IMMEDIATE REPORT

OF

VICTORIA UNIVERSITY OF WELLINGTON ANTARCTIC EXPEDITION

1984 - 85

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WELLINGTON
April 1985

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 of scientific results, and if reference is made to the Report, its interim nature should be made clear.

C O N T E N T S

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FIELD NOTES

LIST of FIGURES and TABLES

SUMMARY OF VUWAE 29

The CIROS drilling project, which is attempting to obtain a record of the early history of the Antarctic Ice Sheet and the rise of the Transantarctic Mountains by offshore drilling in McMurdo Sound, dominated the University field programme. Dr. Peter Barrett and Mr. Alex Pyne, with graduate students Jeff Ashby, Tony Macpherson, Barbara Ward and Ian Wright, flew with the 16-man drilling team to Scott Base in late August, but unseasonally thin ice, bad weather and equipment failures reduced the programme. Nevertheless, one hole, CIROS 2, was successfully drilled to basement 167 m below the sea floor with good core recovery. The core appears to represent 7 glacial advances over the last 4 million years. The core will be studied in more detail over the next year to improve the chronology and climatic interpretation.

Field work for Tony Macpherson's PhD study of Granite Harbour sedimentation was completed this year with a further glacier survey, collection of wind-blown dust from the sea ice and the setting and retrieval of sediment traps in water depths to 800 m. The sediment trap work was carried out in conjunction with a Rice University group carrying out a similar survey of sedimentation rates in McMurdo Sound. Dr. Brad Pillans, Department of Geology, with a special interest in Quaternary processes, assisted with this and the CIROS core logging.

Three other groups from VUW all worked on some aspect of the structural history of the Transantarctic Mountains: Dr. Russell Korsch and Annette George took detailed measurements and samples of basement rocks in the Dry Valleys to establish the history prior to 400 million years ago. Paul Fitzgerald, accompanied by Des Patterson, completed the mapping of major faults and sampling to determine uplift rates for the Transantarctic Mountains in South Victoria Land by apatite fission-track dating. This joint PhD project with the University of Melbourne has already identified the main fault zone and has established that most of the uplift took place over the last 50 million years. The third group, geophysics students Jean Olson and Richard Kellett, worked as part of the West German Expedition to North Victoria Land, investigating the gross structure of this part of the Transantarctic Mountains by magnetic and gravity surveys. In addition to the above, Dr. John Gamble, Department of Geology, joined a U.S. party led by Dr. Phil Kyle (ex-VUW) to look for fragments of the deep crust in the volcanic rocks of McMurdo Sound.

SCIENTIFIC ACHIEVEMENTS

PLIO-PLEISTOCENE GLACIAL SEQUENCE CORED AT CIROS 2, FERRAR FJORD, WESTERN McMURDO SOUND

CIROS (K041) - P.J. Barrett and Scientific Staff.

Abstract

CIROS in 1984 drilled one hole near the middle of Ferrar Fjord, western McMurdo Sound, in 211 m of water. A sequence of sand and glacial debris was cored (67% recovery) to basement gneiss at 166 m. A preliminary estimate of the age of the sequence, based on diatoms and the abundance of basaltic debris, has it ranging from Early Pliocene (about 4 m.y.) to the present, and equivalent to the upper 183 m of DVDP 10 and the upper 240 m of DVDP 11 in adjacent Taylor Valley. A good chronology is expected from the paleomagnetic stratigraphy, diatom assemblages and radiometric dating of basaltic material, including a vitric tuff from 124 m sub-bottom.

The core has been subdivided into 13 lithologic units, representing alternations of "interglacial" and "glacial" conditions. The older interglacial units (13, 11 and 9) are diatomaceous mudstones, but the younger ones (7, 5, 3 and 1) are largely black basaltic sand, like that accumulating on the sea floor today. The oldest 2 glacial units (12 and 10) are basal lodgement tills with internal horizontal shearing and clasts of basalt and basement rocks, some of them striated. The younger glacial units (8, 6, 4 and 2) also contain scattered clasts, some striated, but have stratification features suggesting considerable redeposition and settling through water. Nevertheless, all of these units are considered to represent periods when ice was much more extensive than today. The abundance of basaltic debris in most glacial units suggests that ice flowed into Ferrar Fjord mainly from the east, eroding and transporting debris from the volcanic piles south and east of McMurdo Sound.

The CIROS 2 core should lead to a substantial improvement in both chronology and interpretation of glacial history in western McMurdo Sound over the last 4 m.y.

Introduction

The aim of the CIROS project is to obtain a record of the Cenozoic (and possibly Cretaceous) history of the southwest corner of the Ross Sea by coring the sedimentary strata offshore (Barrett, 1982). There is no record exposed on land to represent the time between the Jurassic basalts 180 m.y. ago and the rocks of the McMurdo Volcanic Group, erupted over the last 15 m.y., though this interval includes two poorly documented events of wide interest and which may be related - the growth of the Antarctic Ice Sheet and the rise of the Transantarctic Mountains.

Background

Seismic surveys over the last decade (Northey et al., 1975; Davey and Bennett, 1981; Wong and Christoffel, 1981), have revealed along the Victoria Land coast a sedimentary basin (Fig. 1) of probable post-Jurassic age, the margins of which are accessible to shallow offshore drilling. The structure of the western margin of the basin in South Victoria Land is shown in figure 2. The MSSTS 1 core has shown that the uppermost strata (to 226 m sub-bottom) are of marine glacial character (Barrett and McKelvey, 1981), and extend back to 30 m.y. (Harwood, 1984).

The first phase of CIROS was to drill two holes in the same area as MSSTS 1. CIROS 1 was to core to the limit of the rig (around 500 m) near the MSSTS 1 site, where earlier seismic refraction data taken from the annual ice showed a marked velocity increase from 2.7 to 3.5 km/sec about 300 m below the sea floor (Iles and Dibble, 1981), interpreted as the change from glacial to preglacial strata (Barrett, 1982). The lower part of this core would provide a record of climatic changes preceding Cenozoic glaciation in the region. The value of the site was increased with the running of a

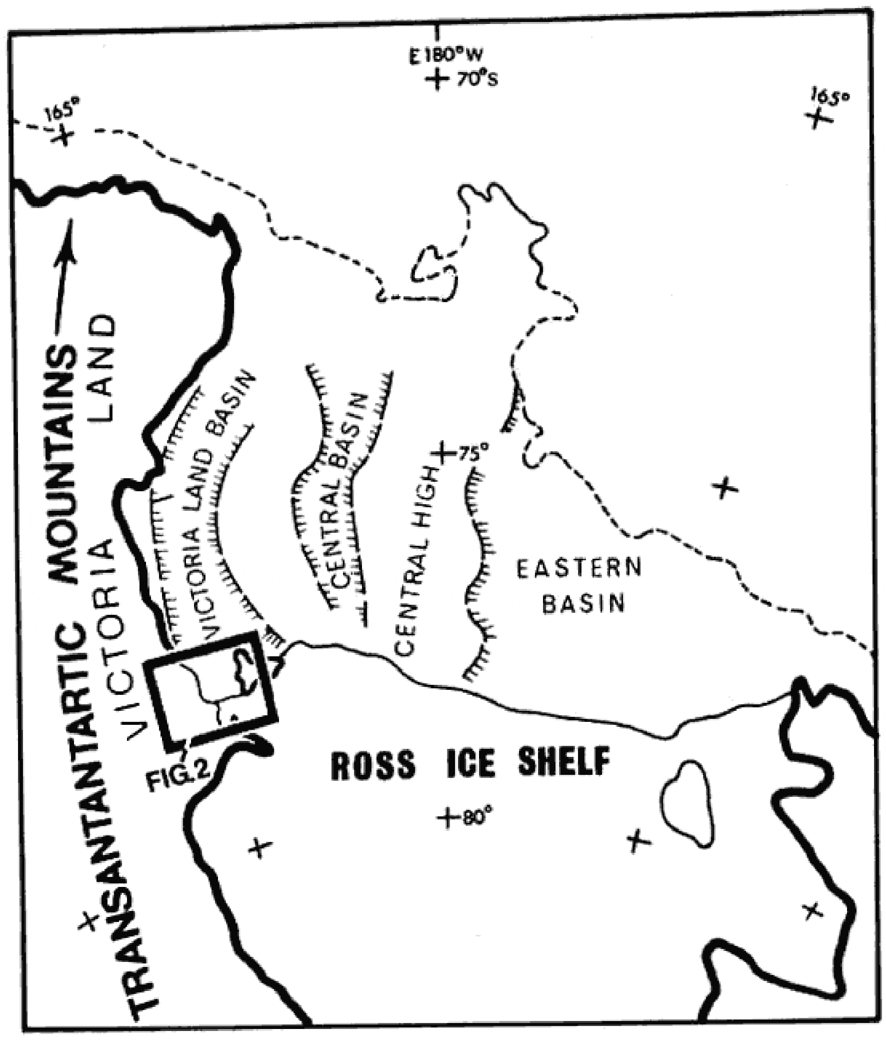

Figure 1. The Ross Sea region showing the location of the Victoria Land basin and the area of CIROS drilling (Fig. 2)

multichannel seismic line in February 1983 by the S.P. LEE from near MSSTS 1 north along the basin margin (Eittreim, Cooper et al., 1984). The new data confirmed the marked velocity increase, though at a slightly greater depth (360 m), and offered the possibility of extending the drill hole stratigraphy further out into the Sound and to the dipping sequence off Cape Roberts, 80 km north and the target for the second phase of CIROS.

The second hole in the first phase (CIROS 2) was to be drilled as far landward as the ice in Ferrar Valley would permit. This hole was to core the sediment deposited on the valley floor to basement to work out the glacial history of the valley and also to obtain a minimum age on the cutting of the valley from the sediment just above the basement. In addition, the core was expected to contain reference planes to correlate with CIROS 1 and hence allow us to gauge the timing and extent of vertical movement within the fault zone between the two sites. The basement core was also of interest for it would be the lowest sample obtained to date for apatite fission-track dating, and hence provide the youngest possible point on the uplift curve for this section of the Transantarctic Mountains.

