IMMEDIATE REPORT
OF
VICTORIA UNIVERSITY OF WELLINGTON
ANTARCTIC EXPEDITION 32

1987-88

Compiled by A.R. Pyne and B.L. Ward from contributions by:

R.R. Dibble
A.R. Pyne
B.L. Ward

Wellington

June 1988

This report is intended to fulfil the requirements of the Ross Dependency Research Committee (Scientific Achievements) and Antarctic Division, DSIR (Field Notes). The Report has also been prepared for the Council of Victoria University of Wellington, the University Grants Committee, and other organisations and individuals who have assisted the Expedition in the execution of its research programme. It is not a final publication in scientific results, and if reference is made to the Report, its interim nature should be made clear.

CONTENTS

List of Figures

VUWAE 32 SUMMARY

In the 1987-88 Antarctic season two Victoria University Programmes were successfully completed.

The McMurdo Sound sediment studies obtained sea floor sediment samples from eight shore-normal transects in McMurdo Sound and along the southern Victoria Land coast. The transects were designed to sample nearshore sediment and biota to a depth of 100 m. Current measurements were also made at many of the sites to improve our understanding of water circulation patterns and their influence on sediment distribution and deposition.

The Mt Erebus seismic programme repaired the TV camera installed on the volcano's crater rim to continue monitoring the activity of the lava lake. Real time TV data was compared to recordings from the Mt Erebus seismic net to understand the eruption mechanisms of this active volcano.

Personnel

McMurdo Sound Sediment Studies (K042)

Leader:	Mr Alex R. Pyne, Expedition Manager, ARC, VUW
Co-leader:	Dr Barbara L. Ward, Research Associate, ARC, VUW
Geological Assistant:	Ms Barbara D. Armstrong
Geological Assistant:	Mr. Philip Shane
Address:	Antarctic Research Centre Research Shool of Earth Sciences Victoria University of Wellington P O Box 600, Wellington.
DSIR Field Assistant:	Mr. Geoffrey Blake
Address:	Intech Electrical 9 Fairview Place, New Plymouth.

Mt Erebus Seismic Study

Leader:	Dr Ray R. Dibble, ARC, VUW
Technician:	Mr Terry B. Ball, ARC, VUW
Student:	Miss Susan M. Ellis, ARC, VUW
Address:	Antarctic Research Centre Research School of Earth Sciences Victoria University of Wellington P O Box 600, Wellington.
Field Assistant:	Mr Steve Lassky, DSIR

PART I - Scientific Programmes

McMURDO SOUND SEDIMENT STUDIES (K042) - A.R. Pyne and B.L. Ward

Abstract

Sea floor sediment samples were obtained from seven shore-normal transects on the southwestern Ross Sea coast from Blue Glacier to Tripp Bay, plus one transect off Cape Armitage, on Ross Island. The transects were designed to sample "near shore" sea floor sediment and biota to 100 m water depth. Samples were taken with a modified Shipek grab. Current measurements were made at most of the 100 m sites with an InterOcean S4 electromagnetic current meter.

The distribution of sea floor sediment at these transect locations is influenced by:

1. Sea floor slopes, up to 17^{o}, for example, Tripp Island and Gregory Island, are generally devoid of sediment and bedrock is exposed at the sea floor. On low angle slopes, averaging 3^{o}, sediment fined offshore from gravelly sand to muddy sand and mud.
2. Sea ice scouring and anchor ice prevents sediment accumulation on bedrock at least down to 5 or 10 metres, especially at exposed coastal locations.
3. Current activity which modifies or prevents sediment accumulation even at moderate depths, for example Gregory Island.
4. Entrapment and protection of sediment, especially by sponge mat, occurs below 50 metres, even at sites with moderate to high current regimes, such as at Cape Armitage.

Current flow is approximately parallel to the southwestern Ross Sea coast and shows reversal of direction within the tidal period. Current speeds up to 25 to 30 cm/sec were measured at Gregory Island and decrease to the south at Blue Glacier, where a maximum of 12 cm/sec was measured. At Cape Armitage, current speeds of up to 75 cm/sec were measured, and were accompanied by a marked directional change within the tidal period.

The macro biota from most sites have consistent substrate preference and depth zonations. Red spiny echinoids and small (up to 5 cm high) red-brown algae prefer exposed bedrock and coarse gravel generally to 20 to 30 metres depth. Pectens commonly were recovered in shallow depths less than 30 metres, usually on sandy sediment and occasionally bedrock. Sponges and sponge mat were recovered from depths greater than 50 metres on substrate from gravel to muddy sand.

Proposed Programme

Surveys of the sea floor of McMurdo Sound and Granite Harbour have shown that sediment texture there is, in broad terms, bathymetrically controlled with mud in the basins, muddy sand on the slopes and sand on the shelves (Barrett et al. 1983). Foraminiferal studies also show some bathymetric control, though in this case the controlling factor is the carbonate compensation depth at 620 m offshore and 230 m in the harbours (Ward et al. 1987). The main purpose of this project is to document the relationship between sediment texture, micro-organisms (diatoms and foraminifera) and water depth from the shoreline to the 100 m contour along the Victoria Land coast. This areally limited zone has come to be of particular interest because studies of the MSSTS-1 drill core (Barrett 1986) show how variations in species diversity and sediment texture may be used to follow sea level changes in cored sequences. Changes to be expected are an increase in mud content and a decrease in mean size seaward due to declining wave power (c.f. Jago & Barusseau 1981; Barrett 1986), an increase in species diversity (Webb et al. 1986) and in the case of diatoms an increase in benthic/planktic ratio (Harwood 1986). Data from the modern shoreline are needed for comparison with older shallow marine polar sequences like that cored in MSSTS-1.

Scientific Endeavours and Achievements

Introduction

This programme involved a five-person party working from the fast ice in the southwestern Ross Sea. Sea floor samples were taken along eight shore-normal transects from Blue Glacier to Tripp Bay and at Cape Armitage (Figure 1). The transects represent a range of coastal types (exposed to embayed) with a variety of substrates, including bedrock, gravel, sand, mud and sponge mat.

We travelled on the fast sea ice by D-3 tractor pulling three Cantago sledges and used a Grizzly toboggan for bathymetry surveys and route finding. The first sledge was set up as a sea ice drilling platform, with hydrographic winch, drill and drill mast, grab, fuel and tools. The second sledge carried the NZ-1 wannigan, which is fitted with bunks, table, desk and small kitchen. This was used as a laboratory for mixing preservative for the sediment samples, as a dry lab for the IBM PC, used for programming and interrogating the S4 current meter, and as a kitchen and working area. The third sledge carried the remaining cargo, such as tents, personal baggage, the Grizzly when not in use, further fuel and miscellaneous cargo. A VUW ski trailer for use with the Grizzly was towed last.

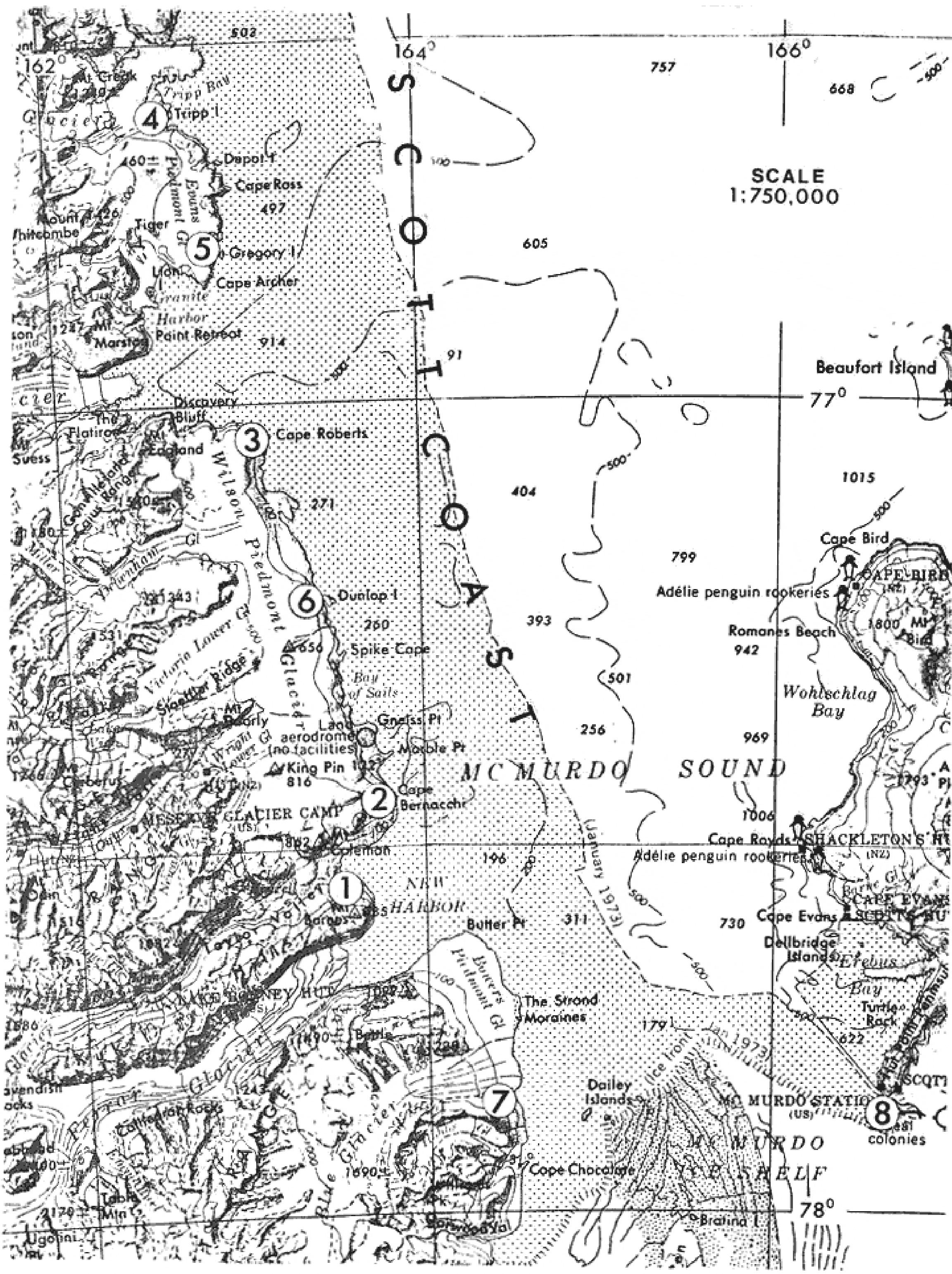

Figure 1. Map showing the eight nearshore seafloor sampling transects.

1. Explorers Cove New Harbour
2. Cape Bernacchi
3. Cape Roberts
4. Tripp Island
5. Gregory Island
6. Dunlop Island
7. Blue Glacier
8. Cape Armitage

Sea floor sediment sampling

At each of the eight sampling transects, a bathymetric survey was carried out to determine the slope and topography of the sea floor (Figure 2). This was carried out by drilling 4-inch holes in the sea ice and using an echo sounder to measure the water depth by passing the 200 kHz transducer through the hole below the sea ice.

The sampling strategy was designed so that sediment was recovered from similar depths at each transect. The depth zones sampled included a sea ice scoured zone, from 0 to 5-10 m, a possible wave influenced zone, from 5 to 20 m, and a non-wave influenced zone, from 20 to 100 m. The effects of bottom currents, which are depth and site specific, were also considered in the sampling strategy.

