, DUKW Driver
Cpl C. McCormick, DUKW Driver
N. Favoloro, Ornithologist
A. Campbell-Drury, Photographer
H.M. Brent, Stores Officer

1952 ANARE

Leader : P.G. Law
Ship : MV Tottan (Captain L.L. Fredricksen)

Heard Island Wintering Party

L.F. Gibbney, OIC and Biologist
L. Ingall, Geophysicist
R. Borland, Meteorologist
J. Faulkner, Medical Officer
A. Perriman, Radio Supervisor
R. Hoseason, Radio Operator (accidently drowned 26.5.52)
J. Carr, Radio Operator
K.C. Hall, Weather Observer
L. Atkinson, Weather Observer
R.G. Frost, Weather Observer
J. Russell, Diesel Mechanic
P. Teysier, Cook
P. Brown, Asst Cook, Storeman
A. Forbes, Dog Attendant (died from exposure 26.5.52)

Supernumeraries

R.H.J. Thompson, Supply Officer
L.E. Macey, Technical Officer
C. Van der Warl, Geophysicist

1953 ANARE

Leader : J. Donovan
Ship : MV Tottan (Captain H.C. Anderson)

Heard Island Wintering Party

J.M. Berchervaise, OIC
J.A. Brooks, Geophysicist
P.J.R. Shaw, Meteorologist
A.M. Gwynn, Medical Officer
K.E. Dalziel, Radio Supervisor
R.V. Parsons, Radio Operator
C.F. O'Brien, Radio Operator
L.R. Welsh, Weather Observer
F. Elliott, Weather Observer
B. Izabella, Weather Observer
J. Hughes, Diesel Mechanic
R.G. McNair, Cook
L.N. Fox, Dog Attendant

Supernumeraries

R.H.J. Thompson, Supply Officer
L.E. Macey, Technical Officer
A. Spalding, Journalist
P. Stahl, French Observer

1954 ANARE

Leader : P.G. Law
Ship : MV Kista Dan (Captain H.C. Peterson)

Heard Island Wintering Party

G. Budd, OIC and Medical Officer
K. Lodwick, Geophysicist
J.H. Gore, Radio Supervisor
G.E. Delahoy, Radio Operator
M.W. Henderson, Weather Observer
J.E. Walsh, Weather Observer
V. Cleland, Weather Observer
L.G. Gardner, Diesel Mechanic
D.P. Sweetensen, Cook

Supernumeraries

R.H.J. Thompson, Supply Officer
A. Migot, French Observer

1963 ANARE

Leader : G.M. Budd
Ship : MV Nella Dan (Captain G. Bertelsen)
Period : 26 January-9 March

Heard Island Party

G.M. Budd, OIC, Physiology & Biology
W.M. Deacock, Botany & Photography
P.J. Stephenson, Geology & Glaciology
A.R. Gilchrist, Medical Officer & Biology
N.T. Lied, Meteorology, Glaciology & Radio
M.C. Downes, Biology

1964-65 SOUTH INDIAN OCEAN EXPEDITION TO HEARD ISLAND

Leader : W.M. Deacock*
Ship : Auxiliary Schooner Patanela (Skipper H.W. Tilman)
Period : January 1965

G.M. Budd, Scientific Officer*
M.C. Hay, Cine-photographer
R. Pardoe, Medical Officer
E.J. Reid, Radio Operator
R.P. Temple, Entomologist*
C.K. Putt, Engineer*
A.J. de V. Hill, Ship's mate
J.R. Crick, Quartermaster*

* Heard Island Party

1969 ANARE

Leader : G.M. Budd
Ship : USCG Cutter Southwind
Period : 11-17 March

Heard Island Party

G.M. Budd, OIC, Biology and Glaciology
W.M. Deacock, Field Assistant
N.R. Miller, Field Assistant

1969 AMERICAN EXPEDITION

Ship : USCG Cutter Southwind
Period : March-November

Heard Island Wintering Party (Satellite Triangulation)

B.D. Roth
E. Kiehnau
J. Shaffery
J.A. Joll
S. Oldland
G. Brannan

1969-70 AMERICAN EXPEDITION

Ship : MV Nella Dan (USS Columbia Hawk for return voyage)
Period : November 1969-April 1970

Heard Island Party (Satellite Triangulation)

H.B. Milburn
R. Cohen
S. Cofer
K. Kerr
R. Kyle
D. Lawhon

1971 FRENCH-AUSTRALIAN EXPEDITION

Leader : R. Gendrin
Ship : MV Gallieni
Period : 25 January-9 March

Heard Island Party

French Members

C. Bercy, Geophysicist
S. Gasverde, Technician
S. Grandini, Geophysicist
G. Jacot, Radio Technician
D. Morin, Geophysicist
M. Peter Cook
R. Riguet, Geophysicist
J. Vienne, Physician

Australian Members

I. Allison, Glaciology
H. Thelander, Geophysics
G.M. Budd, Physiology
I. Dillon, Assistant
I. Holmes, Assistant

During the expedition a brief landing was made by helicopter on McDonald Island by G.M. Budd and H. Thelander.

BRIEF VISITS TO HEARD ISLAND

ANARE visit 9.3.1956

Homeward bound from Mawson - MV Kista Dan.