Programme

The CIROS programme for 1984 called for the movement of 25 CIROS personnel (Table 1) to Antarctica on WINFLY in late August, opening of the Butter Point camp and setting up of the Longyear 44 rig at CIROS 1 by late September. If CIROS 1 were completed by early November CIROS 2 would be drilled. However, the sea ice in 1984 was thinner and more active than usual (Fig. 3), and active cracks on the supply route were a major problem (Fig. 4). Uncertainty as to the stability of the sea ice, along with the delays already experienced, led to the decision to forego drilling CIROS 1 in 1984 and move to the thicker and more secure ice at CIROS 2 (unpublished

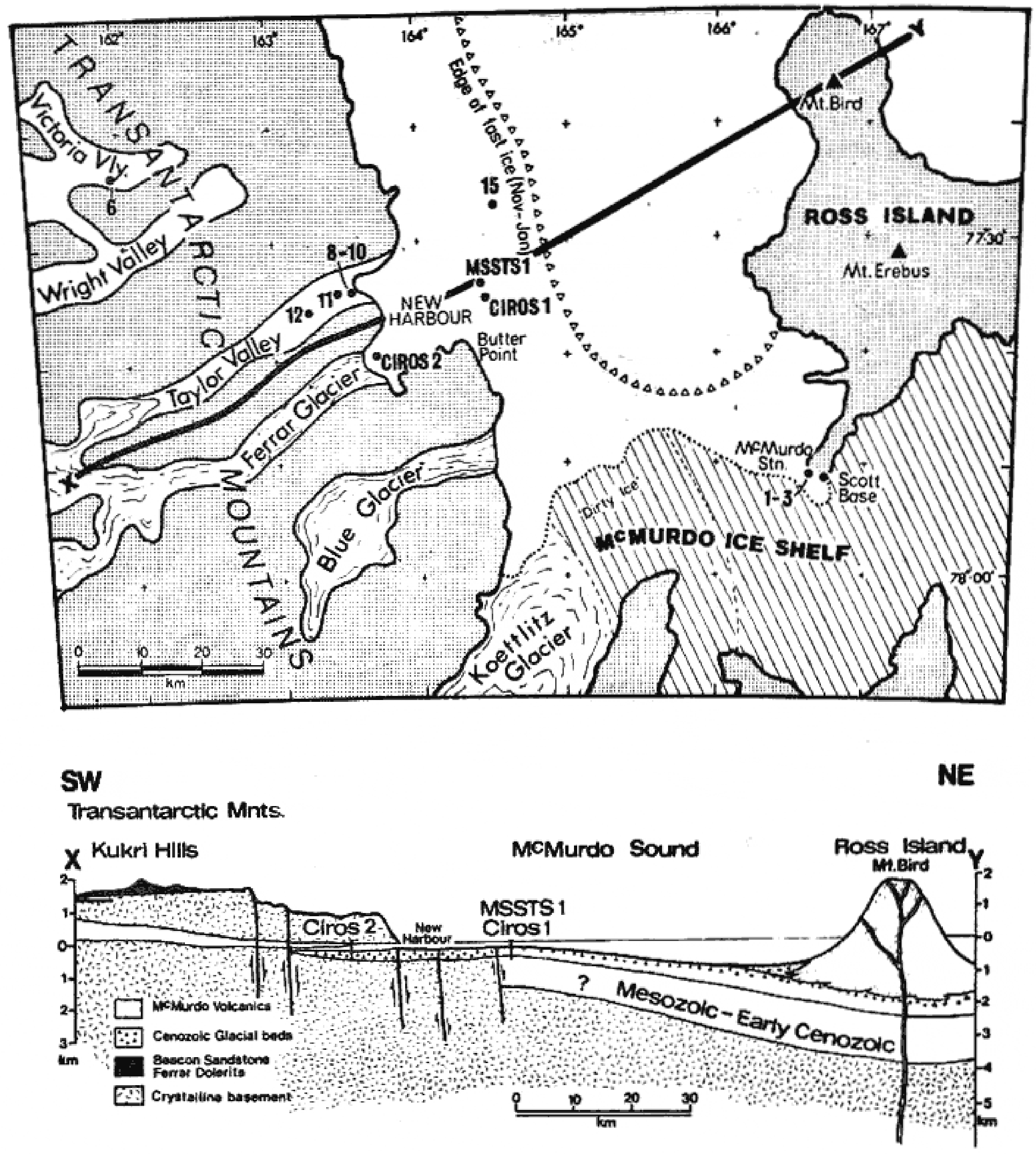

Figure 2. A. Map of McMurdo Sound area, showing the main physiographic features, the location of MSSTS-1, and deep DVDP drill holes (numbers). X-Y locates the section shown in figure 2B.

B. Geologic section across McMurdo Sound (line X-Y in figure 2A). Offshore structure extrapolated from Iles and Dibble (1981) and Wilson et al.(1981). Faulting has been inferred from topography (Webb and Wrenn 1982) but has in places been confirmed by field observations (P.G.Fitzgerald, pers comm).

Table 1. Drill site personnel for CIROS 1984

DRILLING				
Jack Hoffman (Co-ordinator)	Drillers:	Graham Brown	Off-siders:	Jamie McLennan
Jim Gupwell (Chief S'visor)		Pat Cooper		Wayne Little
Terry Griffiths (S'visor)		Larry Weller		Steve Pilcher
Kevin Jenkins (S'visor)				Max Williams
				Jock Ross
				Chris Ollie
CAMP SERVICES				
Neil Stephenson (Manager)	Robin Sharp (Cook)			
Ron Topping (Operator)	Dave Millar (Carpenter)			
SCIENCE				
Peter Barrett (Co-ordinator)	Barbara Ward (Geologist)			
Alex Pyne (Manager)	Ian Wright (Geologist)			
Jeff Ashby (Geologist)	Gary Neale (Surveyor)			
Tony Macpherson (Geologist)	Ansaln Haanen (Surveyor)			
Brad Pillans (Geologist)	Kasi Komura (Geochemist)			

report by P.J. Barrett to the Ross Dependency Research Committee, December 1984). The rig was set up at CIROS 2 by October 10 (Fig. 5) and coring began on October 14. However, 5 of the 14 floats supporting the sea casing collapsed from water pressure causing the casing and drill strings to sag and break at the sea floor. The second coring attempt also ended with a broken drill string, but success was achieved on the third attempt (Fig. 6). Hours after basement was reached 100 knot winds severely damaged most of the drill site buildings and prevented electric logging of the hole. Fortunately the core was undamaged, and arrived at the New Zealand Geological Survey's core store in good condition.

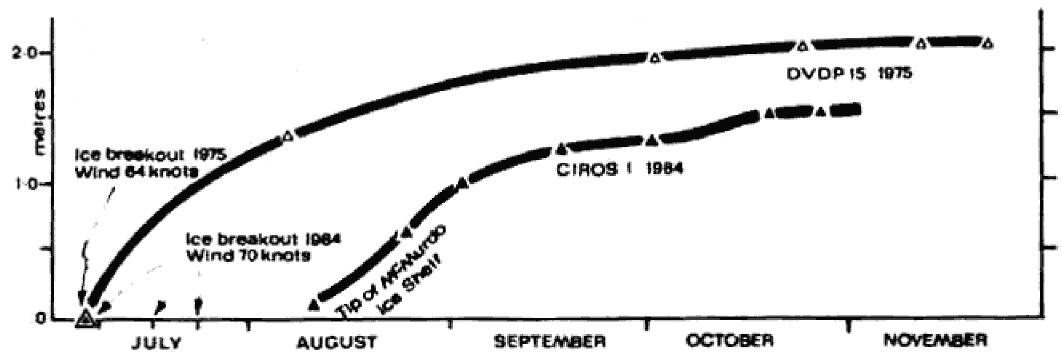

Figure 3. Growth is sea ice thickness at CIROS 1 compared with that at nearby DVDP 15 in 1975, a normal year.

The Butter Point camp operated successfully throughout the operation (mid-September to mid-November, 1984). The camp and its operation are described in some detail in the Manager's report (Stephenson, 1985).

NOTE: Regular surveys of the CIROS 1 site from late September to mid-November show that it did indeed freeze 'solid' after the 6 m of movement in early October and remained in place through several major storms (Fig. 7). This shows that the site can be safely occupied at least until mid-November even in a 'thin ice' year. Had this data been available early in the season we would have probably elected to proceed with the drilling of CIROS 1, though the unexpected failure of the floats would have almost certainly led to termination of the hole before target depth.

Results

CIROS 2 was successfully drilled near the middle of Ferrar Fjord in 210.7 m of water, through 165.5 m of sediment into basement gneiss (Table 2). Basement was found to be slightly deeper than the preferred interpretation of the available seismic data, and somewhat shallower than the estimate based on geomorphic inference (Fig. 8).

Table 2 Basic data for CIROS 2, drilled between October 10 and November 9 1984.

Position:	Lat. 77°41'S Long. 163°32'E 3.0 km from north wall of Ferrar Valley 1.2 km east of snout of Ferrar Glacier Tongue
Water depth:	210.7 m (measured by drill pipe from sea level)
Ice thickness:	2.5 m
Tidal range:	1.03 m
Total penetration:	168.09 m
Percent core recovered:	67%
Basement depth:	166.47 m
Lithology:	Gneiss
Sediment type:	Alternating sand (stone) and diamictite with occasional mudstone
Age of oldest sediment:	Early Pliocene (diatoms)

Figure 4. Active crack in sea ice at the tip of the McMurdo Ice Shelf. The crack is 10m wide and the ice at this time (September 4, 1984) is 30cm thick near the margin and 5cm thick in the middle.