The sediment samples were recovered with a modified Shipek grab designed and built at Victoria University. The grab has two interchangeable 180x180 mm hemicylindrical buckets that take a 90 mm deep scoop of the sea floor. These samples were first photographed and described intact, then split into portions and preserved in formalyn. A subsample of each grab will be preserved as an archive specimen, and another split will be used for foraminiferal work and grain size analysis.

Results

Several areas of exposed bedrock were identified during the sampling programme. These sites had very little sediment cover, and are generally in shallow water. They include exposed capes and steeply dipping (17^{o}) sea floor. Tripp Island and Gregory Island exhibit this sort of submarine topography (Figure 2). The bedrock surfaces extend deeper than sea ice influences, so other factors must be responsible for the lack of sediment. These include glacial ice scouring, non-deposition at the present time and strong current activity.

Intermediately sloping sea floor localities include Cape Roberts, Dunlop Island and Cape Bernacchi (Figure 2). These have exposed bedrock from 0 m to 10 or 20 m, then gravel which grades to muddy sand at about 100 m.

Beach-type coastal topography is found at Explorers Cove (New Harbour, Figure 2) and Blue Glacier. These areas have gravelly sand at 0 m with sediment fining into the deeper water. Blue Glacier (0 to 40 m depth) is a moraine remnant, presumably ice cored, with a slope of 15^{o}. Further offshore the slope lessens to 3^{o}.

Cape Armitage, on Ross Island (Figure 2) has a substrate of volcanic scoria. We found this transect to be strongly influenced by sea floor anchor ice formation in water to 11 m depth, and a very strong current (75 cm/sec) regime.

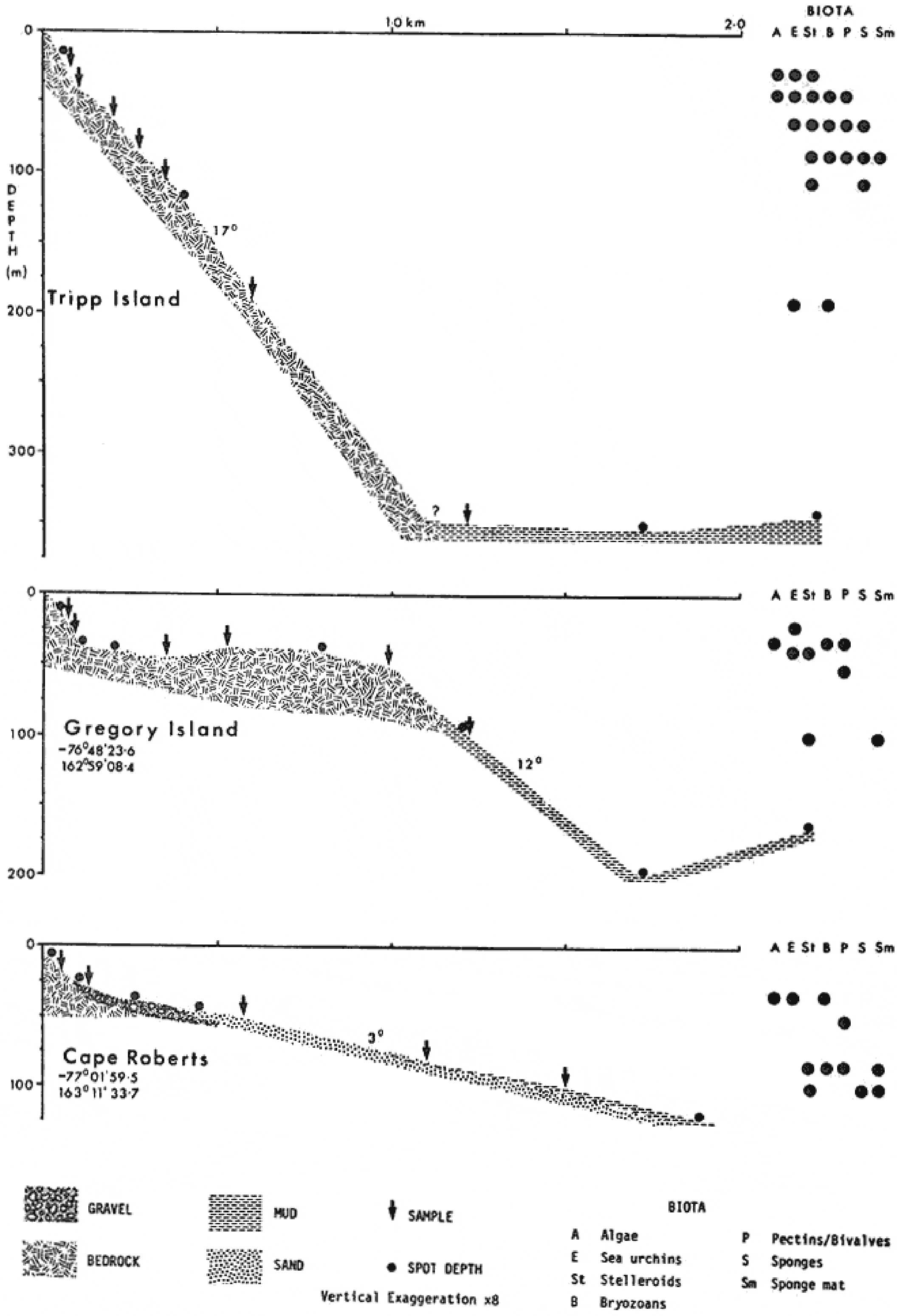

Figure 2. Bathymetry and sediment distribution along each of the eight sampling transects. Spot depths and sample sites (arrows) are shown for each transect. The major types of biota recovered are shown for each sample at the left side of each transect.

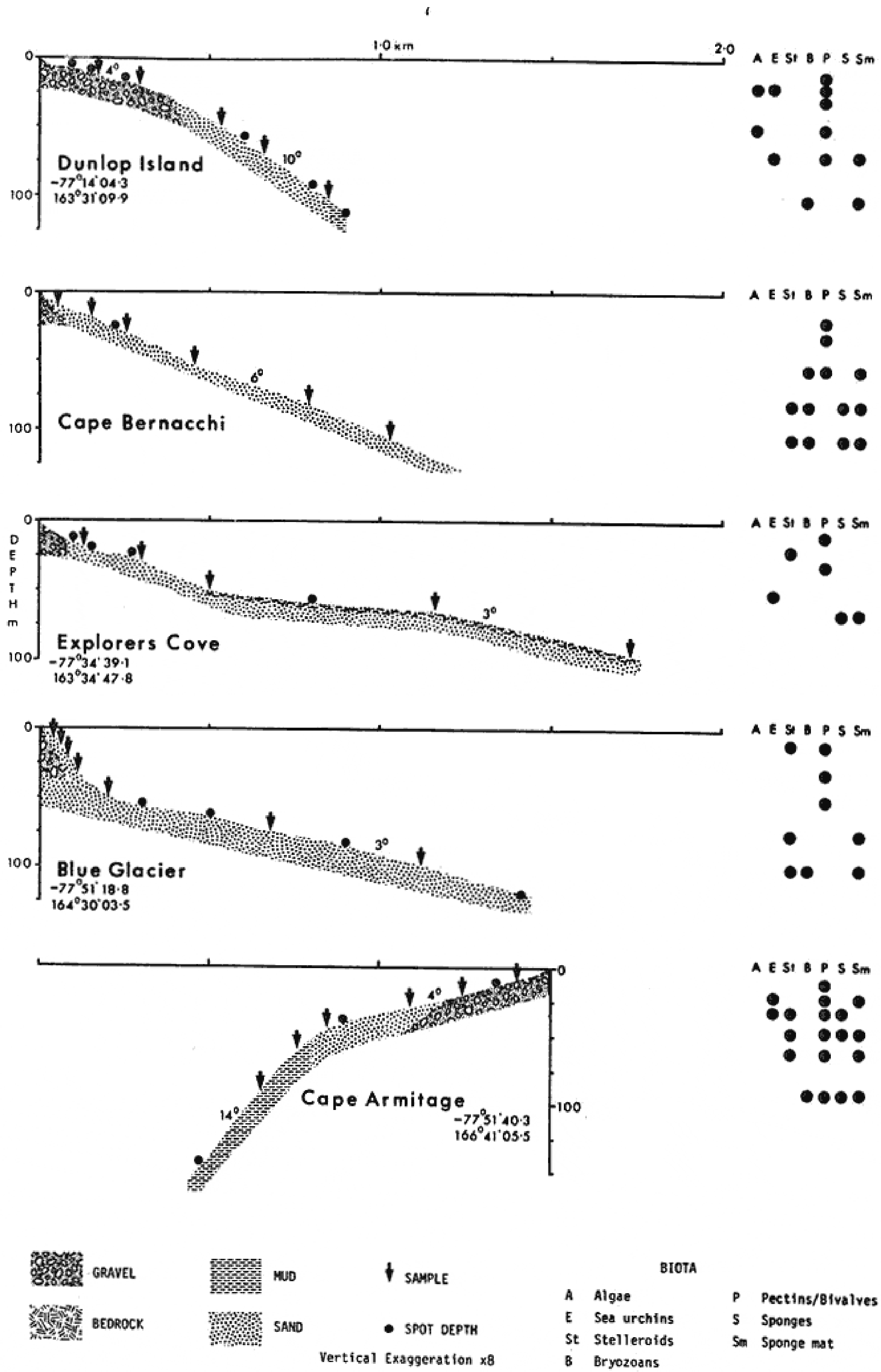

Figure 2. Bathymetry and sediment distribution along each of the eight sampling transects. Spot depths and sample sites (arrows) are shown for each transect. The major types of biota recovered are shown for each sample at the left side of each transect.

Macro-flora/fauna

Invertebrate animals and some plant materials were collected during the grab sampling programme. Different species of animals and plants have certain substrate preferences. Echinoids and some pectens were found on the bedrock surfaces (Figure 2). Pectens were also found in shallow water on sandy mud bottoms. Live sponges and sponge mat (disaggregated dead siliceous sponges) were found from 50 to 100 m and probably continue deeper in certain areas off shore (Ward 1984). Large (5 cm high) reddish algae was found only in the northern areas, as isolated specimens. the algae occurred in water less than 50 m deep, on bedrock or coarse sediment. Its distribution could be influenced by proximity to more open water and Ross Sea circulation patterns.

Micro-algae

Diatoms, often comprising biogenic mud of an olive-green colour, were present entrapped in sponge mat and in deeper water basins, especially in areas of low current activity, such as Tripp Bay. Specimens of diatom ooze were collected for S216.

Current Measurements

Water current measurements were made this season at the 100 m site of most of our coastal transects using a newly purchased InterOcean S4 electromagnetic current meter. This current meter is housed in a 250 mm diameter sphere, has no moving parts, records data internally and is ideal for deployment through our 300 mm diameter access holes in the sea ice. The instrument was programmed and interrogated with an IBM PC operated in the warm environment of the wannigan (NZ-1).

Two modes of deployment were used at the 100 m deep sites. Water column profiling measurements were made while either raising or lowering the current meter with our new hydraulically controlled hydrographic winch. Short term (12-24 hours) fixed-mooring measurements were also made by suspending the current meter on the winch wire 1.5 m $\pm$ 0.5 m above the sea floor. The height of the instrument above the sea floor could not be fixed precisely using this method of deployment because of the approximately 1 m tidal rise and fall of the sea ice platform.

Profiles and short term deployments were also made in central Granite Harbour near the MacKay Glacier Tongue and in central New Harbour (S216 Trap Site). This data will be used for planning a longer term deployment (2 months) proposed for the 1988-1989 season.