P.G. Law
I. Scholossback - US Observer
H. Ayers - NZ Observer

ANARE visit 6.3.1958

Homeward bound from Mawson and Davis - MV Kista Dan.

P.G. Law
R.H.J. Thompson
J. Donovan
K. Mather
R. Dingle
G. Wheeler
F. Hannan
B. Izabella
N. Lied
J. Goodspeed
O. While
E. Sorenson
B. Hansen

ANARE visit 5.3.1960

Homeward bound from Mawson - MV Thala Dan

G.M. Budd
A. Evans
L. Onley
R. Rippon
K. Peake-Jones
J.L. Armstrong
M. Kirkton
C. Braunstaffer

Private Visit - 19-21 January 1972

French Cutter Damien (length 10 m)
Crew : Jerome Poncet
Gerard Janichon

The vessel was en route from France to the Ross Sea, via Iles Kerguelen and Terre Adelie.

Annex C

PROJECT INSTRUCTION

PROJECT INSTRUCTION

BRANCH/SECTION ....OPERATIONS.....

PROJECT NO. NMP/80-015 DIVISION FILE NO NM 79/965.

PROJECT Heard Island Survey 1980

PRIORITY Routine

PURPOSE Surveys at and in the vicinity of the Heard/McDonald Islands

TIME FRAME 28 February - 13 April

MAPS AFFECTED Heard Island 1:50 000 topographic map

CHARTS AFFECTED AUS 401 - Australia to Antarctica - 1:8 500 000 scale
AUS 606 - Heard Island - 1:83 000 scale

DETAILS

1. Bathymetric survey work is required in support of the offshore delimitation between Heard/McDonald Islands and Kerguelen Island.

2. Tidal information is to be obtained at suitable sites in the survey area.

3. In addition an onshore program of JMR Doppler satellite fixes combined with direct measurement is to be carried out to provide further survey control and to re-establish existing control on Heard and McDonald Islands.

4. Survey monuments of a durable nature are to be placed on each island visited.

5. Subject to the availability of Helicopter support and conditions permitting, a program of vertical aerial photography providing stereoscopic coverage, of the Heard/McDonald Islands and nearby shoals and rocks is required.

...2/

DETAILS (Continued)

6. A programme of deployment of expendable bathythermographs for the duration of the survey has been formulated with the Hydrographic Service, RAN, and the Flinders Institute of Atmospheric and Marine Sciences (FIAMS). Water samples will also be taken for FIAMS.

   Natmap will erect an automatic weather station on Heard Island for the Bureau of Meteorology, Department of Science and the Environment, as well as deploying weather buoys in the southern Indian Ocean for the Bureau.

   The Expedition Leader will carry out hydrographic surveys of selected areas in the vicinity of Heard and McDonald Islands - particularly around Atlas Cove.

   A 16 mm documentary movie of the expedition will be produced by National Mapping personnel.

   Natmap will also arrange for the detailed photography of a crashed Walrus aircraft from a previous expedition. This is required for historical purposes.

   Natmap will operate a special "fish-finding" echosounder in the vicinity of the Heard and McDonald Islands for the Fisheries Division, Department of Primary Industry. Personnel will also assist in the collection of fish samples during the expedition.

   The Bureau of Mineral Resources is providing a deep water echosounder and a data acquisition system that will record bathymetry and marine magnetometer data. Magnetic observations will also be made by Natmap on both islands to 2nd and 3rd order standards.

   Normal surveillance duties will be carried out by the MV "Cape Pillar" for the Australian Coastal Surveillance Centre, Department of Transport, for the duration of the voyage.

7. The following Departments and Organisations are cooperating with Natmap on the expedition:

. National Development & Energy	- BMR
. Science and Environment	- Antarctic Division
	- Bureau of Meteorology
. Transport	- Coastal Transport Branch
	- Australian Coastal Surveillance Centre
. Primary Industry	- Fisheries Division
. Defence	- Hydrographic Service, RAN
. University of Melbourne	- Biology Department
. Monash University	- Geology Department
. Adelaide University	- FIAMS.

8. National Mapping's program and the programs of Departments cooperating with Natmap on the expedition are attached.

ACCURACY SPECIFICATIONS

Work is to be performed in accordance with "Specifications for Bathymetric Surveys".

SPECIAL INSTRUCTIONS

Administration of the survey is to be in accordance with Natmap's "Administration Instructions for Field Parties". Photographs of the operations must be taken during the survey. Weekly progress reports are to be sent to Natmap, Queanbeyan, each Monday.

PERSONNEL

See Page 4.