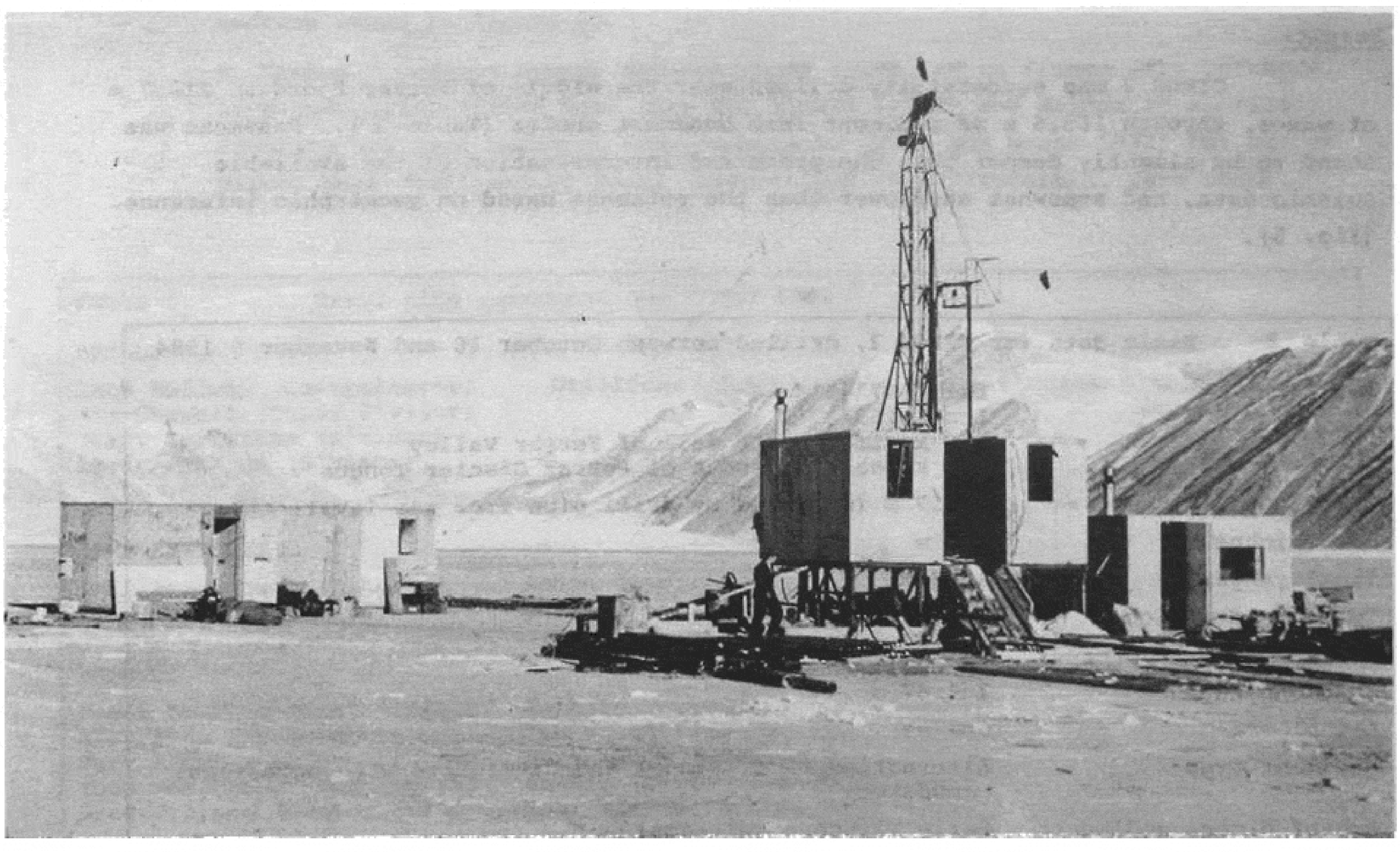

Figure 5. The Longyear 44 rig and Science Hut at CIROS 2 with the Ferrar Glacier in the background.

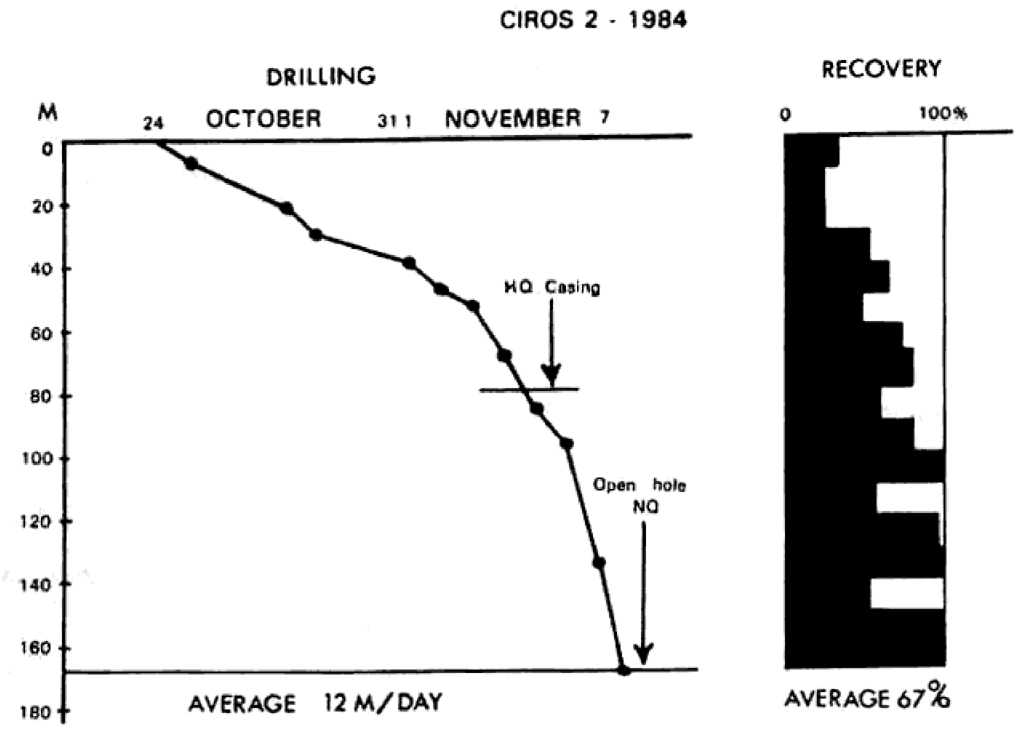

Figure 6. Drilling progress and the percentage of core recovered from CIROS 2.

The sedimentary sequence is subdivided into 10 units (Fig. 9), representing alternations of "interglacial" and "glacial" conditions. The oldest interglacial units (13, 11 and 9) are thin (1 to 5 m) diatomaceous mudstones, like the muds accumulating in Granite Harbour today. Units 7, 5, 3 and 1 consist mainly of black sorted fine to medium-grained sand (Fig. 9B) similar to that on the sea floor around CIROS 2 today, where 3/4 of the sand grains are basaltic (Barrett et al., 1984). The sorting and the indistinct horizontal stratification with the occasional mud laminae indicate sedimentation by settling. However, the sand was probably derived ultimately from the McMurdo Volcanics to the east, glacially transported and deposited on the walls of Ferrar Valley and then blown by wind offshore. Both mud and sand units probably represent times when glacial ice was no more extensive than today.

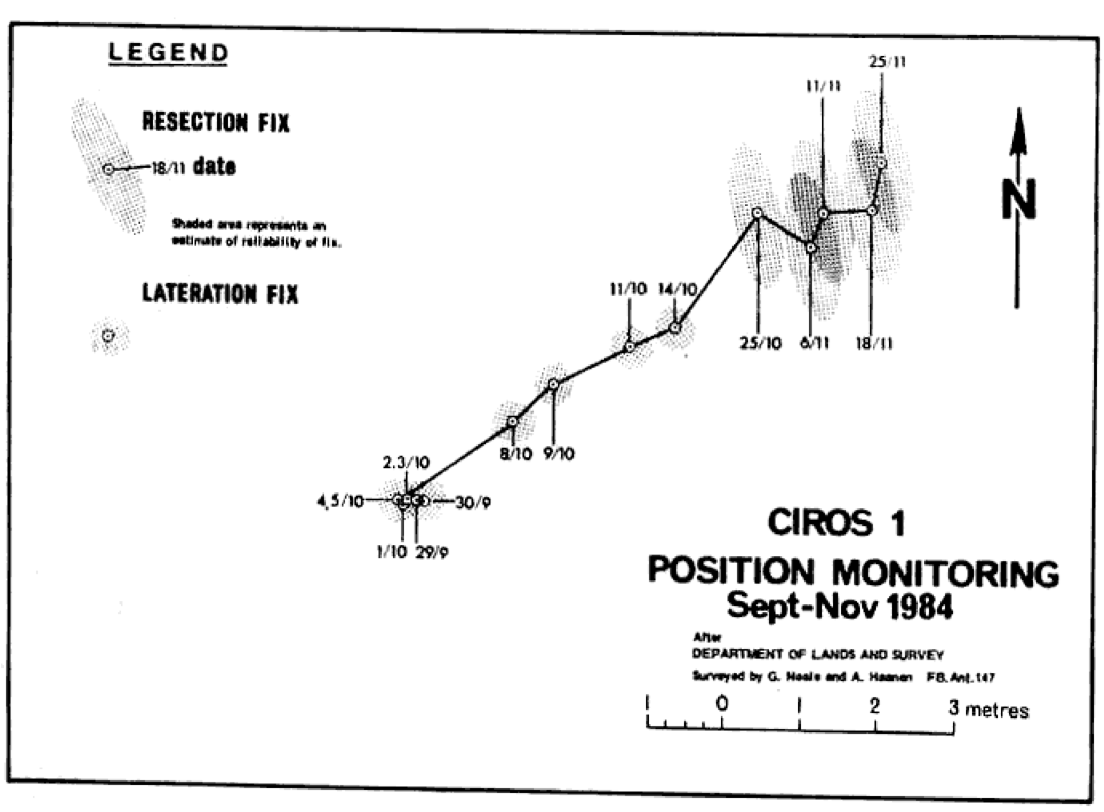

Figure 7. Horizontal movement of the sea ice at CIROS 1 (N.Z. Department of Lands and Survey).

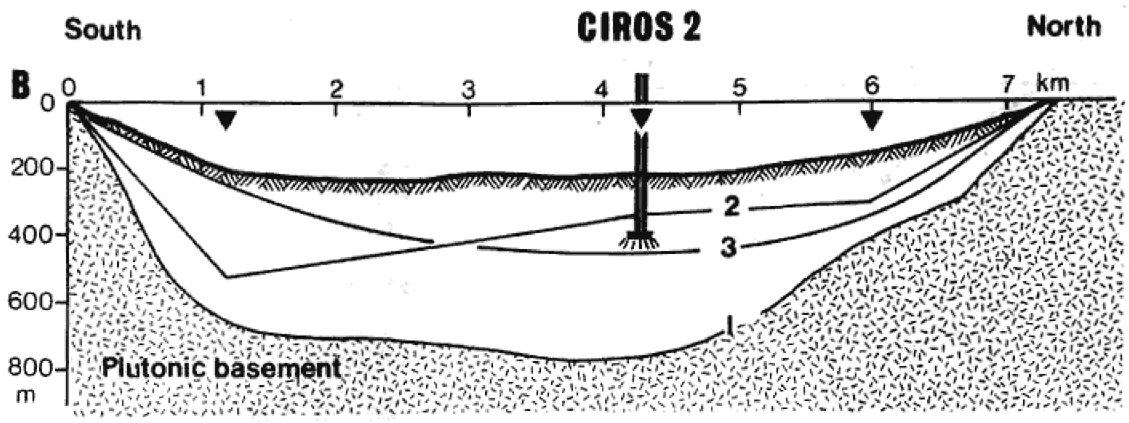

Figure 8. Cross-section of Ferrar Valley through the CIROS 2 site, showing water depth and 3 estimates of the geometry of the valley fill. 1 is from Burdelik (1981) and based on 3 seismic refraction profiles (shown by arrow heads) parallel to the valley axis. 2 is a reinterpretation of Burdelik's data by F.J.Davey (letter to P.J.Barrett, October 1982). 3 is a sketch by Barrett based on the valley slopes above sea level and on profiles across the east-trending Dry Valleys, all of which have their lowest point just north of the middle of the valley. Basement was encountered at 377m below sea level, between estimates 2 (330m) and 3 (430m).