Examples of results from profiles and stationary moorings are presented in Figures 3 and 4. The highest speed measured along the southwestern Ross Sea coast

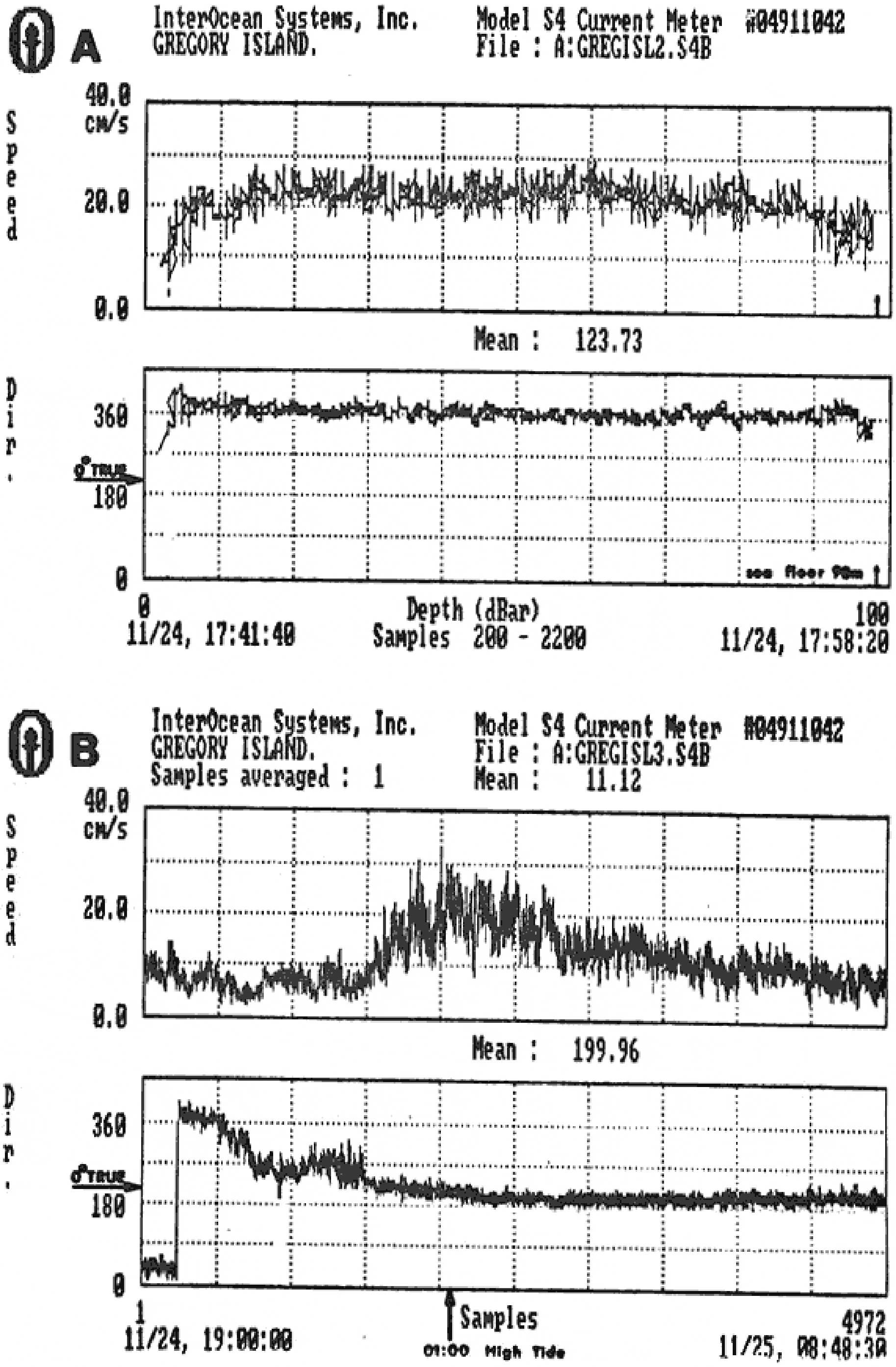

Figure 3. Current measurements at Gregory Island (98 m site).

A. Profile showing consistent speed and direction through most of the water column.

B. Stationary mooring 1-2 m above the sea floor (13 hour 48 min record). Note the increase in speed as high tide is approached and progressive change in direction from southward flow to a northward flow. The strongest flow is to the north.

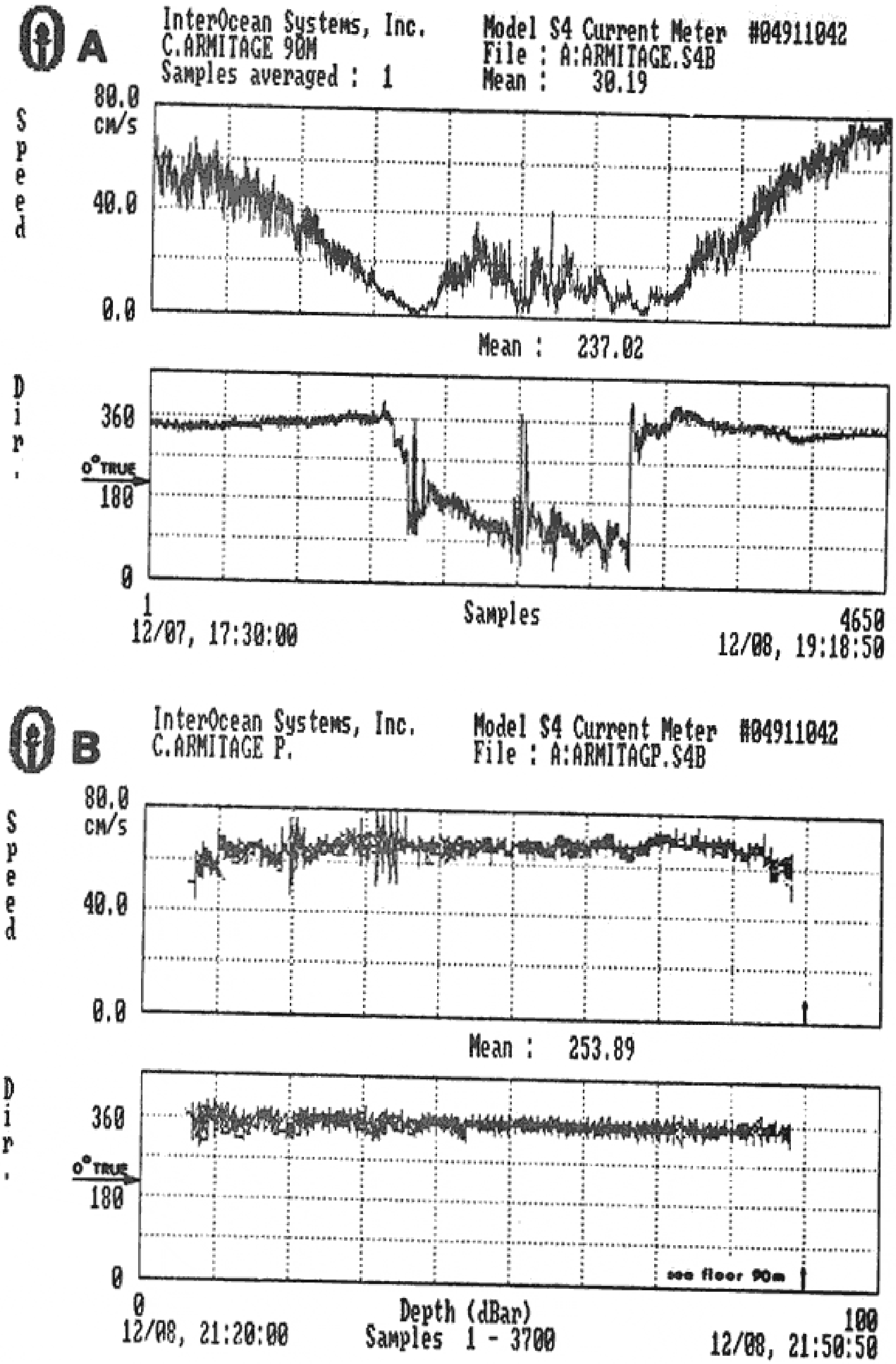

Figure 4. Current measurements at Cape Armitage (90 m site).

A. 26 hour deployment 1-2 m above the sea floor showing currents up to 75 cm/sec were recorded flowing to 150^{o} true (SSE). Lower velocity currents up to 25 cm/sec flowing to 250^{o} true (WSW).

B. Profile about 2 hours after the end of record above (A). A steady flow of 75 cm/sec to 150^{o} T is shown for most of the water column.

was 25 to 30 cm/sec at Gregory Island (Figure 3). The lowest current speed along this coast was 12 cm/sec, measured at Blue Glacier. Current directions are parallel to the coast and change by 180^{o} during the tidal cycle. Speeds measured in embayed areas such as New Harbour, Granite Harbour and Tripp Bay are lower (less than 12 cm/sec) than those on the exposed coast. Current direction at Cape Armitage (Figure 4) also changes with the tidal period, with speeds up to 75 cm/sec, and were the highest measured this season.

Water Sampling

Water samples for oxygen and carbon isotope analyses by Dr Enriqueta Barrera, Ohio State University, were taken at the 100 m site of each of the eight transects. Samples were collected using a small Niskin bottle deployed 10 m below the sea ice and 5 m above the sea floor at each site. Subsamples were measured for pH within 2 hours of collection. We had hoped to collect water samples for this study from previous 1981 sea floor sample sites, but the lack of sea ice cover in the central part of McMurdo Sound made this impossible this season.

Tripp Bay Bathymetry

A spot depth bathymetry survey was begun this season in Tripp Bay in association with Dr Robert Dunbar of Rice University, Texas (S216). The aim of the survey was to compare Tripp Bay with Granite Harbour and identify any deep basins which could be accumulating diatom-rich sediment as in Granite Harbour. We were also interested in this area as a site which is isolated from the influence of McMurdo Sound oceanographic circulation.

The maximum depth recorded this season was 550 m in the area south of Tripp Bay Glacier Tongue (Figure 1). Further measurements are still required to the east and north of the glacier tongue to complete the survey. The New Zealand survey party, K191, surveyed all flagged bathymetric locations so an accurate map of the sea floor in this area can eventually be constructed.

Publications

The three main investigators involved in this project, Dr Peter Barrett, Mr Alex Pyne and Dr Barbara Ward, intend to publish this joint study relating the modern near shore sediment, current measurements and foraminiferal diversity along the coast in a periodical such as the NZ Journal of Marine and Freshwater Research.

Future Research

The purchase and successful deployment of the S4 current meter this season now gives us the ability to quantitatively study water circulation. In the 1988-1989 season we intend to deploy the current meter at the MacKay Glacier Tongue for two months to record bottom current activity to determine whether glacier-generated mud-carrying density currents occur in this polar marine glacial setting.

Sea floor coring in Granite Harbour by Victoria University (Macpherson 1987) and Dunbar (S216) this season indicates that glacially deposited sediment may exist beneath the 1 m thick cover of diatom-rich mud. The glacial sediments were probably deposited during Holocene expansion of the MacKay Glacier, which is fed from the polar plateau. Granite Harbour therefore may contain accessible glacial marine sediments which could record Holocene changes in polar ice volume for this area of Antarctica.

Management of Science in the Ross Dependency

Granite Harbour continues to be an area of interest for polar marine glacial study because it can be logistically supported from McMurdo-Scott Base, yet is sufficiently far away from McMurdo Sound to be a good model for the deep basins along the Ross Sea coast that have been influenced by plateau ice. We suggest that a small summer science base could be established at Cape Roberts to support marine glacial, oceanographic and biological studies in Granite Harbour and this area of the Ross Sea coast. Such a summer base could also be the nucleus of a drilling camp if further offshore drilling were to go ahead near Cape Roberts.