ESTIMATED COST

	Vote	Cost (estimated)	Cost (actual)
Allowances	431 - 1 - 01		
(1) AILOT		8 000	
(2) Public holiday duty		1 400	
(3) Sunday duty		2 800	
(4) Shift penalty		1 000	
(5) Diving			
(6) District		2 300	
Extra Duty	431 - 1 - 02		
Travel and Subsistence	431 - 2 - 01		
(1) Fares		4 200	
(2) TA		2 240	
(3) Camping allowance		500	
(4) Marine allowance		1 000	
Map Printing	431 - 2 - 04		
Vehicles	431 - 2 - 05		
(1) Hire		300	
(2) Running costs		300	
(3) R & M			
Aerial Survey & Photo	431 - 2 - 07	45 000 H'copter	
R&M of P&E	431 - 2 - 09	500 Film	
Hire of Ships/Boats	431 - 2 - 10	262 840	
Computing	431 - 2 - 11		
General Stores	431 - 2 - 12		
(1) Petty cash		300	
(2) Field purchase orders		500	
Office Services	431 - 2 - 13		
Incidental	431 - 2 - 14		
(1) Freight		500	
(2) Hire of equipment			
Plant & Equipment	883 - 1 - 02	-	
	TOTAL	333 680	

PERSONNEL

National Mapping

C. Veenstra	Assistant Director, Survey, and Expedition Leader
B. Obst	Surveyor class 2 and Surveyor-in-Charge, Bathymetry
J. Manning	Surveyor class 2 and Surveyor-in-Charge, Onshore surveys
R. Streeter	Surveyor class 1
E. Graham	Senior Technical Officer grade 1
K. Brown	Senior Technical Officer grade 1
J. Pittar	Act-Senior Technical Officer (Eng) grade 2
M. Spellacy	Technical Officer grade 2

Bureau of Mineral Resources

L. Tilbury	Geophysicist grade 2 and BMR Leader
R. Dulski	Technical Officer (Eng) grade 2

ANARE

G. Johnstone	Zoologist, Antarctic Division and ANARE Leader
R. Williams	Marine biologist, Antarctic Division
J. Jenkin	Botanist, University of Melbourne
J. Clark	Geologist, Monash University

MAJOR PLANT AND EQUIPMENT

Plant on Hire:

MV Cape Pillar
Hughes 500 D helicopter

Plant on Loan:

JMR satellite doppler receiver (WA Lands)
Magnavox satellite doppler receiver, Single Channel (Primary Industry)
Data acquisition system (BMR)
Raytheon echo sounder (BMR)
Simrad echo sounder (Primary Industry)
Bathythermograph launcher and recorder (CSIRO)
Expendable bathythermographs (Hydrographic Service, RAN)
16 mm Bolex cine camera (Antarctic Division)

Departmental Equipment:

Magnavox Satellite Doppler sonar system
Motorola MiniRanger System
Atlas Deso 10 Echo Sounders
7 metre survey launch
Furuno Radar
Tide Recorders
Wild T2 Theodolites
Watts Autoset Level
AGA 78 Geodimeter
CA 1000 Tellurometer
2 x Hasselblad 500 EL Cameras
4 x 35 mm cameras
Codan SSB Transceivers

Vehicles:

Registration No.	Type
ZSU 524 (to Perth only)	International 4 x 4

Project Recommended ..... Assistant Director

Project Approved ..... Director

8 February 1980

Distribution:

Assistant Director, Melbourne
Assistant Director, Survey
Assistant Director, Cartography
Project Register, Production Control (original)
Branch/Section Head
Project Leader

Heard Island Expedition

ANARE Scientific Program

Marine program (R. Williams)

Throughout the voyage, and particularly in the vicinity of Heard Island the abundance and growth rate of phytoplankton (microscopic algae) in the water will be measured with a fluorometer. This instrument measures the amount of fluorescence in the water, most of which is produced by the chlorophyll (green pigment) in the algae. Surface and deep water temperatures will be measured and samples of sea water collected for chemical analysis.

This will be the first such study in this region, and its value, apart from providing new data from an unknown area, will be that the region around Heard Island contains some interesting oceanographic features which may help to elucidate the factors controlling phytoplankton populations. These include the Antarctic Convergence, a boundary between two water masses which runs between Heard and Kerguelen Islands, and the steep slope from the deep ocean floor to the Kerguelen Plateau, west of Heard Island. The existing 30 mile grid that the ship will follow north and north-west of Heard Island will generally be sufficient for these observations, but a westward extension of the grid (marked on Attachment 1) will give extra very valuable results.

Heard Island Expedition

ANARE Scientific Program

Zoology (Dr G.W. Johnstone)

Primarily a census of the bird population on Heard and McDonald Islands. Nothing is known of the ornithology of McDonald Islands and Heard Island has not been studied for many years. Of particular interest will be the amount of increase in the bird populations since the last figures were obtained as a result of the decline in competition by whales for food. Some work will also be done on seals (particularly elephant seals and fur seals) to estimate their numbers and to tag some individuals in order to gain some idea of their movements. Areas of interest are similar to those of the mapping team and the botanical survey.

Heard Island Expedition

ANARE Scientific Program

Botanical survey (probably Dr J.F. Jenkin)

The flora of Heard Island has never been documented except for a few brief references in literature arising from earlier expeditions. McDonald Islands have never been described botanically. Collections will be made of as many plant species as possible (mostly lichens and mosses) and plant communities will be examined and described, so that ecological relationships can be established. These studies will provide information on the distribution of plants between the scattered oceanic islands around Antarctica and on the way in which plant communities have adapted to the unusual climate on Heard Island. As many areas as possible will be visited in conjunction with the mapping team (viz Atlas Cove area, Spit Bay area, the S.W. part of Heard Island and McDonald Islands).