The 6 even numbered units are extremely poorly sorted mixtures of mud, sand and gravel (diamict, Fig. 9A) with occasional striated stones, deposited directly or indirectly from glacial ice. They represent periods when ice cover around Ferrar Fjord was more extensive than at present. The oldest diamicts (Units 12 and 10) contain horizontal striated surfaces that are interpreted as subglacial shear planes, indicating that these units at least are lodgement tills. The other gravelly units, however, show in a number of places signs of redeposition by gravity flows or sedimentation through the water column, but probably accumulated close to the ice front.

The ice that transported the debris forming the diamict units came from one of two directions - west through the Transantarctic Mountains, or east past the volcanic piles of McMurdo Sound, and the debris should reflect this. Basaltic clasts are abundant (30 to 60%) in all diamicts but unit 8, indicating an easterly source. Several small basaltic cones of the order of 100 m across are known from upper Ferrar Valley, and are a potential source for some basaltic debris, but are tiny compared with the large area of exposed basement rocks. The proportion of volcanic debris in the sand fraction should help resolve this question.

Unusually well developed stratification occurs at several levels in the core between 7 and 80 m. It consists of sets of parallel mud laminae 1 to 3 mm thick in a well sorted fine sand (Fig. 9A). They superficially resemble glacial varves but the mud laminae are discrete, rather than part of sand-mud couplets. Also they lack outsized clasts. As yet we have no explanation for them.

The chronology of events recorded in the CIROS 2 core will depend on the results of current paleomagnetic, micropaleontologic and radiometric studies (Table 3). However, a preliminary examination of well preserved diatom assemblages from the lower 30 m of the hole indicates an Early Pliocene age (around 4 m.y.) (Table 4). The abundance of basaltic debris throughout most of the core and to the bottom of the hole is another indication of Plio-Pleistocene age, for basaltic debris appears in cores from DVDP 10 and 11 in the fill of adjacent Taylor Valley only above the late Miocene-Early Pliocene unconformity (Elston and Bressler, 1981; Porter and Beget, 1981). This unconformity and the sediments just above it are taken by Elston and Bressler to represent a significant glacial advance from the Ross Sea. The basalt-bearing lodgement till at the base of CIROS 2 may also represent this event.

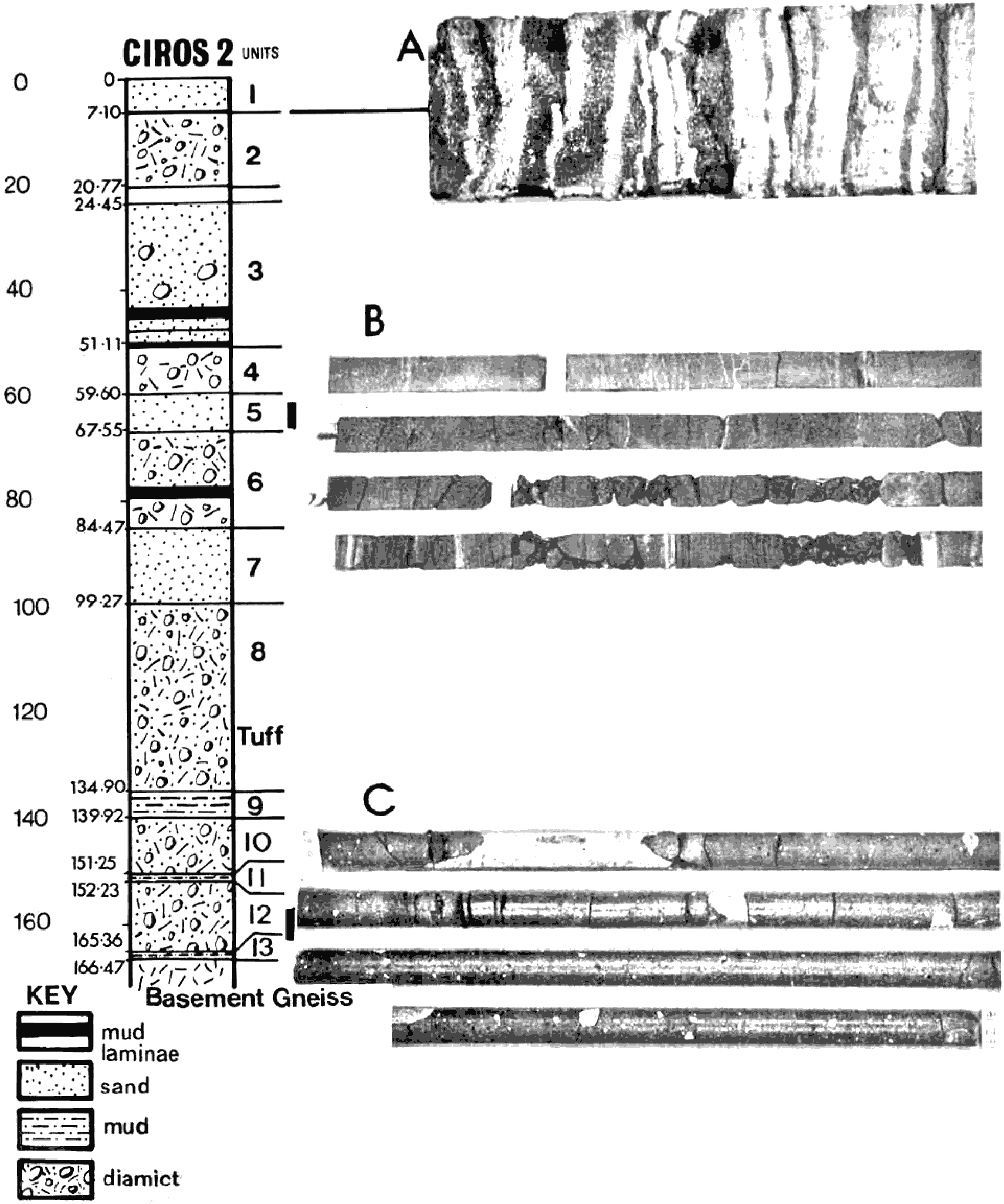

Figure 9. Stratigraphic column showing the major lithologic units in CIROS 2. Insets show the main facies: core width is about 45mm, top to left.

A. Mud laminae in well sorted fine sand from 7.06 to 7.19m.

B. Black sand from 61 to 66m.

C. Diamict from 158.67 to 162.18m.

Table 3. Work in progress on CIROS 2 core chronology

TECHNIQUE	INVESTIGATOR	SAMPLING
Diatoms	D. Harwood, Ohio State University	21 samples spread throughout core though prospects are good only for lower 60 m, where there are good floras
Paleo-magnetism	D. Elston and H. Rieck, US Geological Survey	191 samples spread throughout core
Whole rock K-Ar dating	C. Adams, Institute of Nuclear Sciences	Samples from: 101 m (basaltic clasts from debris flow) 124 m (29-cm-thick vitric tuff) 164 m (basaltic clasts from basal till)

Table 4. Diatoms in samples from CIROS 2 core (J.A. Ashby, Victoria University of Wellington, pers. comm.)

The lower two samples appear to correlate with Biozone B of Brady (1979) on the basis of *N. praeinterfrigidaria* and the possible *Thalassiosira* sp. This biozone, which extends from 137 to 152 m in DVDP 10 and from 195 to 240 m in DVDP 11, was considered Early Pliocene in age (Middle Gilbert after McCollum, 1975).

DEPTH	TAXA
135.50 m	*Coscinodiscus* sp. (90%)
	Cestodiscus sp.
	Nitzchia fragments
138.80 m	*Nitzchia* cf. *praeinterfrigidaria* McCollum
	Coscinodiscus sp.
	?*Thalassiosira* sp.
151.88 m	*Nitzchia praeinterfrigidaria* McCollom
	Coscinodiscus sp.
	?*Thalassiosira* sp.
	Denticula cf. *hustedi* Simonsen and Kanaya
	Actinocyclus ingens Rattray

The sediment resting on basement rock at CIROS 2 was expected to be older, for it was the lowest point (377 m below sea level) from which valley fill has been recovered in the Dry Valleys region. The deepest prior to CIROS 2, DVDP 11 in Taylor Valley, ended in diamict 7 m.y. old (Elston and Bressler, 1981) at 268 m below sea level, though still 150 m above basement (Hicks and Bennett, 1981). The CIROS 2 sequence is also young compared with the MSSTS 1 core 30 km to the northeast (30 m.y. at 420 m below sea level; Harwood, 1984). Nevertheless, the CIROS 2 core will be of special value for the Pliocene history of the region because it is the only sequence of this period in which paleomagnetic zones and diatom assemblages can be radiometrically dated.

The basement gneiss cored at CIROS 2 377 m below sea level has been sampled for apatite fission-track dating by P.G. Fitzgerald at the University of Melbourne to extend the vertical sections he has sampled up nearby Mount Barnes and Trig Herb. The age obtained by this sample should provide the youngest rate of uplift obtained thus far for this part of the Transantarctic Mountains.

A sea ice deformation survey was carried out during drilling at CIROS 2. Results of this survey and the other CIROS surveying programmes will be presented in the NZARP Surveyors Report 1984-85. Tidal movement was also recorded at CIROS 2 and is summarised in Table 5.

Table 5. Tidal records during CIROS 2 drilling in Ferrar Fjord. Mean sea level determined from major peaks and troughs. Time shown is decimal hours NZST ± 0.2 hrs.

Date	Time (hrs)	Peak (m)	Trough (m)	Range (m)
10 Oct. 1984	16.25	Recording started but freezing in the sea ice hole gave poor records until 25 October. The measured tidal range during this period did not exceed 1 m.		
25 Oct.	23.2	+0.41		0.82
26	15.4		-0.47	0.94
27	2.8	+0.47		0.94
	16.0		-0.47	0.95
28	3.5	+0.48		0.97
	17.0		-0.51	1.03
29	3.8	+0.51		1.03
	17.3		-0.5	1.0
30	4.5	+0.45		0.89
	17.6		-0.43	0.84
31	5.3	+0.41		0.82
	17.8		-0.36	0.78
1 Nov.	6.1	+0.36		0.78
	14.0		-0.33	0.66
	21.6		-0.32	0.64
2	6.7	+0.31		0.63
	14.4		-0.31	0.62
	18.8	-0.28		0.57
	23.8		-0.32	0.64
3	7.5	+0.26		0.52
	15.3		-0.22	0.44
	20.7	-0.05		
4	2.1		-0.23	0.47
	8.2	+0.23		0.46
	16.3		-0.18	0.37
	22.0	-0.02		
5	3.0		-0.12	
	9.1	+0.12		
	16.2		-0.14	0.28
	22.2	+0.11		0.22
6	5.2		-0.16	0.33
	9.4	+0.2		
	15.9		-0.18	
	22.8	+0.18		0.37
7	6.2		-0.09	
	8.8	-0.02		
	14.4		-0.21	
	23.5	+0.21		0.43
8	14.0		-0.27	0.54
9	0.2	0.28		0.56
	13.6 (storm)		-0.34	0.62
10	0.8	+0.31		0.62
	recordings ended.			