This season we were joined by Lt Fernando Zurita, a guest scientist (geologist) from Ecuador, whose scientific interest was close to our oceanographic studies. He was only able to spend a short time with us in the field before leaving to organise the Ecuador Antarctic Oceanic Cruise beginning in early December. I think Lt Zurita's visit to Scott Base and involvement in our programme was successful because of our compatible scientific interests, but unfortunately his time with us in the field was rather short, and he was not able to observe the full range of our operations.

Acknowledgements

We wish to thank the University Grants Committee and the VUW Internal Research Committee for financial support. Our thanks also to Antarctic Division, DSIR, for logistic and field support, to OIC, Scott Base and summer support staff, particularly Clayton Ross, summer mechanic, for advice and help while we were in the field.

Special thanks to Geoffrey Blake, our DSIR field assistant, for his enthusiasm and mechanical expertise, and to Lt Fernando Zurita, for his help and cooperation at Scott Base and during the short time he was in the field.

We are grateful for the technical expertise and willing assistance of the Kiwi surveyors, Brian Anderson and Garth Falloon, K191. We also appreciated the assistance and cooperation of S216, from the U.S. programme.

VUW Mechanical Workshop provided practical assistance and expertise with the hydraulic winch, grab and other equipment, and their efforts are greatly appreciated.

References

Barrett, P.J., Pyne, A.R. and Ward, B.L. 1983. Modern sedimentation in McMurdo Sound, Antarctica. In Oliver et al. (eds), Antarctic Earth Science, Australian Academy of Science, Canberra.

Barrett, P.J. 1986. Sediment texture. In Barrett, P.J. (ed.), Antarctic Cenozoic history from the MSSTS-1 drillhole, McMurdo Sound. DSIR Miscellaneous Bulletin 237.

Harwood, D.M. 1986. Diatoms. In Barrett, P.J. (ed.), ibid.

Jago, C.F. and Barisseau, J.P. 1981. Sediment Entrainment on a Wave-graded Shelf, Roussillon, France. Marine Geology 42: 279-299.

Macpherson, A.J. The Mackay Glacier/Granite Harbour System (Ross Dependency, Antarctica) - A Study in Nearshore Glacial Marine Sedimentation. PhD Thesis, VUW Library.

Ward, B.L. 1984. Distribution of Modern Benthic Foraminifera of McMurdo Sound. Antarctica. PhD Thesis, VUW Library.

Ward, B.L., Barrett, P.J. and Vella, P. 1987. Distribution and Ecology of Benthic Foraminifera from McMurdo Sound, Antarctica. Paleogeography, Paleoclimatology, Paleoecology, 58: 139-153.

Webb, P.N. 1986. Foraminifera (Late Oligocene). In Barrett, P.J. (ed.) ibid.

Webb, P.N., Leckie, R.M., and Ward, B.L. 1986. Foraminifera (Late Oligocene). In Barrett, P.J. (ed.), Antarctic Cenozoic history from the MSSTS-1 drillhole, McMurdo Sound. DSIR Miscellaneous Bulletin 237.

MOUNT EREBUS SEISMIC STUDY (K044) - R.R. Dibble

Abstract

TV surveillance of the Erebus lava lake was restored to full operation on 17 November 1987 by replacing the camera box, the window of which had become opaque by etching in volcanic gas. The quality of the pictures was also improved by changing the lens from 16 to 25 mm, and raising the transmitter antenna.

The explosions were weaker than in 1986/7, but the lava lake was larger, and was L-shaped rather than round as before. By 3 January, 108 eruptions had been videotaped at the Scott Base receiving station, and the recordings from the Erebus seismic net had been played back, and later analysed for the 27 eruptions which were seen to eject bombs.

The total TV view time of the crater was 435 hours in 38 days, an average of 11.4±9.2 hours per day, and the average interval between eruptions was 4.03 hours. The eruptions were not randomly distributed, but were clustered in the periods 00-02 and 08-14 hours UT.

As in 1986/7, the TV explosion instant was earlier than the intercept time of P-waves (at zero distance) by 0.69±0.33 second, but the apparent velocity of P was lower, at 1.77±0.42 km/s. This reflects the smaller seismic amplitudes, and consequently later readings of emergent onsets at the more distant stations.

The seismic and infrasonic signals were all of the short period Alpha type, reported by Shibuya in 1984, reflecting the small but increasing area of the lava lake.

Proposed Programme

Erebus is a unique volcano. It is at higher latitude than any other active volcano above sea level, and is situated in an aseismic intraplate region. At present it has a negligible rate of lava eruption (c. 1 m^3 per day) but it has maintained a liquid lava lake in its crater since before 1972. The phonolitic lava has higher silica content (56%) and theoretical viscosity (10^3 Pas at 1200°C) than any other persistent lava lake, yet it persists in unusually cold conditions at high altitude (3580 m).

Expeditions to the summit have consistently reported an average of several eruptions per day. These are accompanied by explosion earthquakes and as well, more than 100 volcanic earthquakes per day occur in the range M_L-2 to +2. The foci are as deep as 15 km, and all the seismologists of the IMESS team (1980-1985) agreed that the foci of explosion earthquakes, identified by accompanying infrasound, extended down to 4 km below the active vent.

The installation of TV monitoring of the lava lake in the 1986/87 season showed that surface explosions of the lava lake were the source of the explosion earthquakes, and suggested that the previously determined focal depths were an artifact of adopting model velocities which were lower than the true velocities in the volcano. Accurate determination of the true velocities is difficult because the onsets are emergent, but the seismic wave-forms of different explosions at the same station are often "identical" (cross correlation coefficients exceeding 0.85), and can be stacked to improve the signal to noise ratio. Volcanological observations around the world are just realising the importance of this, and I co-operated in discovering identical explosion earthquakes by computer search methods at Sakurajima volcano, Japan, in February 1988. The instrumentation at Erebus and recording facilities at Scott Base rival the best volcanological observations in the world.

The principal objectives of research for the 1988/89 season are to make the search for "identical" families of volcano-seismic events more efficient by installing a PC computer based digital seismic event recording system at Scott Base, and by using cross correlation, stack and residual software on all adequately recorded events in a routine manner, assemble enough data for reliable statistics and location of the families.

Scientific Endeavours and Achievements

The work fell into 4 categories:

4-9 November Preparation for ascent of Erebus

As well as the normal preparations for field work in mountainous areas (done by Lassky and Ellis), it was essential for Dibble and Ball to check that the Erebus telemetry equipment at Scott Base was in good condition and adjustment. Otherwise, much time could be wasted on the mountain trying to cure faults later found to be at Scott Base. For instance, the poor locking of the time code on the TV picture, which the 1987 Science lab Technician had blamed on the TV transmitter up Erebus, was found to be caused by the BNC connector to the time code generator being left half undone over more than half the year. Also, the time channel to the 14 channel Sony data recorder had been disconnected since no one knows when!

9-19 November Work on Erebus

A welcome change from the 1986/87 season was that VXE-6 resumed flying helicopters to the lower hut, thus reducing our dependence on toboggans to get equipment up the mountain. In a last-minute switch, however, they delivered our Grizzly to Fang Glacier, when we had all expected to be air-lifted from Fang acclimatisation camp to the hut. After some difficulty starting it because the switch was stiff, the

Grizzly easily climbed the mountain with 2 people and their survival bags aboard. It was also used to take the replacement TV camera box and test equipment to the crater rim. The new box had a 2 watt heated window constructed from a 75x50 mm microscope slide with an evaporated gold film connecting between electrodes of circuit board material cemented along the ends. It was coated with Epithane 343 2-pot Polyurethane clear plastic to protect the fragile gold film, and sealed onto the main plate glass window with the gold surface on the outside, using silicon rubber, so that sealed air space was present between the two sheets of glass. The objective was 100% efficiency in evaporating an ice film which was presumed to be the cause of the fogging of the TV picture in 1987, but in fact the window had turned white due to corrosion by volcanic gases. Fortunately, the Epithane 343 resisted this corrosion efficiently.

Terry Ball tried to cure the faults in the camera which had nearly defeated us in 1986/87, by changing components as described in a manual belatedly supplied by Philips. Unfortunately, the instructions did not apply to our camera, and the original components had to be replaced with the fault uncured. Briefly, if the supply voltage drops momentarily, the camera locks into a stable inoperative mode.

While Terry wrestled with this, Ray Dibble, Steve Lassky and Brian Anderson (surveyor) were shifting the TV transmitter and antenna 70 m closer to Scott Base and adding 0.8 m to the mast so as to improve the ground reflected RF signal, and Susan Ellis was making infrared temperature measurements of the lava lake, and warm ground inside and outside of the craters.

Sunshine and shelter from the wind were important for comfort on the rim, and while Ray, Steve and Brian sweltered, Terry, Susan and their equipment 200 m away got cold, and the infrared measurement became unreliable. A further problem with the TV was that transmissions from the Tait radios near the camera also caused it to lock into inoperative modes, necessitating extra trips back to the summit, opening the camera box, and disconnecting/reconnecting the power. Perhaps it was one too many such actions which weakened the power connection so that it failed on 6 December after we had descended. We were greatly indebted to Bill McIntosh of S081, who found and cured the fault for us.

The type LX06002D infrasonic microphones at EI and CON were replaced by type LX0503A barometric pressure sensors to cure intermittent operation. Over most of the first half of 1987, the microphones operated only in the afternoon, seeming to work only in the sunshine, despite the very wide operating conditions of temperature (to -50^{o}C) and pressure. Ice blocking the pin hole pressure ports was a possible cause, although the microphones had been entirely sealed inside condoms in 1985/86 to prevent this, and also corrosion by volcanic gas. The condoms were still in excellent condition, but the resistance of the strain gauge bridge in the microphones had changed for some reason. No explanation for the intermittent operation could be found, but it appears that the reliable life on Erebus of these comparatively cheap devices is only about 2 years. We already knew that expensive microphones would have a short life, so cheap ones are still the best.

At E1 we also reinstalled the long period horizontal seismometer provided by NIPR in 1986/87 in a niche in the lava dike, 2 m from the previous site, in order to reduce the tilting which had stopped it operating. The component was again radial to the lava lake.

19 November to 7 January 1988: Recording and Analysis of Data at Scott Base

It was the task of Susan Ellis, the longest staying member of the team, to videotape the Erebus TV as many hours a day as possible, and to fast scan each tape, and re-use those with no useful data. The San-ei visual writing seismic recorder was used to help find eruptions on TV. Susan copied each obvious eruption onto an edited videotape, and at the end of her stay, photographed the TV monitor display of the edited videotape with an NTSC camera and recorder provided by NIPR, to get an NTSC copy for Japan and USA. The original recordings were also kept.

The Erebus seismic network was being recorded as part of the normal work of Scott Base, and as each tape was taken off the Sony Data Recorder, Susan replayed it on a second machine at 100x recording speed into a log amplifier and 4 pen chart recorder to get short index charts of time scale 4 mm per hour of the entire 8 day record. Photocopies of these charts of log seismic amplitude will be sent to Drs Kyle, Kienle, and Kaminuma so that they can choose earthquakes for further analysis, or look at statistics of occurrence. (Normally, staff play tapes back at Scott Base x 10 faster, and record the entire waveforms).