Heard Island Expedition

ANARE Scientific Program

Geology (Mr I. Clarke)

The object of this program is to collect rocks of as many varieties and from as many localities on Heard and McDonald Islands as possible. Their chemical composition, magnetism and age will then be elucidated. This will give information about the history of the island, specifically its age, past movements (in relation to continental drift) and on whether there was a volcanic 'hot spot' in the area maintaining crustal movement, as has been conjectured. Specific areas of interest are Atlas Cove, Spit Bay, Cape Lockyer, Winston Lagoon and McDonald Islands, and in general movements can be tied in with those of the mapping team.

Heard Island Expedition

ANARE Scientific Program

Automatic weather station (Antarctic Division)

An automatic weather station will be set up at the old base site to transmit via satellite meteorological information to Australia.

Heard Island Expedition

BMR Scientific Program

Marine Geophysics Operation (L. Tilbury, R. Dulski)

The Bureau of Mineral Resources (BMR) intend to collect magnetic bathymetric data using a computer-based digital acquisition system (DAS). Data will be collected continuously while the ship is underway, both over the deep ocean basins, and over the Heard-Kerguelen ridge, the large bathymetric ridge on which the islands of Heard and Kerguelen are situated.

Two items of geophysical equipment will be used: a proton precession magnetometer to measure the total intensity of the earth's magnetic field, and a deep sounding echosounder designed to measure water depths down to 5000 metres. The magnetometer sensor is towed about 200 metres behind the ship. This separation ensures the magnetic effect of the ship's steel hull is small enough to be disregarded. A winch at the stern of the ship is used to deploy the magnetometer sensor and to store the cable when not in use.

The Raytheon echosounder is a special purpose system that transmits a 'chirp' signal using an array of up to 9 transducers mounted inside the ship's hull. This method avoids having to cut large numbers of holes in the bottom plates. The return echo is correlated and compressed by a 'black box' into a normal type signal. The signal is displayed on a graphic recorder and under optimum conditions a sub-bottom penetration of a hundred metres or so can be seen in deep water. This 'penetration' facility is useful in defining whether the sea floor is hard rock or soft rock (sediments). At the same time the depth is converted to digital form ready for the DAS.

Magnetic and bathymetric values are recorded directly by the DAS computer every 10 seconds. Navigation data, that is the position, course and speed of the ship, are received via a computer-computer link from the Magnavox satellite navigation system. All data are written onto cassette tapes for permanent retention. Facilities exist within the DAS program to list data on the terminal at nominated intervals, to report on errors, and to plot raw or reduced data on a 'Zeta' digital plotter.

The two transit lines between Australia and Heard Island will cross a deep ocean basin which contains the Southeast Indian Ridge - a large submarine mountain ridge along which new oceanic crust is being formed. This formation of new crust at mid-ocean ridges is a characteristic feature of continental drift which has resulted in Australia moving northward away from Antarctica at a rate of a few centimetres per year. These survey lines will provide bathymetric information across this Ridge, and also magnetic profiles across the ocean basin, which by comparison to the profiles of standard magnetic models can be interpreted to determine the age of the sea floor.

Magnetic data will be used to define the extent and thickness of any sedimentary basins which may be located within the 'Australian' region of the Heard-Kerguelen Ridge. Should any large basins be found, further more detailed surveys would be needed to determine their economic potential.

Heard Island Expedition

BMR Scientific Program

Magnetic Observations - to be undertaken by NATMAP

The cause of the Earth's magnetic field is unknown, but is connected with fluid motions in the central core. In geological terms, its erratic and unpredictable changes - the so called secular variation - are very rapid, and their study is vital to an understanding of geomagnetism as a science.

On a more practical plane, the secular variation necessitates the preparation of magnetic charts at frequent intervals (about every 5 years) for applications in navigation, radio communications, geophysical surveying, and the power and gas transmission industry.

The basic data for charting the magnetic field are provided by continuous recordings (at magnetic observatories) and periodic measurements (at magnetic 'stations'). In 1947 BMR established a magnetic station at Heard Island, and a magnetic observatory in 1951. The observatory was closed down in 1954, when the Antarctic base at Mawson was established, but the observation piers were left for future re-occupation.

One of the objects of the magnetic program in the 1980 expedition is to re-measure the field at the observatory site, and so determine the secular variation. This work has added importance at this time because it will be done during the short lifetime of a unique satellite - MAGSAT - which was launched late in 1979 to give global magnetic measurements. Many countries are making special efforts to obtain 'ground control' measurements in remote regions for the MAGSAT project.

In addition, measurements at several places around the island will be made to give a picture of the distortion of the smooth main field produced by the volcanic island. Without this information it is difficult to assess how representative the observatory-site data are.

Heard Island Expedition

Bureau of Meteorology Program - To be undertaken by NATMAP

The Bureau of Meteorology Automatic Weather Station will transmit Barometric Pressure via the French NOAA satellite. This information is needed for the International Meteorology Observation Service.

The buoy from the Bureau of Meteorology is to be dropped in the water in a position to be determined during the return voyage from Heard Island. The buoy will transmit Barometric Pressure and Surface Temperature, and the NOAA satellite will determine the bouy's position. This information is for the "First Global Atmospheric Research Program".