Publication

This report will appear, in condensed form, in the New Zealand Antarctic Record. The detailed core descriptions will be published along with core photographs and grain size data in the University's Antarctic Data Series in a few months. An article on the stratigraphy and sedimentology will be prepared over the next year for the New Zealand Journal of Geology and Geophysics. An article for Science or a similar journal on the chronology of the core is planned when the results of the present round of work are known.

Future Work

We are now preparing for CIROS 1 in late 1986, and will present a more detailed proposal using multichannel seismic data from the S.P. LEE for drilling CIROS 3 and 4 from Cape Roberts in 1988 to the Ross Dependency Committee later this year.

Acknowledgments

The success of CIROS 1984 depended on many people, but we must first thank the team at Butter Point for their cheerfulness, enthusiasm and hard work. We are also grateful to Antarctic Division and the team of 1983 for setting up such a fine base at Butter Point. Throughout CIROS 1984 we depended heavily on the support of the Scott Base winter-over team led by Eric Saxby, and the 1984-85 team led by Peter Cresswell.

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GRANITE HARBOUR SEDIMENTATION STUDY (K042) - Tony Macpherson.

Abstract

Sedimentation in Granite Harbour-Mackay Glacier system (140 km north of Scott Base) is dominated by the basal debris of the Mackay Glacier, the flow rate of which averages 226.5 ma^{-1}, both summer and winter. Basal debris approximate 7.5% by weight of basal ice. Aeolian debris is an important sediment source contributing about 23,000 tonnes a^{-1} into the system. Summer biogenic activity results in diatomaceous muds and faecal material collecting in the deepest sinks within the harbour. Redistribution of sediments as a result of current activity will be identifiable from vertical water column profiles of both salinity and suspended particulate.

Introduction

The 1984-85 season was the final in a Victoria University-Oceanographic Institute sponsored project into the main sediment sources, transport processes and sinks operating in the Granite Harbour-Mackay Glacier sedimentation system. Granite Harbour is essentially a closed system, 140 km north of Scott Base on the Victoria Land coast.

Mackay Glacier Movement

A pole network established in late November 1982 was resurveyed this season by Lands and Survey Department surveyors, both in November 1984 and January 1985. In addition, surface ablation was measured in November 1984. Results are tabulated below (Table 6).

Table 6. Mackay Glacier Movement

Pole	1982-83			1983-84			Nov.84 - Jan.85			Average Annual Movement	Avg. Annual Δ H
	Distance (m)	ΔH (m)	Annual Mov.	Distance (m)	ΔH (m)	Annual Mov.	Distance (m)	ΔH (m)	%Annual Mov.		
1/1	210.6	-40.8	221.5	194.4	+14.7	215.0	50.3	-5.4	23%	218.3	-13.1
1/2	235.0	-2.9	247.2	211.1	-11.2	233.5	52.5	-21.6	22%	240.4	-7.1
1/3	222.4	-8.1	234.0	187.6	-5.2	207.5	46.8	-1.1	23%	220.75	-6.7
2/3	268.2	+1.1	281.9	251.4	-0.4	278.0	59.8	-0.7	21%	280.0	+0.4
2/4	264.0	0	277.7	244.5	+0.6	270.4	59.1	-0.3	22%	274.1	+0.3

ΔH - change in surface elevation between measurements.

N.B.: % of year between measurements = 23%

Mackay Glacier Ablation (surface lowering)			
Pole	1982-83	1983-84	Avg.
1/1	0.57	0.75	0.66
1/2	0.47	0.31	0.39
1/3	0.75	0.36	0.56
2/3	0.58	0.45	0.52
2/4	0.68	0.54	0.61

In addition, a traverse along the length of the Mackay Glacier Tongue was attempted, to survey surface elevation. However, the tonque is badly crevassed and the survey was abandoned after several hours.

Annual movement of the Mackay Glacier, above its grounding line, is 226.5 m, and on the floating tongue is 277 m. The two surveys this season show that there is no measurable change in the flow rate of the Mackay Glacier from winter to summer.

Glacial Debris

Englacial debris was again sampled from overturned bergs about the southern grounding line of the Mackay Glacier. Two valves of a scallop were found 10 cm within the ice, on its basal surface, implying some "freezing on" occurs, at least at the edge of the tongue where the southern ice stream meets the ocean. Previously, it had been considered that the Mackay was wet based over its entire bottom and actively melted dropping basal debris immediately it entered Granite Harbour.

Samples of clasts were taken for provenance determinations. However, ice samples taken in order to determine sediment/ice ratios melted in transit to New Zealand. Measurements of sediment charged ice collected in 1983-84 show the sediment to be approximately 7.5% by weight of the basal ice. This is considered a minimum sediment concentration of the basal ice of the Mackay Glacier.

Ocean Currents

Previous attempts to measure currents in the area have not revealed any currents greater than 5 cm/sec (measurement threshold of the instruments). This season an indirect method of determining currents by measuring salinity changes and suspended particulate concentrations was attempted.

(a) Salinity: 143, 250 ml aliquots have been taken from 22 sites within Granite Harbour. These were equally spaced within the water column; however, the density of the spacing was increased in strategic areas, e.g. around the Mackay Glacier Tongue and bergs within the harbour.

(b) Suspended Particulate: 79 filtrations of 2000 ml aliquots were executed in the field through 0.8 mm "Nuclepore filters". Sampling density was similar to that carried out for salinity.

The samples from these programmes have yet to be analysed; however, it is hoped that vertical water column profiles will give an indication of gross water mass movement. It is unlikely that tidal currents play a major role in redistributing sediment within the Granite Harbour system as average tidal flows are calculated to be approximately 0.1 cm sec^{-1}. It is not known yet whether tidal flow is constant over the whole cycle or whether surges occur. Tide gauge measurements from previous years are interpreted to show that steady flow conditions are most likely.

Table 7 1984 Sample Sites

Site	Depth (m)	Number of Salinity Samples	Number of S.P.M. Aliquots	Sediment Traps - at depths of (days)	Sediment in ice samples - area	Average snow depth	Dominent wind direction
84-1	700+	8	8	Not recovered	10 m²	.07 m	50% ; 50%S
-2	40	1	1		21 m²	.07 m	100%S
-3	700+	8	8	@ 20,125,325(57)			100%S
-4	535	8	6	@ 20,160,360,540(57)			100%W
-5	700	11	1				100%W
-6	120	4	1				100%W
-7	335	8	4				100%W
-8	63	3	1				70%W; 30%SE
-9	115	4	2		10 m²	.01 m	70%W; 30%SE
-10	235	6	4		10 m²	.07 m	70%W; 30%S
-11	360	5	5				70%W; 30%S
-12	245	4	4		10 m²	.03 m	70%W; 30%S
-13	715	10	8				60%S; 40%W
-14	235	6					100%SW
-15	285	7	4		10 m²	.03 m	100%SSW
-16	390	7	5		10 m²	.11 m	75%S; 25%W
-17	390	7	4				100%SW
-18	240	6					100%S
-19	295	7	4				100%S
-20	310	7					85%S; 15%W
-21	385	8	5				100%S
-22	550	8	4	@ 20,200,400,550(56)			50%SW; 50%W
TOTAL		143	79				

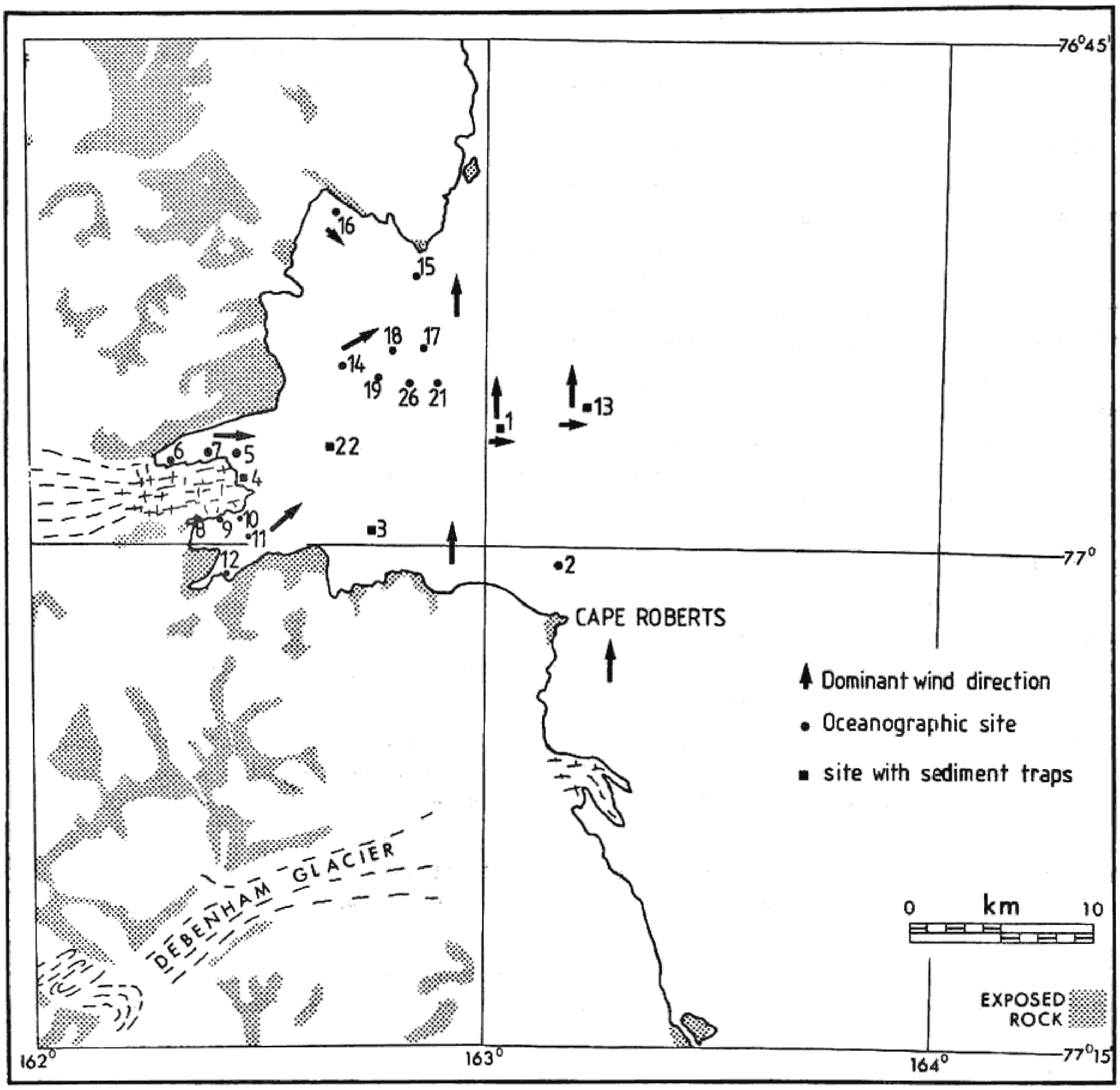


Figure 10. Map showing the 1984 sample sites and dominant wind directions in Granite Harbour.