For the well recorded explosion earthquakes, and other earthquakes, Susan made normal seismograms of all useful data channels by playing the tapes at recording speed and the chart recorder at 1 mm/s and 10 mm/s. Initially, there were only 6 channels (limited by discriminators) but after Prof. John Schlue of New Mexico Institute of Mining and Metallurgy had carried out some tests with long period seismometers at Abbotts Peak, he brought back the rack of discriminators which NSF had removed from Scott Base on 7 January 1987, and 8 channels were then recorded.

Susan's final task, before she returned to New Zealand on 8 January was to replace the Sony Data Recorder which had been recording Erebus data for 2 years, with the one used for playback, and to pack up the playback equipment for return to NZ and Japan.

7 January 1988 onwards:

Mr Stan Whitfield, the Science Lab Technician in charge of MEEMS at Scott Base for 1988, is continuing to record one or more videotapes each day until the power to the camera/transmitter switches off in the winter night, and to scan them, and re-use tapes with no recorded eruptions. He is also running the Erebus seismic recorders as for the previous IMESS project. Recordings up to 16 February were sent to NZ by the last flight out.

In New Zealand, Susan read the seismograms of explosion earthquakes to 4 January 1988, and plotted the time distance graphs and TV origin times. She also plotted the infrared temperatures, and compared them with those measured in the 1986/87 season.

Publications

The paper on the TV results presented as a poster at IUGG, Vancouver, September 1987 was written up in Japan for publication by the University of Kyoto Disaster Prevention Research Institute, and presented at their Annual Meeting on 3 February. A comparative study of Erebus and Sakurajima results using computer techniques was begun at Sakurajima Volcano Observatory in February 1988. A list of papers published for 1987 is shown in VUWAE publications.

Future Research

The recognition of families of "identical" earthquakes is a fast developing area in volcanic seismology, because it enables the work of locating earthquake foci to be reduced and/or made more accurate. It is easy to do using digital seismograms, and then the stacked average seismogram with improved signal to noise ratio, and the residual waveform showing how individuals differ from average are easily obtainable.

Already an important difference between Erebus and Sakurajima has been found: Erebus explosion earthquakes are often identical from onset to coda, but Sakurajima ones become different in the coda, presumably because the source volumes of the explosions develop differently, even though they may initiate in the same place, and thus cause earthquakes with identical onsets.

Management of Science in the Ross Dependency

In regard to the MEEMS project, NZARP coped very well with the special time limitations, transport problems to and on Erebus, and co-operation with NSF season. The political problems of 3 way co-operation between RDRC, NSF, and NIPR are not yet resolved, and seem to revolve around the US requests for equitable opportunities for trade and scientific exchange with Japan.

Although the different financing and accounting procedures in those two countries make accurate comparison difficult, I believe that the Japanese investment in IMESS equalled that of USA, and that as Drs. Kienle, Kyle and Dibble spent a total of 7 months at NIPR as invited and supported scientists, with as yet no similar invitations to NIPR scientists from either NZ or USA, the Erebus program should be excluded from this confrontation.

The major problem of co-operation in IMESS was the delay in distributing data due to the intensive work of playback, and the time advantage that the institution doing the playback enjoyed. My good relationships with all the parties involved have survived the problem, and I am hopeful that our continued co-operation on a scientist to scientist basis will help reduce the present international and institutional problems.

Acknowledgements

There was not a single person who was less than helpful in avoiding delays and crises with the 1987/88 programme, but special mention must be made of Jim Barker, Garth Varcoe, Cass Roper, the OIC and Base Mechanic of Scott Base, and VXE6 Helicopter Squadron for giving us the priority and good will needed to make my extremely tight timetable for Erebus and the Sakurajima Volcano Observatory possible. I assure them all that it was very worthwhile.

I also thank my team of Susan Ellis, Terry Ball and Steven Lassky for their dedication, Brian Anderson, and Bill McIntosh for assistance on the mountain, Phil Kyle for co-operating in our descent from Erebus, and for supporting the continuation of the seismic programme with NSF, and Katsu Kaminuma for his full and generous support of the programme, even though he did not get permission to come to Scott Base this season.

PART II. Logistic Notes

McMURDO SOUND SEDIMENT STUDIES (K042)

Aims

Surveys of the sea floor of McMurdo Sound and Granite Harbour have shown that sediment texture there is, in broad terms, bathymetrically controlled, with mud in the basins, muddy sand on the slopes and sand on the shelves. The main purpose of this project is to document the relationship between sediment texture, micro-organisms (diatoms and foraminifera) and water depth from the shoreline to the 100 m contour along the Victoria Land coast.

Sea floor sediment samples were obtained from seven shore-normal transects from Blue Glacier to Tripp Bay, plus one transect off Cape Armitage, on Ross Island. Current measurements were made at most of the 100 m sites with an InterOcean S4 electromagnetic current meter.

The programme involved a five-person party working from the fast ice in the southwestern Ross Sea. Sea floor samples taken with a modified Shipek grab along the eight transects sampled diverse substrates and biota. The areas sampled represent a range of coastal types (exposed to embayed) with a variety of substrates, including bedrock, gravel, sand, mud and sponge mat.

Preparations for the Field

This event used several large equipment items from Scott Base which required checking and minor repair-cleaning before use. Our field assistant Geoff Blake went to Scott Base early to prepare some of this equipment and our scientific equipment. It was a little disappointing however to find more items than I expected required servicing before we could use them. This servicing should have been the responsibility of Scott Base staff. The main problems were the Cantago sledges which required digging out of the snow and servicing, NZ-1 wannigan which we had to clean twice because it was used for Scott Base Sunday excursions after we had taken possession, and the D3 servicing which is the Scott Base mechanic's responsibility, although some people thought this was our job also. There was also some confusion over generator allocation and other mechanical items which are serviced by the mechanic but controlled by the storeman. A solution to this type of problem would be for the mechanic to have both servicing and issue responsibility for this equipment. An example of this problem was that our field assistant ended up servicing two generators, one for our use and one that was allocated to another field party.

Field Transport

NZARP vehicle

We travelled on the fast sea ice by D3B LGP tractor pulling three 5 ton Cantago sledges and used a Grizzly toboggan (G4) for bathymetry surveys and route finding. The first sledge was set up as a sea ice drilling platform, with hydrographic winch, drill and drill mast, grab, fuel and tools. The second sledge carried the NZ-1 wannigan, which is fitted with bunks, table, desk and small kitchen. This was used as a laboratory for mixing preservative for the sediment samples, as a dry lab for the IBM PC, used for programming and interrogating the S4 current meter, and as a kitchen and working area. The third sledge carried the remaining cargo, such as tents, personal baggage, the Grizzly when not in use, further fuel and miscellaneous cargo. A VUW ski trailer for use with the Grizzly was towed last.

D3B LGP operation

The towed load for the D3 was quite high as indicated by the necessity to remain in 2nd gear on soft dry-cold snow in the area from Ross Island to the McMurdo Ice Shelf. We estimate that each Cantago sledge with cargo had a dead weight of about 5 ton giving a total dead weight of 15 ton. There was no method available to measure draw bar pull directly, however, this was estimated from published D3 performance curves to be about 8000 lbs (35 kN) on soft snow in 2nd gear, reducing to about 3000 lbs (15 kN) in 3rd gear on thin snow-smooth sea ice. This would seem to be a sensible maximum load for long distance travel when a variety of surface conditions are encountered. The D3 performed very satisfactorily with only a few minor problems. The ether cold start facility was required at temperatures below -5°C and the batteries require heating below -15° to -12°C. A Herman Nelson heater should be considered a necessary accessory for the D3 when in the field, especially in the October-November period. A field rescue kit consisting of 2 heavy duty snatch blocks, chain and materials to make a deadman anchor should also accompany any bulldozer while in the field. This was not required by us this season but recent experience has highlighted the advantage of such equipment.

We had minor problems with clogging of the primary fuel filter which is in a different priming pump configuration than shown in the operator's manual. Perhaps a manually operated priming pump should be used in Antarctic conditions. There was also a leaky engine seal which required regular additions of oil. The loss of oil however decreased as the atmospheric temperature increased and as the engine accumulated more operating hours. The winch-wind wire became damaged while extracting the D5 on 1 November. This problem reoccurred in New Harbour and required cutting the winch wire and enlarging part of the gap between winch drum and cheek to remove the crushed wire. A new wire was provided later in the season. The gap between winch drum and cheek should be reduced because the problem will easily reoccur.

A running log for the D3 is shown in table 1 with an analysis of fuel consumption for varying conditions.

Cantago sledges

Several of the older ski shells on these sledges require replacement as the keels have been worn through. The draw bars and rear ski connecting bar should also be raised to give better ground clearance, as on the newer sledges and USARP sledges.

NZ-1 wannigan

The wannigan proved to be very useful for our laboratory, kitchen and eating area and is well fitted out. The following improvements are suggested to increase the NZ-1 versatility.

- (i) Permanently fixed aluminium ladder to give safe access to roof aerials.
- (ii) Small step ladder for safe access to door when on sledge.
- (iii) Increase solar panels to enable faster charging of VHF nicad batteries.
- (iv) Electrical noise suppression from generator when radios in use.
- (v) Mini vacuum cleaner (eg 12 v) to clean dust and clothing fluff in lab environment.
- (vi) The "fridge" could be improved by removing from wall and installing through the floor. Its sharp corners at head height are dangerous.
- (vii) Hermetically sealed double glazed skylight.
- (viii) 12 volt internal wiring to attach to generator.

Grizzly toboggan (G4)

This toboggan was used generally for short distances (bathymetry and route finding) and travelled for much of the time on the third Cantago sledge to keep the distance travelled to a minimum. The machine performed satisfactorily with adjustments required to the chain drive gear box and twin carburettor, which are more difficult to tune than the standard engine.

Helicopter operations

Four hours helo time was used for a sea ice reconnaissance to Tripp Bay. The route expected to be taken by the D3 was flown to make a map of ice conditions. Two ice crack monitoring stations at Depot Island and C. Roberts were also established during this flight. The helo reconnaissance proved to be extremely valuable and the route map used extensively. We recommend that similar flights should be made for future tractor trains.

Event Diary

14 Oct.	G. Blake arrive Scott Base.
14-24 Oct.	G. Blake preparing equipment for K042. Attended survival course.
24 Oct.	A.R. Pyne and B.L. Ward arrive Scott Base (3 day weather delay in Christchurch).
25 Oct.	Unpacking cargo. G. Blake drove D3 and NZ-1 to ice edge for Scott Base recreation trip. Equadorian guest scientist Fernando Zurita arrives Scott Base.
26 Oct.	Began setup of drilling equipment on sledge (winch and hydraulic unit and drilling mast). Cleaned up NZ-1 after Sunday trip. Pyne, Ward, Zurita attend evening survival lecture.
27 Oct.	Helo reconn. of sea ice to Tripp bay. (Pyne, Ward, Blake, Ayres and Saxby). Established ice crack monitoring stations at C. Roberts and Depot Island. Zurita attend survival course, joined by Pyne and Ward in late afternoon.
28 Oct.	Continue equipment preparation. B. Armstrong and P. Shane arrive Scott Base.
29 Oct.	Survey work at Erebus Ice Tongue to locate S216 sediment trap. DOSLI surveyors (Anderson, Faloon) and K042 personnel. Test of K042 Grizzley (G4). Armstrong and Shane attend evening survival lecture.
30-31 Oct.	Armstrong and Shane attend survival course. Continue preparation of equipment. Meeting with S216, Surveyors and K042 at Scott Base to discuss respective programmes and cooperation for the season.
1 Nov.	Preparing equipment in morning. Pyne and Blake take D3 and rescue equipment to Erebus Ice Tongue for D5 rescue.
2 Nov.	Continue equipment preparation including adjustment of G4.
3 Nov.	Final packing sledges and equipment. Tested drill sledge equipment and grab in front of Scott Base in afternoon. Pyne and Zurita tested S4 current meter in fish hut. Tractor train departed Scott Base at 10.30 p.m. Spent night on sea ice near runway.
4 Nov.	Continue travel towards tip of Dirty Ice. Met K191 near sea ice edge to discuss route and ice conditions. Arrive Butter Point 2.30 a.m. 5 Nov.
5 Nov.	Leave two NZARP survival boxes at Butter Point. Pick up explosives. Continue to Explorers Cove, New Harbour, arrive 9.00 p.m. Winch wire jammed in drum on D3.
6 Nov.	Visit S043 (diving group, SCRIPPS) to discuss local sea floor topography and ice conditions. Bathymetry survey of proposed sample line.