Heard Island Expedition

Fisheries Profile - To be undertaken by NATMAP

Simrad Echo Sounder

Aim and use of echo sounder traces

- to determine depth and configuration of the bottom between Albany/Fremantle and Heard Island and as much of the bottom as possible in depths of less than 800 metres surrounding the islands of Heard and McDonald.

- to determine occurence and density of bottom and mid-water fish schools

- to determine thermoclines and planktonic occurrence

Fishing Activity

Basic fishing gear has been provided in the form of

- hand lines
- gill nets
- lobster pots

to sample for possible commercial fish and crustacean species

Information required is

- identification or photo or preserved specimen
- length and weight
- approximate weight per hook/hour
- or weight per pot/lift/per day/night
- or total weight per gill net hour set day/night

Annex D

1980 NATIONAL MAPPING EXPEDITION PERSONNEL

1980 NATIONAL MAPPING EXPEDITION

Leader : C. Veenstra
Ship : MV Cape Pillar - Captain G.L. Maxwell
Period : 29 February 1980 to 9 April 1980

McDonald Islands Party

Period : 11 March 1980 to 15 March 1980

J. Manning	OIC, Surveyor Class 2, National Mapping
R. Streeter	Surveyor Class 1, National Mapping
E. Graham	Senior Technical Officer Grade 1, National Mapping
G. Johnstone	Acting Senior Biologist, Antarctic Division
J. Jenkin	School of Botany, Melbourne University
I. Clarke	School of Earth Sciences, Monash University

Heard Island Party

Period : 16 March 1980 to 27 March 1980

C. Veenstra	OIC, Assistant Director, National Mapping
J. Manning	Surveyor Class 2, National Mapping
R. Streeter	Surveyor Class 1, National Mapping
E. Graham	Senior Technical Officer Grade 1, National Mapping and Official Photographer
G. Johnstone	Acting Senior Biologist, Antarctic Division
J. Jenkin	School of Botany, Melbourne University
I. Clarke	School of Earth Sciences, Monash University

Supernumeraries

D.L. Ross	Helicopter Pilot
R. Rayner	Helicopter Engineer
R. McNeill	AB, MV Cape Pillar, Base Assistant

Shipboard Party (Offshore Operations)

Period : 29 February 1980 to 9 April 1980

B. Obst	OIC, Surveyor Class 2, National Mapping
L. Tilbury	Geophysicist Class 2, Bureau of Mineral Resources
J. Pittar	A/g Senior Technical Officer Grade 2, National Mapping
K. Brown	Senior Technical Officer Grade 1, National Mapping
R. Dulski	Technical Officer Grade 2, Bureau of Mineral Resources
M. Spellacy	Technical Officer Grade 2, National Mapping
R. Williams	Biologist, Antarctic Division

Crew of MV Cape Pillar

G. Maxwell	Master
R. Ireland	Chief Officer
A. Codrington	2nd Officer
P. Verheyden	3rd Officer
R. McManamon	Marine Radio Officer
V. Osborn	Boatswain
T. Merson	Shipwright
E. Orman	Able Seaman
D. Cleghorn	Able Seaman
W. Rothacker	Able Seaman
C. Bridge	Able Seaman
K. Balling	Able Seaman
A. Scott	Able Seaman
N. Cobb	Able Seaman
J. Hatfield	Able Seaman
R. McNeill	Able Seaman
R. Davidson	Chief Engineer
P. Stokes	2nd Engineer
P. Pittiglio	3rd Engineer
J. Vinter	4th Engineer
P. Jiear	Electrical Engineer
P. Birch	Wiper
M. Flood	Wiper
R. Lidster	Wiper
P. Gardner	Chief Steward
P. Hutchins	Steward
A. Aquillina	Steward
S. Stokoe	Steward
T. Roxby	Junior Steward
B. Fowler	Chief Cook
T. Spence	Cook
B. Mulligan	Sculleryman
M. Treloar	Crew Attendant

Annex E

NOTES LEFT AT HEARD ISLAND BY EXPEDITIONS 1955-1980

Territor[illegible]eard and McDonald Islands — Commonwealth of Australia

TO VISITORS

A scientific Station was established at Heard Island by the Australian National Antarctic Research Expedition in December 1947 and maintained continuously until March 1955 by the Antarctic Division of the Department of External Affairs. Certain basic essentials of the establishment have been left intact to serve as a haven for any mariners unfortunate enough to be forced to seek safety on this bleak island. The whole establishment remains the property of the Commonwealth of Australia.

YOU ARE REQUESTED:

1. Not to open the huts or touch the stores or equipment unless you are in dire need.
2. To treat all stores and equipment with care and economy – others after you may have need of it.
3. To seal up all huts tightly and securely before leaving (deterioration is rapid once the wind finds a way of entering) and to leave the Station in a condition ready for immediate use by any subsequent visitors.