Aeolian Sediment

This season we attempted to determine the abundance of aeolian debris on the sea ice at eight sites within Granite Harbour.

Fine and very find sand accumulates on the surface of the sea ice and, therefore, when collected in late November, represents the amount blown there since the sea ice had formed (early winter?).

At each site, a 5 x 2 m area was staked out perpendicular to the dominant wind direction. Surface snow (varying in depth from 0.01 to 0.12 m) and the top 0.02 m of sea ice (which was chipped off) was collected and melted in a copper drum using a petrol immersion heater. Some contamination from flaking paint proved unavoidable. Preliminary results are tabulated below.

In general, sediment abundance varies with proximity to source with some samples having a high mud component as a result of diatoms frozen into the top 0.02 m of the sea ice.

For a few months each year, the harbour is ice free, and windblown sediment passes directly into the system. During the rest of the year, the harbour is ice covered and, therefore, collected windblown sediment could be rafted out of the system as the sea ice breaks up.

Considering the average weight for 10 m², there is an input of approximately 23 x 10^3 tonnes/annum onto the sea ice or directly into the system.

Table 8	Aeolian Sediment
Site	Wt. collected material/10 m²
84-1	23.09 gms
84-2	26.86
84-8	18.44
84-9	215.19
84-11	288.81
84-14	15.09
84-15	54.0
Averages	Sites 1; 2; 8; 14; 15 = 27.5/All sites = 91.64

Sediment Trapping

Four strings of three single traps were deployed for approximately 56 days at various sites in Granite Harbour. The trap design and deployment is outlined in Pyne (1984).

The string from the deepest sink proved impossible to recover. However, all other traps had measurable quantities of mainly biogenic material. Samples were preserved in alcohol and will be analysed for biogenic silica, organic carbon and sedimentation rate.

In addition, S.216 from Rice University, Texas, deployed a string of seven traps immediately east of Granite Harbour. Logistic support was provided by K.042 as part of a co-operative programme. The Rice University party have analysed some of the sediment trapped from Granite Harbour in 1983-84.

Equipment

No major scientific equipment problems were experienced by K.042 this year. However, mechanical failure of the 5 to 7 year old toboggans supplied by Antarctic Division reduced the planned field programme.

BEDROCK STUDIES (K043)

The major objective is to document the uplift history of the Transantarctic Mountains in the McMurdo Region:

1) by determining pre-Devonian structural and metamorphic history of the basement in the Victoria and Wright valleys, with emphasis on the depth of burial and amount of uplift prior to Beacon sedimentation.

2) by determining the Late Mesozoic and Cenozoic uplift history of the Royal Society Range.

Structure and Metamorphism of the Basement Complex (K043A) - R.J. Korsch

Abstract

The lower Victoria and Wright valleys are relatively ice-free and hence ideal to determine the pre-Devonian structural and metamorphic history of the basement complex. The rocks have suffered polyphase deformation with possibly four fold generations being recognised. F1 produced isoclinal folds which have been refolded during later events. F2 is the dominant fold generation, producing close to isoclinal asymmetric folds and a well-developed, subvertical, NW-SE striking axial surface foliation. Fold axes have variable plunges within this plane. F3 and F4 are localised in extent. Some Theseus Granodiorite dykes contain the S3 foliation and hence are pre-F3 in age, whereas the Vanda porphyries and lamprophyres are unfolded and hence post-F3 in age. The field studies confirm a complicated pre-Devonian structural and metamorphic history of the McMurdo region of the Transantarctic Mountains.

Introduction

Field work during the 1984-85 summer season concentrated on the Robertson Ridge in the lower Victoria Valley and the ridges between the Meserve and Goodspeed valleys in the lower Wright Valley. Field objectives were to carry out detailed structural mapping, and the collection of structural data and a representative suite of the metamorphic rocks. As well, nine large (>35 kg) samples of granitoids and related rocks were collected for U-Pb zircon dating.

The basement complex in the lower Victoria and Wright valleys consists of multiply-deformed metasedimentary rocks intruded by granitoids and related rocks of the Wright and Victoria Intrusive Suites. The metamorphic rocks have been referred to as the Asgard Formation (McKelvey and Webb, 1962) or the Meserve Member of the Hobbs Formation (Findlay, 1983). They are now biotite schist and gneiss, hornblende gneiss, quartz-feldspar gneiss, augen gneiss and calc-silicate rocks along with rarer pure marble, amphibolite, quartzite and pelitic schist. Prior to metamorphism they represented a sedimentary sequence dominated by sandstone but also containing mudstone, pure limestone and impure limestone suggestive of a passive continental margin depositional environment.

Although most rock types are represented at each locality, the proportions vary: at the Robertson Ridge the dominant lithology is quartz-feldspar-biotite-hornblende gneiss, and augen gneiss is rare; between the Meserve and Hart glaciers the sequence is dominated by augen gneiss and between the Hart and Goodspeed glaciers, hornblende schist is most abundant and augen gneiss less common.

Preliminary structural results determined in the field, suggest that, with minor differences, the lower Victoria and lower Wright valleys have very similar deformational histories.

At Robertson Ridge, evidence was observed for at least three deformational events, here labelled F1, F2 and F3.

F1: The earliest deformation produced isoclinal folds with fold axes now having variable orientations. Apart from in the hinge zones, lithological layering has been transposed into parallelism with the axial surface foliation (S1). It is possible that the lithological layering represents original bedding, but the lack of recognisable sedimentary structures hinders confirmation. The axial structures of the F1 folds also have variable orientations due to later refolding by F2 and F3 events (Fig. 11). F1 folds are relatively rare in comparison with F2 folds.

F2: This is the dominant fold generation, producing abundant, close to isoclinal, asymmetric folds, along with a well-developed axial surface foliation (S2) in certain lithologies. The plunges of the fold axes vary from subhorizontal to moderately plunging within a subvertical, NW-SE striking axial surface. Where folding has been intense enough, the lithological layering has been transposed into parallelism with S2. Elsewhere, the S2 foliation is oblique to the lithological layering and/or S1 foliation. Minor structures associated with this fold event include the long axes of boudins, mineral lineation and intersection lineation, all of which parallel the orientations of the fold axes.

F3: This deformation produced gentle to tight folds, crenulations and occasionally an axial surface cleavage (S3). The F3 folds refold both F1 and F2 folds and have axial surfaces which dip 50° - 70° to the NW. Most of the fold axes plunge gently to the north. Although this deformation is only of localised extent it is extremely useful in that it enables some members of the Victoria Intrusives to be dated relative to this deformational event. Dykes of Theseus Granodiorite contain the S3 foliation but no evidence of S2, and hence are post-F2 but pre-F3 in age. The Vanda Porphyry and Lamprophyre are unfoliated and hence post-F3 in age.

The structural history of the lower Wright Valley is very similar to that of the Robertson Ridge, the main exception being orientations of the F2 fold axes. Structurally, the area between the Meserve and Hart glaciers can be subdivided in two, with the steeper part of the ridge separated from the lower, flatter part by a band of scree. In the upper part of the ridge, the F2 fold axes normally plunge very gently to the SE, whereas on the flatter section the F2 fold axes plunge subhorizontally to steeply both to the NW and SE. In the areas between the Hart and Goodspeed glaciers, the F2 fold axes plunge gently to the NW and SE. The large (λ = 1 km) folds between the Meserve and Goodspeed glaciers visible in aerial photographs (Fig. 12) are here interpreted as F2 folds.

Evidence for a fourth, very localised fold generation was observed between the Hart and Goodspeed glaciers and on the flatter section between the Meserve and Hart glaciers. Gentle to open upright folds plunge steeply to the E and W, and boudins with long axes of the same orientation occur also. This generation post-dates F2 but no time relationship with the more common F3 structures could be established. Late, minor faulting occurred at some time after F3.

The structural history outlined above differs to some extent to that proposed by Murphy (1971). My F2 is mainly equivalent to Murphy's F3 but could possibly include some of his F2, and my F1 is equivalent to Murphy's F1 plus F2. Murphy did not recognise equivalents of my F3 or F4 (Table 9).

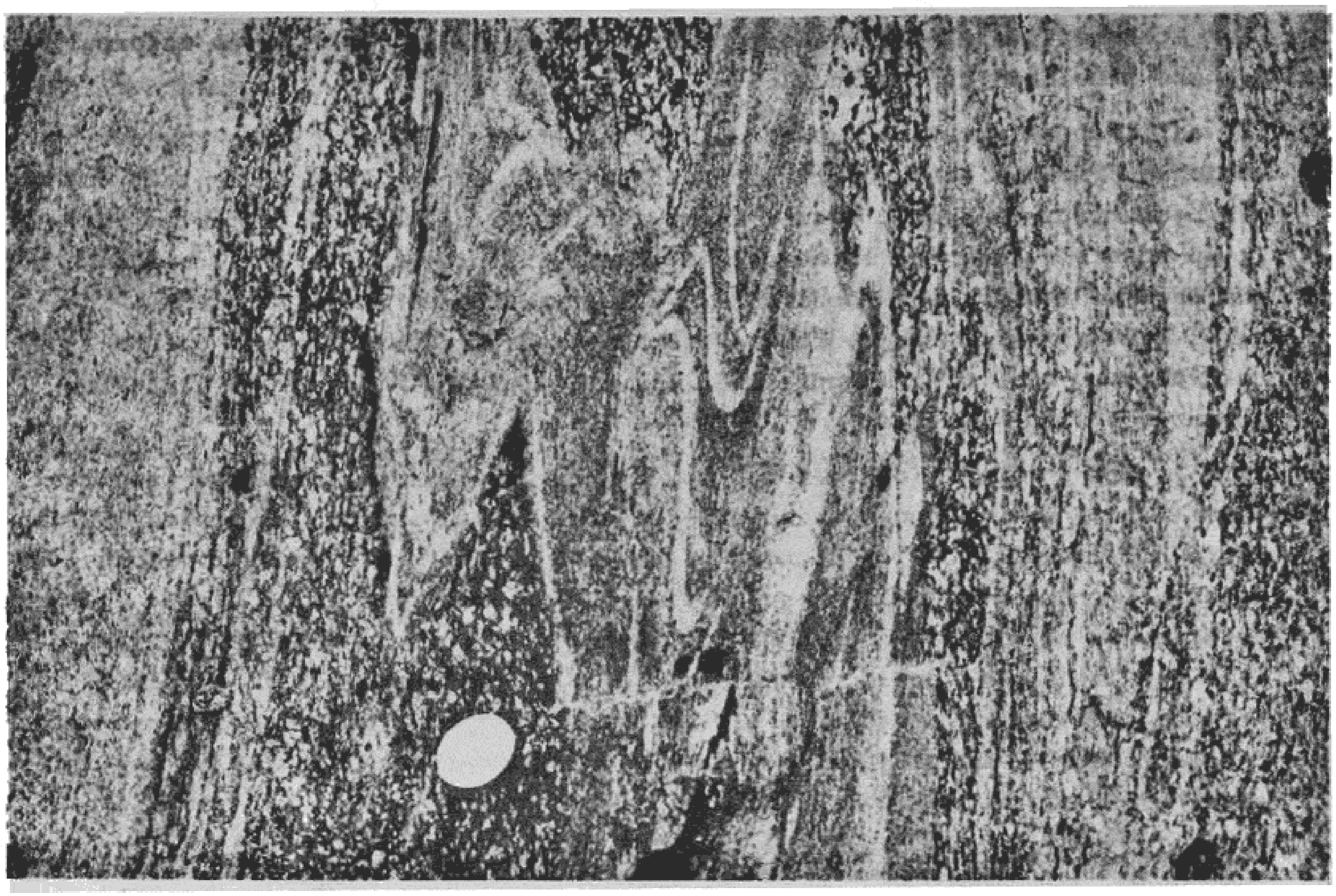


Figure 11. Minor F1 fold with curved axial surface being refolded by F2 folds. Ridge between Meserve and Hart glaciers, lower Wright Valley.