7 Nov.	Start 87-1 sample site. Drilling access holes and taking grab samples. Ward sprains ankle. Zurita picked up by helo 2.00 p.m. to return Scott Base.
8 Nov.	G4 used by Pyne and Shane to locate route to 100 m sample site (87-1-6). Echo sounder repaired in afternoon. Last sample for Explorers Cove taken.
9 Nov.	Depart Explorers Cove 1000 hours. Arrive Cape Bernacchi 1700. Samples put into preservative. Echo sounder soldered by Blake.
10 Nov.	Blake checking sample line route with D3. Armstrong and Shane do bathymetry survey with G4. Pyne and Ward set up IBM PC and test S4 compass. In afternoon start grab sampling on surveyed line (87-2).
11 Nov.	Bathymetry survey completed. Two final sites grab sampled. Ward and Armstrong mix batch of preservative, preserve sediment samples. Blake reorganizes gear sledge. S4 current meter profile taken twice at 87-2-6 (108 m) site, for comparison of data. S216 arrive 1930 hours.
12 Nov.	Depart Cape Bernacchi 1030 hours. S216 remain to core sea floor. 1645-1700 at Marble Point, load 6 fuel drums. Depart Marble Point 1735 hours. Arrive Spike Cape 2250 hours. Unload K121 penguin tracking hut. Pyne blasts hole in 44 gal drum, to leave with one other.
13 Nov.	Depart Spike Cape 1000 hours. Travel over rough ice. Pass Dunlop Island 1200 hours. Pyne and Blake change oil filter in D3, 1700 hours, just south of Cape Roberts. Still having problems. Blake discusses problem with Clayton Ross, Scott Base mechanic, 1900 hours. Changed another oil filter. Proceed at 2030 hours through very rough ice to Cape Roberts. Continue around point to smoother ice, arrive 2225 p.m.
14 Nov.	Helos behind schedule, proposed VIP visit uncertain. Scott Base 'flu hampering operations. Request relayed for resupply via K191 (Surveyors). Bathymetry survey carried out. Drill four holes (87-3) and take grab samples.
15 Nov.	S216 arrives with sampling equipment provided by Dr. E. Barrera, Ohio State University; pH meter non-functional, mercuric oxide containers (glass) broken. Disposed of contaminated material by burning. Finished sediment sampling. Pyne took two current profiles at 100 m site. Camped third night at Cape Roberts.
16 Nov.	Current profiling in central deep (800 m) basin in Granite Harbour. S216 arrive 1700 hours with mail, new pH meter.
17 Nov.	Depart for inner Granite Harbour 0935 hours. Took water profile with S4 off Couloir Cliffs. S216 coring nearby. Depart 1430 hours for

Mackay Glacier Tongue snout. Put S4 down at 705 m for overnight profile. Camped near S216.

18 Nov. Retrieve S4 after 15.3 hour profile near sea floor. Moved camp to Cuff Cape, on south side of Mackay Glacier Tongue. Set S4 to profile overnight in 152 m water. S216 still coring in area.

19 Nov. Retrieve S4 0900 hours. Depart Granite Harbour 1045 hours. S216 remain to continue coring. K042 continue north, crossing two cracks, traveling on outside of large bergs, arrive Tripp Island 2400 hours.

20 Nov. Pyne, Ward, Armstrong and Shane carry out bathymetric survey for sampling line. Blake checking Herman Nelson operation. S216 arrive 2100 hours.

21 Nov. Sampled Tripp Island grab transect (87-4-1 to 7). S216 continue areal bathymetric survey for Tripp Bay area. K191 survey flagged sites.

22 Nov. Ward, Armstrong and Shane take bathymetric survey in tide crack. Blake and Pyne start S4 profile and water sampling on grab line. Echo sounder freezing up during use. In afternoon, Armstrong, Blake and Shane take G4 to Fry Glacier Tongue to continue areal bathymetric survey. Pyne and Ward finish S4 profiling. Ward mixes batch of formalyn. Camp with K191 and S216.

23 Nov. Travel to Gregory Island. K191 continue survey at Tripp Bay, S216 depart for Granite Harbour. Arrive Gregory Island 1635 hours. Pyne and Shane do bathymetric survey.

24 Nov. Sample grab transect 87-5. Take S4 current profile. K191 arrive 2000 hours. Ward preserved sediment samples.

25 Nov. Retrieve S4. Ward and Armstrong mix formalyn. Shane packs gear, tents. Blake and Pyne straighten wannigan sledge towbar. Depart 1320 for Granite Harbour. Arrive 1800 hours. S216 coring nearby. Set up S4 for overnight current profile at 858 m. Brake system on S4 slipped at 0520 hours on 26th. Reset and continue profiling.

26 Nov. Thanksgiving Day. S216 departs for Dunlop Island. K042 travels to Cape Roberts, arriving 1630 hours. Pyne, Blake, Shane and K191 clean junk from C. Roberts hut, for retro to Scott Base.
Thanksgiving Dinner with K191.

27 Nov. Depart Cape Roberts 1000 hours, arrive Dunlop Island 1500 hours. Bathymetric survey of grab transect completed.

28 Nov. Started grab transect 0930 hours (87-61 to 6). Put S4 current meter down for profile. VIP helo dropped off mail about 1400 hours. Returned 1 hr later for 45 min visit (Ruth Richardson, Jim Barker and

co.). Showed them samples, biota, and S4 results. Put S4 down for overnight profile.

29 Nov. Ward and Armstrong check all preserved samples for pH reading, and adjust (0945-1745 hours). Blake and Shane retrieve S4 and sledge from 87-6-6 site.

30 Nov. Depart Dunlop Island for fuel stop at Marble Point. Met S-216-seconded Armstrong to S-216 to assist in setting sediment traps. Received spark plugs from helicopter, sent out mail. K042 pick up 1 barrel Mogas at Marble Point, continue to large iceberg in New Harbour, arrive 2220 hours.

1 Dec. Pyne, Blake, Shane drill one access hole (87-1-8, 164 m) take grab sample, set S4 for 24 hour profile. Armstrong still with S216, who have mechanical breakdown of transport at Marble Point. Pyne, Blake, Shane take G4 to Butter Point to dispose of old explosives. Ward prepares batch of formalyn, preserves sediment samples.

2 Dec. S216 still at Marble Point with mechanical problems. Ward and Pyne preserve samples, check pH of formalyn mix.

Retrieve S4 current meter at 1400 hours. Tried 3 profiles through water column; considerable distortion in data.

Met two Greenpeace personnel touring New Harbour on toboggan.

3 Dec. Pyne retrieves Armstrong from S216 with G4. S216 mobile. Ward, Blake, Shane continue with D3 train to Cape Chocolate. Armstrong and Pyne catch up 1315 hours. S216 passed K042 at 1400 hours. Continue to Cape Chocolate, crossing several large cracks. Pyne and Shane scout route in G4 toboggan. Cape Chocolate inaccessible. Deviate to Blue Glacier. S216 arrive 2050 hours. Leave Cape Chocolate survival box at Blue Glacier.

4 Dec. Pyne and Shane do bathymetric survey for grab transect. Grabs completed 1800 hours. K191 arrive 1930 hours. Set S4 for 12 hr profile at 87-7-7, 107 m, overnight.

Armstrong and Ward preserve samples.

5 Dec. K191 remains at Blue Glacier site to wait for helo and S-216 (Dunbar) for survey of sediment trap sites. Ward and Armstrong drive ASV (K191 vehicle) back to Scott Base, departing 1100 hours. Blake drives D3, Shane and Pyne scout route with G4 toboggan. VIP helo (Holborow, Suggate, Taylor) buzz our caravan, do not stop. Helo arrives for K191. K042 continues past Dirty Ice to Scott Base, arriving 2040 p.m.

6 Dec.	Depart SB for Cape Armitage transect 1045 hours. Bathymetric survey completed and flagged sample sites. Ward and Armstrong mix formalyn. Cleaning of wannigan started. Final discussions with S216 at McMurdo Station.
7 Dec.	Grab transect at Cape Armitage (87-8-1 to 6) completed at 1630 hours. Water samples for Dr Barrera taken. Cleaning continues.
8 Dec.	Cleaning and sorting of gear continued. Blake and Pyne unloading sledges. Shane to McMurdo Sick Bay with fever and dehydration. 1900 hours back to final grab site (87-8-6) to demonstrate operation to VIP party (Holborow, Suggate, Taylor) and TVNZ film crew.
9 Dec.	Finish packing sediment samples. Retro cargo packed for shipment (air) to NZ. Sledges unloaded, field gear returned.
10 Dec.	Armstrong and Shane depart for NZ.
11 Dec.	Blake and Pyne assist S216 (Dunbar) to set sed trap at Erebus ice Tongue. Ward takes K042 cargo and baggage to Hill Cargo, finishes personal packing.
12 Dec.	Ward and Pyne depart for NZ.
14 Dec.	Blake departs for NZ.

Field Equipment

20-person day food boxes:

The improvements made in field rations are commendable. The availability of packets of frozen vegetables, roasts, chops and bacon was most appreciated. Comments on quantities, etc. were made on the form filled out for the field Store Person before leaving Scott Base.

We do feel the organisation of the food boxes could be standardised further. The food boxes should include staples, such as flour (not just self-rising), toilet rolls and paper towels. The only items to be obtained separately should be perishables, such as cheese, salami, frozen meat and vegetables.

"Fin" Ice Augur

A new "Fin" 4" diameter hand operated ice auger was used extensively by K042 this season. It is a fast efficient way of drilling holes to test ice thickness and therefore especially useful for the D3 operation. The drill was also used for bathymetry surveys to make a hole for the echo sounder transducer. The drill should be available for future tractor trains; however, some care and skill is required for efficient operation. Good quality files, sharpening stone and adequate instruction is necessary to keep the drill razor sharp and operating properly.

Survival Boxes

Three large red survival boxes were carried by the tractor train and were deployed at Butter Pt Hut, Cape Roberts Hut and on the south side of Blue Glacier for helo lift to C. Chocolate. In addition, old food caches were returned to Scott Base from the C. Roberts trig site and Butter Pt. huts. A food cache in old NZARP 20 man day cardboard boxes at the Commonwealth Stream Delta in Explorers Cove was pointed out to us by Bill Stockton (S043), but we were unable to retro it to Scott Base.

K121 Penguin Tracking Facility (toilet)

A small dismantled hut (toilet) was carried by the tractor train to Spike Cape where it was offloaded for K121 and later helo-lifted to Hanson Ridge. This could have been better organised at Scott Base, as we understand no fasteners were supplied to erect the hut. Two empty 44 gal fuel drums were also supplied by K042 with tops removed by plastic explosives, for anchoring the hut on Hanson Ridge.