YOU ARE ADVISED:

1. That food is stored in the food store and in the pantry. Elephant seals and birds are plentiful between October and March. From April until September most animals migrate but sea leopards visit the beaches during these months and gentoo penguins remain. There is an AGA stove in the kitchen and a plentiful supply of coke.
2. That some clothing and blankets are stored in the clothing store. There is a small selection of medical requirements in the surgery.
3. A radio transceiver, batteries and battery charger are ready for use, with instructions, in the radio hut.
4. Diesel engines and alternators for electric power are in the engine room. They have been dismantled to delay deterioration but can be reassembled in a short time. They supply 230 volt A.C. power for light and for the radio. A small selection of essential tools is supplied to assist in the reassembly. Diesel distillate (gas-oil) is in the 1000-gallon tank beside the engine room; kerosine is in 44-gallon drums marked "K"; lubricating oil for the diesel engines is in the spare diesel hut with the kerosine
5. Kerosine lamps and heaters are ready for use in the mess hut and various useful stores are available in other store huts
6. A plan of the Station is supplied herewith.

Good luck and God help you safely home again.

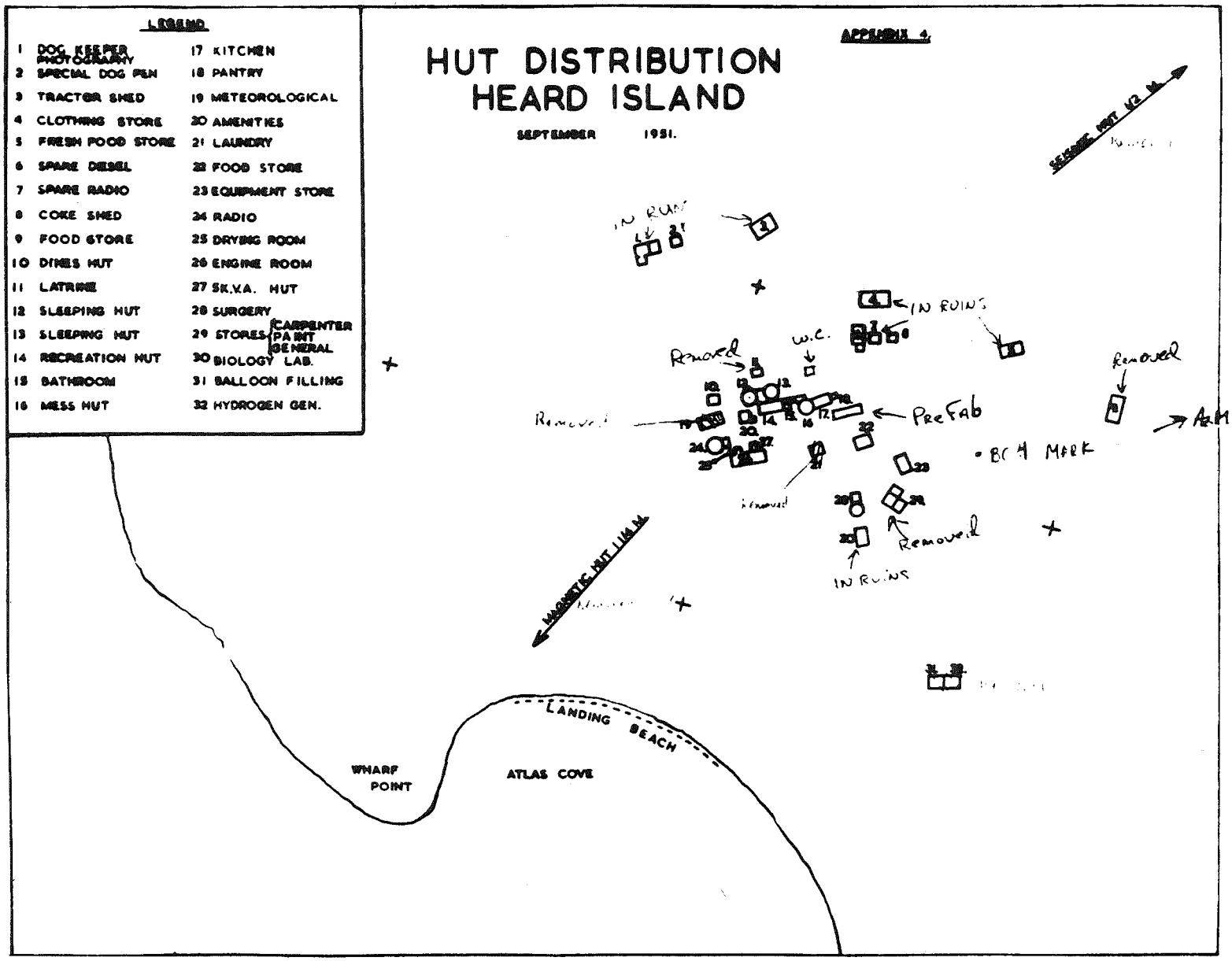
[illegible] 8/2/55

P.G. Law - Director - Antarctic Division.

APPENDIX 4.

HUT DISTRIBUTION HEARD ISLAND

SEPTEMBER 1951.



The Heard Island Base of A.N.A.R.E.
was visited on Friday 9th March
1956
by P. G. Law, Director of the Division
and by homeward bound members
of the 1955 Mawson Base (Antarctic
Continent) Expedition.
U.S. Observer I. Schlossbach and
N.Z Observer H. Ayres were also
in party.

The establishment was found to
be in excellent order and
duly re-sealed.