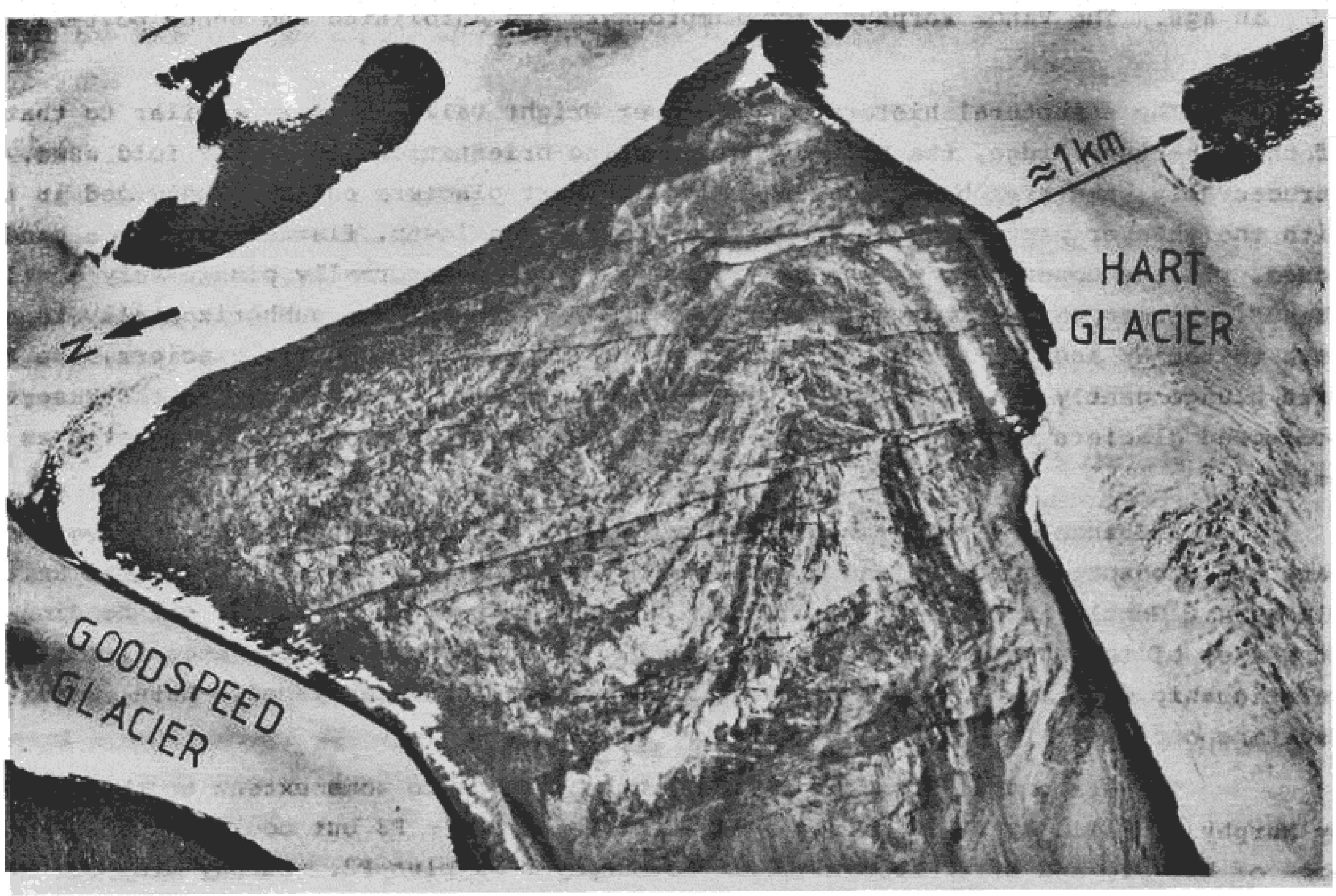
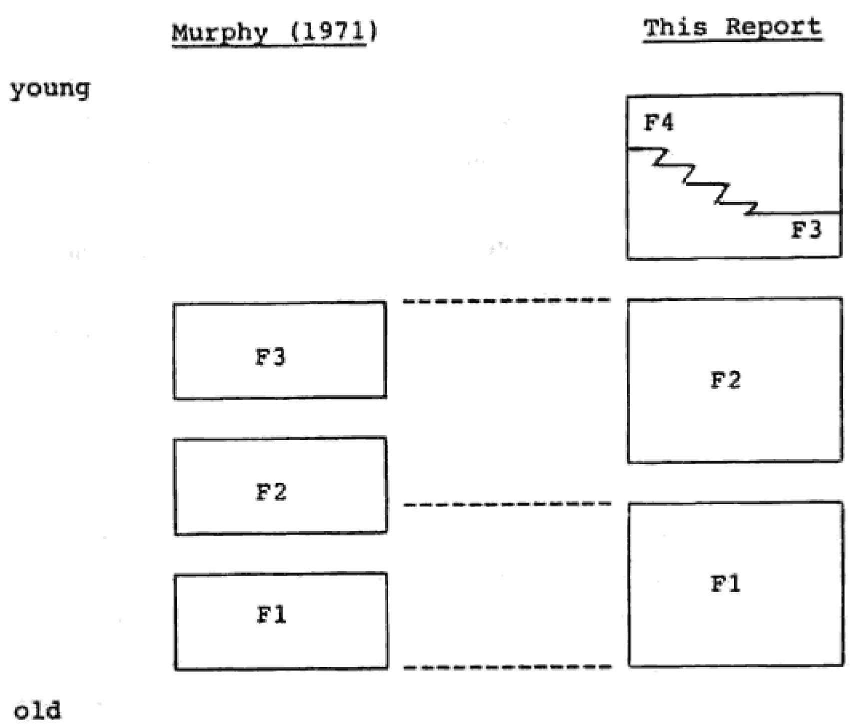


Figure 12. Part of oblique aerial photograph TMA360-00166 (F33) looking south, showing the south wall of the Wright Valley between the Goodspeed and Hart Glaciers. Note the obvious large F2 folds visible in the valley wall. Photograph courtesy of the United States Geological Survey.

Table 9. Correlation of fold generations with those of Murphy (1971).



Laboratory work on the rock specimens collected this season will concentrate on:

1) metamorphic petrology to assess the pressure-temperature conditions and allow an estimate of the original depth of burial of the rocks.

2) U-Pb isotope dating of zircons separated from the granitoid samples.

These studies coupled with structural analysis of the field data should provide an integrated tectonic history of the McMurdo portion of the Transantarctic Mountains prior to commencement of deposition of the Beacon Supergroup in the Devonian.

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Bedrock Studies (K043B) - P.G. Fitzgerald

Abstract

Sampling of granitoid basement rocks to determine the late Mesozoic and Cenozoic uplift history of the Transantarctic Mountains in the McMurdo Sound region was completed this season. The study will utilise fission-track dating techniques on apatites at the University of Melbourne to provide uplift rates across the mountains.

Granitoid samples were collected from the New Harbour area including "basement" from the CIROS 2 drill hole. Topographic features attributed to faulting are an eastwards decrease of peak heights along the Kukri Hills and a saddle on the east flank of Mt Coleman.

The Transantarctic Mountain Front from Miers Valley across the Blue Glacier to the Royal Society Range was also sampled. The upper Blue Glacier lies in a graben bounded on the west by a number of normal faults and to the east by the block of Miers to Salmon Valleys area.

This was the second field season of a PhD study to determine the uplift history of the Transantarctic Mountains using fission-track dating. This technique depends on the determination of the gradient of apatite fission-track age with elevation, which requires the taking of samples at regular intervals over significant elevation ranges in order to gain information representing the greatest possible time period. The main area visited this season was the Blue Glacier which contains exposures with relief of up to 2500 m over short horizontal distances. Miers Valley, the New Harbour area and Robertson Ridge were also visited.

Field objectives were:

1. Reconnaissance mapping of the basement looking for physical evidence of faulting, such as displaced surfaces or crush zones.
2. Collection of samples for fission-track studies in order to obtain uplift rates and measure vertical movement and timing of the faulting (Fig. 13).

Field work last season as well as previous reconnaissance fission-track studies (Gleadow, 1982; Gleadow et al., 1984; Gleadow and Fitzgerald, 1984; Fitzgerald and Gleadow, 1984) show that step-faulting is important in controlling the eastern front of the Transantarctic Mountains. They also reported that uplift during the Mesozoic was a steady 15 m/Myr but this increased dramatically close to 50 Myr ago to about 90 m/Myr.

The geology of the field area consists of the multiply-deformed Pre-Cambrian Koettlitz Group which is composed of marbles, conglomerate, amphibolitic, quartzo-feldspathic and pelitic schists intercalated with quartzofeldspathic gneisses. Intruding this are the Cambro-Ordovician Granite Harbour Intrusives composed of a number of pre- to post-tectonic granitoids. These basement rocks are unconformably overlain by the Devonian-Jurassic Beacon Supergroup which is made up of glacial, alluvial and shallow marine strata. Both the Beacon and the basement rocks were intruded in the Jurassic by the Ferrar Dolerite in the form of a number of essentially horizontal sills. These sills can be traced with little offset over distances of up to tens of kilometres, especially in the basement. They can therefore be used as reference surfaces to determine displacements that occurred in post-Jurassic times and which may be related to the tectonic development of the Transantarctic Mountains.