Radio Communications

A Codan SSB installed in NZ-1 and 2 Tait VHF radios were used this season. This combination of radio systems was generally very satisfying with the VHF radios giving us flexibility for surveying and route finding. Some minor problems were noted and these are listed below for future consideration.

(i) Some of the Tait VHF batteries are tired and could not be charged from a solar panel and would not hold the charge even when a generator was used.

(ii) NZ-1 wannigan requires a greater solar panel charging capacity (see NZ-1 in the field transport section).

(iii) The VHF system repeater at Mt. Newall has some unexpected blind spots such as close along the coast from Spike Cape. It is also obscured in much of Granite Harbour and north of Cape Ross as expected.

(iv) The surveyors (K191) used high gain aerials on the VHF radios which improved performance, especially over long distances without elevation, eg sea ice. These aerials are light in weight and very useful for our sea ice work.

On 2 or 3 occasions we travelled late into the night and could not contact Scott Base after stopping between 0100-0300 hours. We had understood Scott Base was operating a 24 hour radio watch and we felt unfairly criticised when we did not respond to the 0800 hours schedule. There seemed to be some breakdown in communication between the radio operators' and field operators' organisation at Scott Base.

Refuge Huts

Cape Roberts

The area around the C. Roberts hut was cleared of redundant equipment stored during previous VUWAE-K042 visits in 1982-1984. All this equipment was returned to Scott Base for disposal or return to NZ.

Butter Point

Explosives remaining at Butter Pt. from the CIROS programme were destroyed as per request from Ant. Div. Building and Services Officer. A small quantity of explosives was returned to the NZARP magazine after this season's field programme.

Garbage Disposal

A 44 gal. drum incinerator was made in the field to burn flammable and metal wastes on the sea ice. The incinerator in conjunction with some fuel gave a clean smokeless burn which reduced to non-burnable materials which were returned in the drum to Scott Base for disposal. Human and biodegradable waste were released into the sea.

Table 1. D3B Running Log

Date		Location	Distance	Running hours	Fuel (Diesel)	Engine	Comments
Nov	3	Scott Base-Ice Shelf	12 km	2.5	20%	0.51	Snow cover, 2nd gear only
	4	Ice Shelf-Butter Point	60 km	14.0	150%	2.51	3rd gear
	5	Butter Pt.-Explorers Cove	20 km	5.0	50%	1.01	2nd gear, snow and multiyear ice
	6	Explorers Cove	-	-	-	-	
	7	Explorers Cove sampling	3 km	2.0	20%	-	Short run and idling
	8	Explorers Cove sampling	5 km	2.0	10%	0.51	Short run and idling
	9	Explorers Cv-C.Bernacchi	15 km	6.0	100%	0.51	2nd gear, heavy snow & multiyear ice
	10	C.Bernacchi sampling	10 km	3.0	30%	-	Blading & pushing snow on transect line
	11	C.Bernacchi sampling	3 km	3.0	25%	-	Idling
	12	C.Bernacchi-Spike Cape	25 km	14.0	80%	0.51	Snow & multiyear ice at Bernacchi Bay 4 hours idling at Marble Pt, fuel pickup
	13	Spike Cape-Cape Roberts	35 km	10.0	80%	0.51	3rd gear, thin snow cover, smooth ice
	14	C. Roberts sampling	2 km	2.0	15%	-	Idling
	15	C. Roberts sampling	4 km	1.0	10%	-	Idling
	16	C. Rbts-Cent.G.H.-C.Rbts	25 km	4.0	40%	-	3rd gear,2 sledges only,smooth ice,snow cover
	17	C. Roberts-Mackay Gl.	20 km	6.0	50%	0.51	3rd gear, smooth ice & snow
	18	Mackay Gl.-Cuff Cape	8 km	2.0	20%	-	3rd gear, smooth ice, no snow
	19	Cuff Cape-Tripp Island	54 km	14.0	140%	1.01	3rd gear, smooth ice & snow cover
	20	Tripp Island	-	-	-	-	
	21	Tripp Island sampling	3 km	8.5	15%	-	Idling
	22	Tripp Island sampling	5 km	4.0	15%	-	Idling
	23	Tripp Is.-Gregory Island	15 km	4.0	45%	-	3rd gear
	24	Gregory Island sampling	4 km	6.0	20%	-	Idling
	25	Gregory Is.-Central G.H.	15 km	4.0	80%	0.51	3rd gear,snow cover,small area rough ice
	26	Central G.H.-C.Rbts	10 km	2.0	20%	-	
	27	C.Roberts-Dunlop Is.	25 km	5.0	45%	0.51	3rd gear, good travel on snow ice
	28	Dunlop Island sampling	3 km	6.0	20%	-	Idling
	29	Dunlop Island	-	-	-	-	
	30	Dunlop Is.-New Harbour	45 km	10.0	95%	-	2nd & 3rd gear. Multiyear ice Bernacchi Bay-New Harbour
Dec	1	New Harbour	-	-	-	-	
	2	New Harbour	-	-	-	-	
	3	New arbour-Blue Gl.	40 km	8.0	80%	0.51	3rd gear, smooth ice, little snow
	4	Blue Gl. sampling	6 km	6.0	15%	-	Idling
	5	Blue Gl.-Scott Base	60 km	10.0	105%	0.51	3rd gear, bare ice & fast warm snow
	6	C. Armitage	6 km	5.0	20%	-	
	7	C. Armitage	6 km	8.0	20%	-	
	8	C. Armitage	6 km	3.0	20%	-	
Totals			550 km	180.0	1455% 16601 370 gal	8.51	

Analysis of running log gives the following indications of performance for different conditions towing near maximum suggested load.

Condition	Transmission	Fuel Consumption	SPEED
Soft thick snow on rough (blocky) ice	2nd	16% per hour:6.7% per km	2.5 hour
Soft thick snow, smooth surface	2nd	13.6% per hour:4.7% per km	3 km per hour
Hard, thin snow/sea ice	3rd	10.5% per hour:2.6% per km	est 5-7 km per hour
Fast warm snow/bare sea ice	3rd	10.3% per hour:2% per km	6 km/hour

In exception conditions on warm (wet) sea ice the D3 and sledges were measures travelling at 12-14 km per hour with the ASV speedo. For general planning in good surface conditions we suggest using an expected fuel consumption of 12% per hour:3.5% per km and speed between 5-7 km per hour.

MOUNT EREBUS SEISMIC STUDY (K044) - R.R. Dibble

Aims

To study the mechanism of the strombolian eruptions from the lava lake, as it reforms after disappearing in the 1984 activity, by a combination of TV surveillance, seismic infrasonic, and infrared monitoring of the eruptions. The study is made jointly by Victoria University of Wellington and the National Institute of Polar Research, Tokyo, and in close cooperation with New Mexico Institute of Mining and Technology. They are studying the release of volcanic gases from the lava lake, both during and between eruptions, by means of a correlation spectrometer, and by collecting samples of aerosols, sublimated salts, and newly ejected lava bombs.

The MEEMS project makes use of the old IMESS seismic array by unofficial courtesy of NSF. The infrasonic sensors, and the long period horizontal seismometer connected to the array at E1 and CON belong to VUW and NIPR respectively. The recording equipment at Scott Base belongs to NIPR, and the telemetry receiving equipment belongs to NSF, except for one bank of discriminators, which belongs to VUW. All the TV monitoring equipment belongs to VUW. Seismic recording materials are provided by NIPR, and videotapes are provided by VUW.

The year's work from the date K044 arrives, comprises servicing the Scott Base installation, and then the Erebus installations while observing the changes in crater temperature, activity and morphology. Ideally, all seismic tapes recorded since Winfly should be played back on to paper charts at Scott Base for distribution to NIPR, VUW, NMIMT, and GIUA. This enables analysis to begin promptly on data collected under our control. Priority is given to eruptions for which both TV and seismic data are available. If this is not done before the seismic tapes and playback machine are returned to Japan, the analysis will be delayed for about 8 months, and equipment faults may persist.

Planning

The planning phase was complicated by the initial belief by the Program Manager that the problems of international cooperation would force cancellation of the program. Accordingly, I accepted a 3 month fellowship in Japan from December 1987 through February 1988. Further, I was committed to attend the IUGG General Assembly in Vancouver, which clashed with the Tekapo Training Week. To the credit of all concerned, the Antarctic field programme did not suffer, and if anything, the personal relationships and understanding of the problems were improved all round. However, I remain convinced that regular attendance at Tekapo, and the event briefing session is essential in normal circumstances.

Cargo

My cargo going South was no problem. It consisted of one large cargon (500 kg) of NZ and Japanese equipment and 150 lb hand carry (see Appendix 1 for detail). Susan Ellis had a problem coming north, because she had to bring all the recordings as hand carry luggage. She was relieved to be met at Christchurch, and given some help.

Cargo between NZ and Japan proved a problem, because there were no Japanese participants to smooth the way through Customs. Prof Kaminuma had difficulty clearing the seismic tape recordings when they arrived in Japan, even though he purchased and shipped them from Japan. His solution is to always use "Kaminuma and Dibble" as both consignor and consignee, to ensure that one of us is present at each end, but he was confused when tapes (used) I sent him arrived soon after he had sent new ones south, and thought his had done a round trip!

Preparations for the Field

i) The briefings by the OIC and DOIC were outstanding. Already a good liaison with NSF Rep existed, and no contact was necessary by me.

ii) All the equipment requested from Ant Div was available and in good condition, except that the Generator (tested by Steve at S.B.) would not run.

iii) Survival training was combined with "shakedown", and enabled the 'first timers' Terry and Susan to cope well with conditions on Erebus.

iv) There were no significant delays.

Field Transport

i) NZARP vehicles

Grizzly No.5 was in good order, and already tuned for high altitude when we received it. We had hoped to learn riding skills on the easy slopes at Fang, and be able to drive up Erebus, and so avoid helicopter delays, but the decision was to fly the Grizzly direct to the hut. The helo pilot declined, and delivered it to Fang when he came to lift us to the hut. So at short notice, we tried to drive it up. It wouldn't start (frozen switch), and we had to go up by helo as planned, and then Steve and Brian walked down to try again, and easily rode it up. The Grizzly proved equal to the NSF Bombadier, except it was harder to turn.

12/11/87 Fang to hut. Hut to Truncated Cones and return.

13/11/87 Hut to Tramways rtn. Hut to Summit rtn.

15/11/87 Hut to Upper Hut rtn.

16/11/87	Hut to Cones rtn. Hut to Summit rtn.
17/11/87	Hut to Summit rtn
18/11/87	Hutt to Summit rtn.
19/11/87	Hut to Fang, for rtn to Scott Base by helo

About half a tank of fuel was used per day. The windscreen broke in half when I was trying to secure it while the helo was waiting to take us up to the hut on 12/11/87.

ii) Helicopter Operations

Our put in was combined with K191, and took 3 lifts to Fang on 9/11/87.

Our lift to the Hut was delayed 1 day by weather. On 12/11/87, 2 cargo trips from S.B. to hut, and then 1 to Fang with the Grizzly, and 2 from Fang to Hut were made. The last of these medivac'ed Garth to Scott Base with a viral infection.

K191 returned to S.B. in 1 flight on 16/11/87. K044 returned in 2 flights, 1 from Fang with the Grizzly, and 1 from the hut.

The initial lift on 9/11/87 was free, and the return from Fang was a backload on S081's put in.