OIC
Mawson
1955

OC Mawson
1955

THURSDAY 6 MARCH 1958

ANARE

The following ANARE men visited this Heard Island station on the above date, landing from MV Thala Dan when returning from the relief of the Mawson and Davis stations. All was in order and the hut was sealed up again

P.G Law	B. Izabelle
R.H. Thompson	N. Lied
J. Donovan	J. Goodspeed
K. Mather	O. White
R. Dingle	
G. Wheeler	E. Sorensen
F. Hannan	B Hansen

P.G. Law

Director

Director

5th March 1960

The following members of ANARE, returning to Australia from Mawson, visited the station and lunched here. M. Keiton (Mawson Geophysicist, [illegible]) made a magnetic determination

K Laakso
J.H. Armstrong.
Les Orley.
Bert Evans.
A Ritson
M Keiton B.M.R.
G.M. Budd
Claude Bonnetaffe

ANARE Summer Expedition to Heard Is, 1965.

Medical Stores, [redacted] are st[illegible] in good order, the operating [illegible] & drugs in particular. They are still in the original places. See note in jar in (octagonal) [illegible] hut in jar on shelves on left of door.

The surgery is in poor condition due to the entry of elephant seals and due to water from the broken western skylight. Repairs have been limited to repairing doors & skylight.

The mess, the kitchen (including the Aga stove), & the eastern sleeping hut are still in good order & have been used by the expedition.

The huts at Spit Bay & Saddle Pt are in good order. There is a small supply of usable food & fuel at Saddle Pt (although the sugar in the 4-gallon tin is suspected of causing dysentery in one of 3 members of this expedition who ate it), & large supply at Spit Bay. At Long Beach there is a dump of food & fuel used by this expedition — it is 60 feet above sea-level & 100 yards NW from the beach where the stream from the hanging glacier (at the eastern end of Long Beach) meets the sea.

J. M. Budd

Leader, 1965 expedition.

4/3/65.

U.S. DEPARTMENT OF COMMERCE
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
COAST AND GEODETIC SURVEY

1 April 1970

Heard Island was visited and occupied by the United States World-Wide BC-4 Satellite Triangulation Teams from March, 1969 to April, 1970, to photograph satellites with other stations around the World. The first team consisted of:

Ben D. Roth

J. Allen Joll

Stan Oldland

Ted Kiehnau

John Shaffery

George Brannan

This team left in November, 1969 and was replaced ce a team from U. S. Coast and Geodetic Survey consisting of:

Hugh B. Milburn

Richard Cohen

Shepherd ~~Sheperd~~ Cofer

Ken Kerr

Richard Kyle

David Lawhon ~~Leahon~~

The ships which called during this time were the :

M. V. Nella Dan, November, 1968

U. S. C. G. C. Southwind, March, 1969

M. V. Nella Dan, November, 1969

M. V. Melita, February, 1970 (A Russian Research Ship)

U. S. S. Colombia Hawk, April, 1970

Food stores, clothing, and medicine were left in the metal Prefab building. Kerosene, oil, and other fuels will be found around the area. All buildings were repaired and later boarded up which were of any use. Best of luck on this island, may your stay be only as long as you wish.

The Gang

FRENCH-AUSTRALIAN EXPEDITION 1971

Between the 25th of January and the 9th of March 1971 a french-australian party was organized at Heard Island. Its main purposes were

- to study geophysical phenomena (such as magnetism, VLF emissions, aurorae) in connection with similar studies at Kerguelen Island and at the magnetically conjugate stations in USSR (Sogra and Dolgoschelie).
- to make glaciological studies of the near-by glaciers
- to take some samples of botanical and zoological species
- to make the round trip of the Island for biological and glaciological studies.

The members of the party were

Name		Nationality	Speciality & Work
ALLISON	IAN	A	glaciologist
BERCY	CLAUDE	F	geophysicist (VLF emissions)
BUDD	GRAHAM	A	Dr. (Physiology, Biology, Glaciology)
[illegible]ILLON	IAN	A	Expedition assistant
GASVERDE	SIMON	F	Technician (electricity)
GENDRIN	ROGER	F	Geophysicist (chief of the expedition)
GRANDIN	SERGE	F	geophysicist (magnetism)
HOLMES	IAN	A	Expedition assistant
ALCT	GERARD	F	Technician (radio)
MORIN	DOMINIQUE	F	geophysicist (aurorae)
PETER	MEDARD	F	COOK (a good one!)
RIGUET	ROGER	F	geophysicist (VLF emissions)
THELANDER	HUGH	A	Geophysicist (aurorae)
VIENNE	JACQUES	F	Physician (Zoology, Botany)

They have used
- the two octogonal australian huts for sleeping
- the american shelter for cooking and eating

They have erected 4 metallic huts, two near the camp, two others far away which can be used for geophysical measurements of high sensitivity, free of interferences. In one of the near ones, there is a concrete pedestal which can be used for putting galvanometers on. Three other concrete slabs exist in the field according to the attached map.

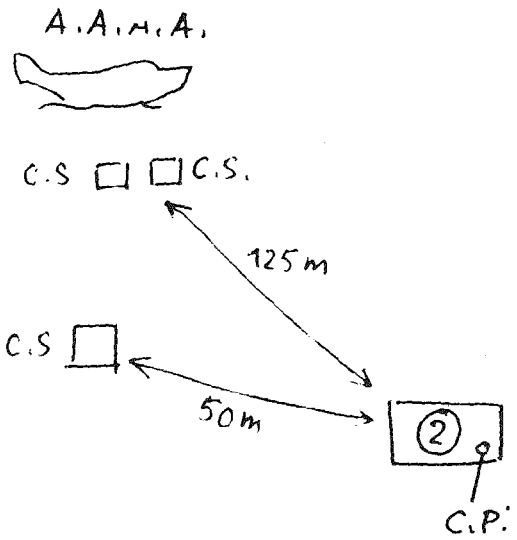
Heating facilities are provided in two of these metallic huts. They must only be used with butane gas. Instructions of how to use them are to be found in hut n° 2.

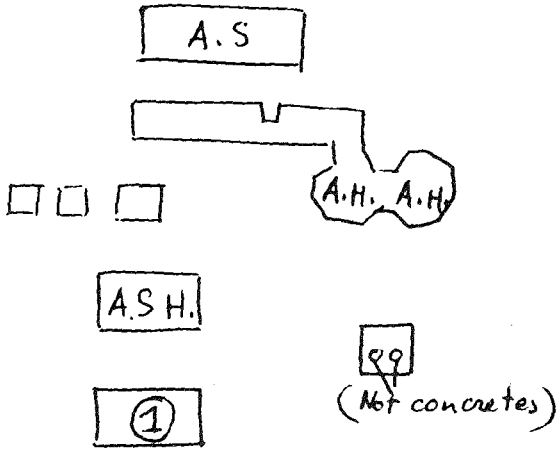
During the stay, 220V-50Hz power was used, but the old american wiring has been returned to its original layout (110V) which is attached. Note that the electrical lines going through the australian huts are leaking and we were unable to use them.

Some food (principally military rations) have been left in the australian store house. Some equipment (beds, wires, ...) has been left in the french store-house.

Heard, the 2nd of March 71

Gendry





A.A.A.A. Ancient Australian Amphybian Airplane

A.S. American Shelter

A.S.H. Australian Store House

A.H. Australian house

C.P. Concrete Pedestal

C.S. Concrete Slabs (~1 m², more or less burried in the ground at 80cm depth and protected by a cubic box)

3

4

PASSAGE DU CÔTRE "DAMIEN"
(La Rochelle - FRANCE) à
HEARD, 19 - 21 JANVIER 1972,
venant de KERGUELEN, en route
pour TERRE ADELIE - MER DE ROSS.

DAMIEN : longueur 10,10 mètres
largeur 3,08 mètres
déplacement 5 tonnes

Equipage : Jérôme PONCET 25 ans
Gérard JANICHON 25 ans

Heard le 21 Janvier 1972

DAMIEN

PASSAGE of the cutter "DAMIEN"
(La Rochelle FRANCE) in
HEARD Island 19th-21st January
1972
coming from KERGUELEN, going
to ADELIE LAND and SEA ROSS

DAMIEN: length 10,10 meters (33 feet)
beam 3,08 meters (10 feet)
weight 5 tons

CREW: Jérôme PONCET 25 years
Gérard JANICHON

Heard, the 21th of January 1972

DAMIEN

This document was placed to commemorate the voyage of the Australian M.V. Cape Pillar for Bathymetric / Magnetic survey work on the Heard / Kerguelen Plateau and associated land based surveys on the Australian Territory of Heard and Mc.Donald Islands. in March 1980.

The voyage also included scientific investigations in the fields of zoology, geology, botany and marine biology.

List of Ships crew

Master	G. Maxwell	
C/O	R. Ireland	
2/O	A. Codrington	
3/O	P. Verheyden	
Bosun	V. Osborn	
M.P.O.	R. Mc.Manamon	
A/B	E. Orman	
A.B.	D. Cleghorn	
A.B.	W. Rothacker	
A.B.	C. Bridge	
A.B.	K. Balling	
A.B.	A. Scott	
A.B.	N. Cobb	
A.B.	J. Hatfield	
A.B.	R. Mc.Neill	
S'wrt.	T. Merson	

Ships crew (cont)

C/E.	R. Davidson	
2/E.	P. Stokes	
3/E.	P. Pittiglio	
4/E.	J. Vintner	
E/E	P. Jiear	
Wpr.	P. Birch	
Wpr.	M. Flood	
Wpr.	R. Lidster	
C.Stwd.	P. Gardner	
Stwd.	P. Hutchins	
Stwd.	F. Aquilina	
Stwd.	S. Stokoe	
J. Stwd.	J. Roxby	
C.Cook	W. Fowler	
Cook	T. Spence	
Scully	B. Mulligan	
C.A.	M. Treloar	

Nat Map Personnel

Expedition Leader C. Veenstra

J. Manning

B. Obst

R. Streeter

K. Brown

E. Graham

J. Pittar

M. Spellacy

D. Ross

R. Rayner

B.M.R. Personnel

L. Tilbury

R. Dulski

A.N.A.R.E. Personnel

G. Johnstone

R. Williams

J. Jenkin

I. Clarke