Event Diary

4 Nov	Dibble, Ball and Ellis fly to S.B. by Starlifter. Begin servicing MEEMS equipment at S.B.
5 Nov	Continue servicing. Begin survival course.
6 Nov	Finish survival course. Prepare field equipment.
7 Nov	Prepare field equipment. Service MEEMS.
8 Nov	As for yesterday.
9 Nov	Put in to Fang with K191. 3 helo flights.
10 Nov	Acclimatising. Weather deteriorating.
11 Nov	Acclimatising. Weather improving.
12 Nov	Helo lift to Hut. Service Cones telemetry station.
13 Nov	K191 plus Steve and Susan survey Tramways, and Dibble and Ball retrieve TV camera from Summit.
14 Nov	Modify and test TV camera. Rebuild VLF microphone.
15 Nov	Service E1 telemetry station.
16 Nov	Install VLF mic at Cones. Reinstall TV camera, and shift transmitter and antenna at Summit. Incomplete.
17 Nov	Continue infrared survey and TV servicing.
18 Nov	Complete infrared survey and TV service. Service E1 telemetry again. Rebuild VLF mic for E1.

19 Nov	Return to S.B., 2 flights.
20-23 Nov	Record data and revise instructions for MEEMS.
24 Nov	Dibble returns to NZ.
25 Nov-5 Dec	Increase the seismic recordings to 8 channels.
6 Dec	Ball returns to NZ.
7 Dec-7 Jan	Recording and processing MEEMS data.
7 Jan	Ellis returns to NZ.

Weather

Mr Steve Lassky will include our weather in his report.

Accidents

No significant accidents occurred, but people using toboggans on difficult terrain should get practise before their put in.

Field Equipment

The Dome tents again proved excellent on the Erebus Plateau.

Chocolate biscuits and instant noodles should be a standard item in ration boxes.

Our troubles starting the generator and Grizzly made us wish for better instructions in the Field Manual, particularly about the complexity of the Grizzly starter switch. Perhaps more comprehensive field manuals should be supplied with these equipment items.

Radio Communications

The Tait VHF handheld radios were again outstanding for communicating with "Scott Base" and with the Science Lab itself, via the repeater station. Battery charging by the solar panels was excellent. The small PEL sets on 5400 kHz were again useless at Fang Glacier, which is within the skip distance, and in the shadow of Erebus.

The general efficiency of Scott Base radio skeds was excellent, which helped the smooth running of the field program this year.

Laboratory Facilities

We made considerable use of the Scott Base Science lab, and were very grateful to Paul Purvis of Telecom, who helped out after the technician assigned to MEEMS resigned, until his replacement arrived. It is pleasing that the ionosonde is no longer next to our telemetry receivers, and that interference is reduced.

Necessary additions to the lab equipment include:

Dual tracking power supply

Tunable narrow band voltmeter for multiplexed subcarriers

Portable battery powered oscilloscope for outside use.

Better designation of storage areas for spares, and recording materials and box files for service manuals and instructions would help the lab technicians.

Refuge Huts

The two NSF huts on Erebus were in good condition, and contain adequate food, cooking equipment (white spirit) and furniture. Both have some bedding inside, and a survival box outside. Also fire extinguishers and oxygen bottles, but those in the upper hut are of uncertain condition. Both sites are tidy.

Garbage Disposal

All garbage and sewerage was retroed to McMurdo by helo.

APPENDIX I VUWAE CARGO SUMMARY

TO ANTARCTICA

K042 McMurdo Sediment Study

CARGO (unaccompanied)

1.08 m^3	Scientific equipment	est	450 kg	
0.72 m^3	" "	est	300 kg	
0.22 m^3	" "	est	40 kg	
0.13 m^3	" "	est	80 kg	
0.07 m^3	Trailer skis	est	30 kg	
0.71 m^3	Winch		250 kg	
0.50 m^3	Hydraulic unit		130 kg	
	Hazardous chemicals		5 kg	
				1285 kg

CARGO (accompanied baggage)

0.12	S4 Current meter		45 kg	
0.22	IBM PC & printer	est	75 kg	
0.10	Chilly bin with equipment	est	30 kg	
				150 kg
	subtotal			1435 kg

K044 Mt Erebus Study

CARGO (unaccompanied)

1.44 m^3	Scientific equipment	est	500 kg	

CARGO (accompanied baggage)

Electronic equipment		est	100 kg	
	subtotal			600 kg
	TOTAL			2045 kg

FROM ANTARCTICA

K042 McMurdo Sediment Study
CARGO (unaccompanied)

1.08 m^3	Scientific equipment				
0.72 m^3	Scientific equipment				
0.71 m^3	Winch				
0.50 m^3	Hydraulic unit				
0.3 m^3	Scientific equipment				
0.22 m^3	Scientific equipment				
0.13 m^3	Scientific equipment				
					1590 kg
CARGO (Accompanied baggage)					
	Samples		est	80 kg	
0.12 m^3	S4 current meter			45 kg	
0.22	IBM PC & printer		est	75 kg	200 kg
		subtotal			1790 kg
K044	Mt. Erebus Study				
CARGO	(unaccompanied)				
1.44 m^3	Scientific equipment			290 kg	
2 ctns	Tapes			20 kg	310 kg
CARGO	(accompanied baggage)				
	Scientific equipment			30 kg	
				20 kg	50 kg
		subtotal			360 kg
		TOTAL			2150 kg

VUWAE PUBLICATIONS AND THESES 1987

Barrett, P.J. Oligocene sequence cored at CIROS-1, Western McMurdo Sound, New Zealand Antarctic Record, 1987, 7(3), 1-7.

Barrett, P.J. Workshop in Cenozoic Geology of the Southern High Latitudes, The Ohio State University, Columbus, August 16 and 17, 1985, New Zealand Antarctic Record, 7(1), 9-11.

Barrett, P.J., Elston, D.P., Harwood, D.M., McKelvey, B.C. and Webb, P.N., 1987. Mid-Cenozoic record of glaciation and sea level change from the margin of the Victoria Land basin, Antarctica. Geology, 15: 634-637.

Barrett, S.I.D. and Dibble, R.R. International Mount Erebus Eruption Mechanism Study (Abstr.) New Zealand Antarctic Record, 1987, 7(3), 52.

Gamble, J.A. and Kyle, P.R. The origins of glass and amphibole in spinel-wehrlite xenoliths from Foster Crater, McMurdo Volcanic Group, Antarctica. Journal of Petrology, 1987, 28(5), 755-779.

Graham, I.J. and Palmer, K. New precise Rb-Sr mineral and whole-rock dates for I-type granitoids from Granite Harbour, South Victoria Land, Antarctica. New Zealand Antarctic Record, 1987, 8(1), 72-80.

Palmer, K. XRF analyses of granitoids and associated rocks from South Victoria Land, Antarctica, Geology Board of Studies Publication No.3; Analytical Facility Contribution No.12, Antarctica Data Series No.13, VUW, 1987, 26p.

Pyne, Alex (Compiler). Antarctic Expedition 31 1986-87 Immediate Report. May 1987. 31p.

Robinson, P.H., Pyne, A.R., Hambrey, M.J., Hall, K.J. and Barrett, P.J. Core Log, Photographs and grain size analyses from the CIROS-1 drillhole Western McMurdo Sound, Antarctica. Antarctic Data Series No.14, RSES, VUW, Wellington, May 1987.

Ward, B.L., Barrett, P.J. and Vella, P. Distribution and ecology of benthic foraminifera in McMurdo Sound, Antarctica. Paleogeography, Paleoclimatology, Palaeoecology, 1987, 58, 139-153.

Ward, B.L. Schackoinella antarctica, a new species of Foraminiferida (Glabratellidae). New Zealand Journal of Marine & Freshwater Research, 1987, 21, 621-625.

Seismic and Video Telemetry Studies of Mount Erebus, Antarctica.
Barrett, S.I.D. (BSc Hons thesis)

Abstract

During the period of 16th December 1986 to 7th January 1987, 65 eruptions of Mt Erebus, Antarctica were recorded on videotape by a television camera mounted on the crater rim. The associated earthquakes were recorded on a net of nine seismometers and two infrasonic microphones. Timing on seismic and video records enabled reading to 0.04 s but due to their emergent nature, onset times were rarely this accurate. Plotting seismic arrival times from stacked eruptions against distance from the crater showed the seismic intercept time to be 1.48±0.05 s later than the time of visible explosion, and gave a surprisingly high apparent seismic velocity of 4.0±0.1 km/s. These values suggest that the source of the seismic waves is the visible explosion rather than that the seismic waves trigger the explosion. 60 of the recorded eruptions occurred in and around the lava lake, throwing out bombs and being accompanied by earthquakes. The other five took the form of ash jets, from vents near the lava lake, and were weakly seismic or aseismic. Time in flight measurements for bombs gave ejection velocities ranging from 5 to 75 m/s and a maximum thrown height of 300 m above the lava lake.

The Mackay Glacier/Granite Harbour System (Ross Dependency, Antarctica) - A Study in Nearshore Glacial Marine Sedimentation
Macpherson, A.J. (PhD Thesis)

Abstract

Granite Harbour (77^{o} south) is a glacially scoured embayment twenty kilometres across and up to 900 metres deep on the Victoria Land coast of Antarctica. Most of the ice entering the harbour comes from the Mackay Glacier, a 500 metre thick outlet glacier from the East Antarctic Ice Sheet. The Mackay is largely wet-based, flowing at a rate of 214 m yr^{-1}, and terminates as a floating ice tongue more than four kilometres long. Granite Harbour is of normal marine salinity as it receives virtually no input from meltwater streams, and as it is ice covered and microtidal, currents and waves have little influence on sediments.

Sediment entering and being deposited within the Harbour was sampled during the austral summers of 1983 to 1985, and rates of transport and deposition determined. More than 60 textural analyses from 18 shallow penetration gravity cores show that the sea floor sediment is dominantly sandy mud with a few scattered clasts. The sea floor sediment is divided into seven lithofacies which correspond to divisions of glacial marine sedimentation made by Anderson et al.

(1980) and Powell (1984). A bathymetric map of the Harbour has been compiled and is used as a base for mapping sediment patterns. From a number of debris-rich bergs of overturned Mackay basal ice, it has been calculated that about 29 5000 tonnes yr^{-1} of sediment enters the Harbour as basal debris, but melts out beneath the Mackay Tongue within one to two kilometres of the grounding line. Textural studies indicate that about one third of the basal sediment is carried into the deeper parts of the Harbour, probably by lateral advection, in low velocity bottom-hugging currents from beneath the Mackay Glacier Tongue. The remainder is inferred to form a prograding wedge of sediment seaward of the grounding line. Lateral advection is also inferred for transporting up to 45 000 tonnes yr^{-1} of biogenic-rich mud from shallow areas or from outside the Harbour and depositing it within the harbour basins. Less important processes that introduce quantifiable amounts of sediment are the deposition by dominantly katabatic winds of about 1 810 tonnes yr^{-1} of coarse silt/fine sand onto the Mackay Glacier surface and the sea ice, and the settling from free suspension in the water column of about 340 tonnes yr^{-1} of biogenic rich debris.

Sediment accumulation rates have been determined using the decay profiles of unsupported ^{210}Pb within two sea floor cores from the deep areas of Granite Harbour. The rate has averaged 2.48 mm yr^{-1} over the past 100 years. This rate is used to provide an estimate of sediment deposition of 150 000 tonnes yr^{-1} for the area of the Harbour deeper than 400 m (about 50%).

Ice-rafted detritus is present within sea floor sediments from the Harbour, but most have characteristics associated with supraglacial debris. An implication of this observation is that coarse debris, within the recent veneer of Antarctic continental shelf sediment, probably represent ice-rafted supraglacial debris, which is likely to be more abundant during interglacial rather than glacial periods.