In areas where the Ferrar Dolerite does not crop out, fission-track dating can be used to generate reference surfaces. Because it has been demonstrated that the apatite ages vary with elevation in a number of profiles, each age can be taken to represent a certain tectonic level. Sampling for fission-track studies is limited to those rocks which contain suitable uranium-enriched minerals. This study is looking mainly at apatite which is common in granitic rocks and in the majority of areas visited this season, dolerite did not crop out, hence the need for artificial reference planes.

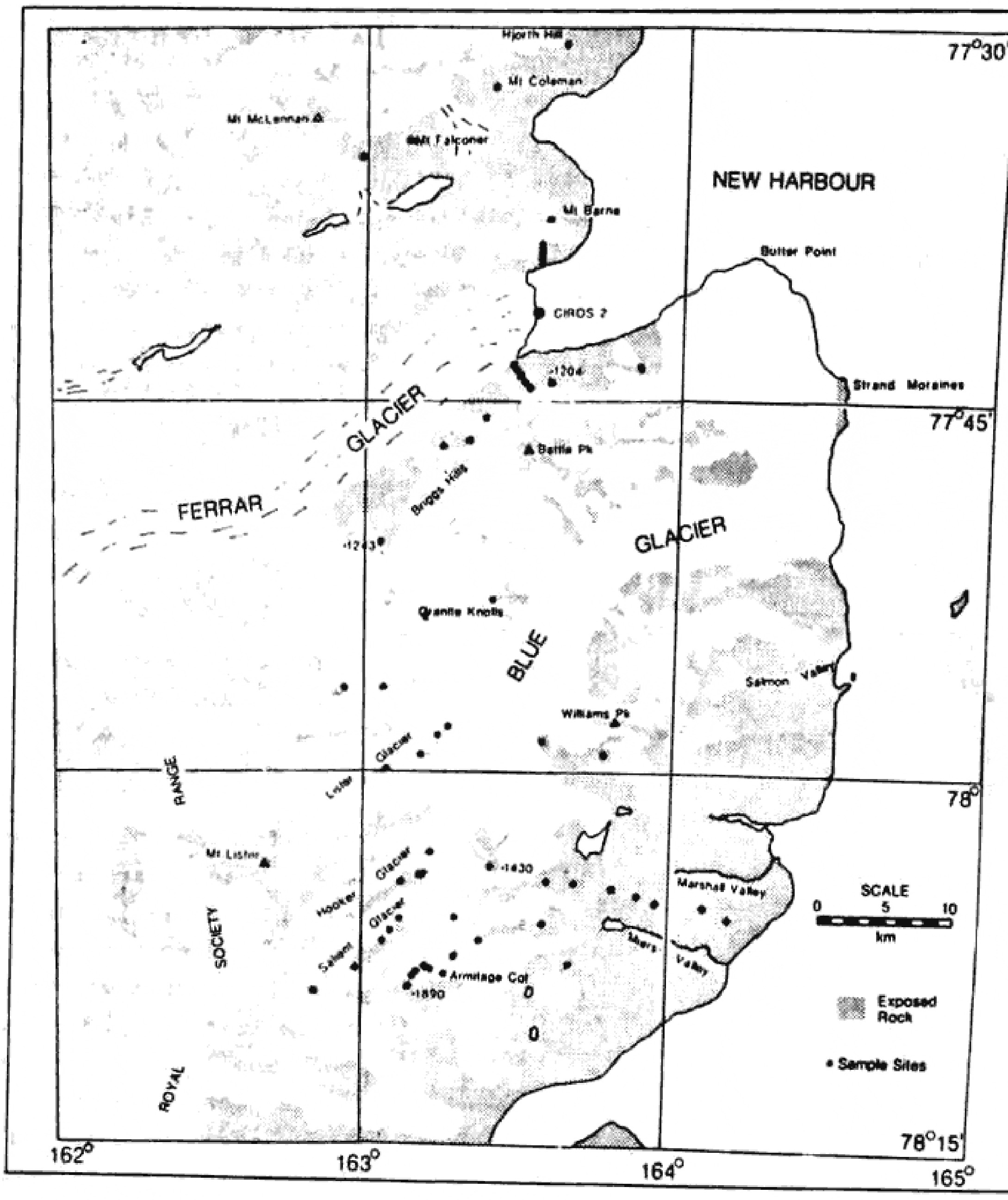

Figure 13. The New Harbour and Blue Glacier areas showing localities sampled for fission-track dating this season.

New Harbour

CIROS 2, drilled in October-November 1984 at the snout of the Ferrar Glacier, struck basement at 167 m sub-bottom, approximately 378 m below sea-level. This gave us our lowest sample yet and the chance to quantitatively measure offset across the mountain front. A vertical sampling profile was taken off the eastern end of the Kukri Hills, starting from the top of Mt Barnes. Another vertical sample line was also taken on the south side of New Harbour, off the peak lying just to the west of spot height 1204 m.

Individual samples were taken from Hjorth Hill, Mt Coleman, Mt Falconer and the south ridge of Mt McLennan as well as Mt Herb (spot height 1097) and spot height 1204 m. This was to try and locate the position of any faults, such as the Bowers Fault (Gunn and Warren, 1962), postulated to run across the front of the Transantarctic Mountains. The topographic expression of this fault can be seen on the east flank of Mt Coleman. The abrupt drop in peak height as one moves east along the Kukri Hills, is possibly further evidence of faulting, as suggested by Wrenn and Webb (1982). Fission-track data from this area should do much towards solving this problem.

Miers Valley

The Miers Valley was briefly visited in the 1983/84 season and a vertical sampling profile of 800 m was taken off Surveyors Peak. This yielded apatite fission-track ages of 56 ± 3.7 to 43 ± 1.6 Myrs and again shows the change of uplift rate from 15 m/Myr prior to 50 Myr, to approximately 95 m/Myr (Fig.14). It became clear from this that ages younger than 50 Myr are useless as tectonic markers as the errors in age compared to change in elevation overlap considerably. The errors in ages older than 50 Myr are small compared to change in elevation and so are good tectonic markers, a change of a few 100 m or so producing a significant age difference. It was therefore necessary to take samples from the tops of ridges or summits of peaks when they were to be used as tectonic markers. A horizontal sampling line across the Transantarctic Mountain Front was started at the coast and continued along the ridge between the Marshall and Miers Valleys almost as far west as spot height 1430 m.

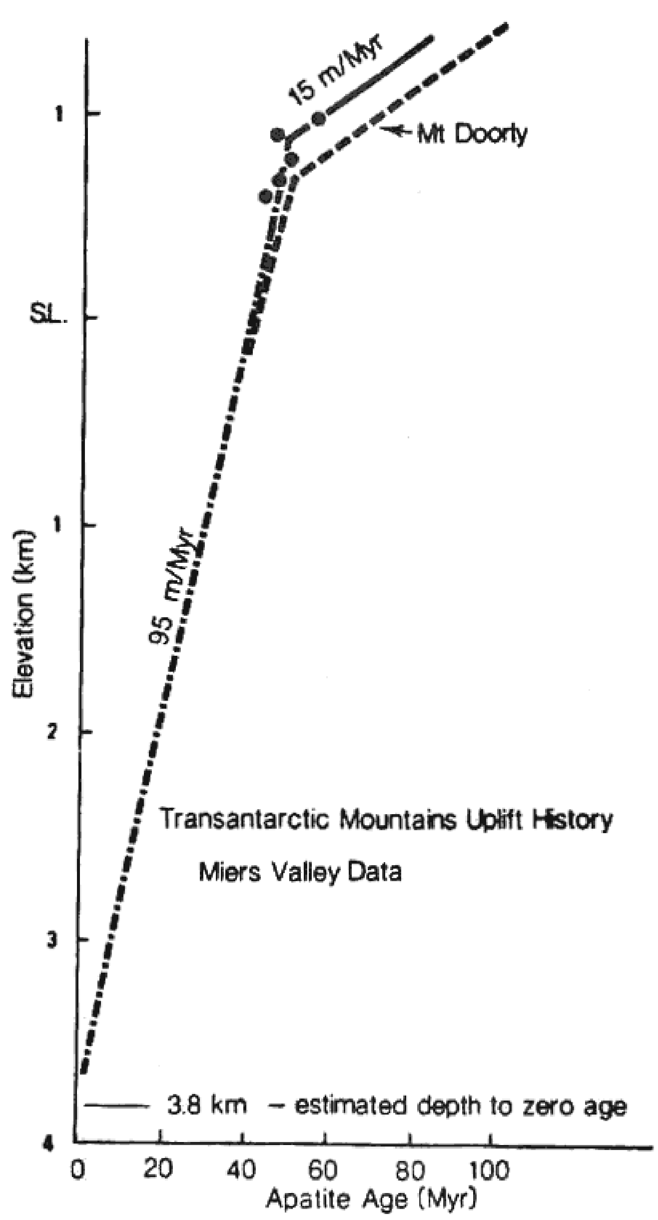

Figure 14. Model for the uplift history of the Transantarctic Mountains in the Miers Valley area based on observed apatite age variation versus elevation and the estimated depth to zero age. The dramatic change in uplift rate at 50 Myr from 15 Myr prior to this and 95 m/Myr after it has been interpreted using the uplift curve from Mt Doorly (Gleadow and Fitzgerald, in prep.)

Blue Glacier area

The sample line across the Transantarctic Mountain Front started in the Miers Valley area , was picked up at spot height 1430 and extended across the Blue Glacier and up the ridge south of Salient Glacier. Samples were also taken from other ridges to try and tie down structural trends. A vertical sampling profile of 800 m was taken from spot height 1890. Samples were also taken across the north end of the Blue Glacier/Briggs Hills area in an extension of work done in the New Harbour area.

A prominent scarp west of Bettle Peak suggesting a fault downthrown to the west is also seen further south to the west of Williams Peak. This is the Foothills Fault of Gunn and Warren (1962) and defines the eastern margin of the Blue Glacier graben; the western margin being defined by the Lister Fault running along the end of ridges which come down off the Royal Society Range lying to the west. However, there exists another fault between the Lister Fault and the Royal Society Range. This is seen in ridges underneath Chaplins Tableland just north of Mt Lister where the basement dolerite sill is downfaulted approximately 200 m to the east. It continues south to Armitage Col and north to the Ferrar Glacier, however no evidence of it is seen north of the Ferrar. Numerous notches in these ridges suggest the presence of more faults in the Southern Foothills running parallel to this fault but no slickensides were seen in what in some cases were possibly poorly indurated crush zones.

In summary: The upper Blue Glacier appears to lie in a graben, its western boundary defined by a number of normal faults. Its eastern boundary is delineated by what appears to be a single block, consisting of the Miers-Marshall-Salmon Valleys and probably also including a small block to the north of the lower Blue Glacier. The block is bounded on its western side by a large normal fault and most probably on its eastern side by a number of step faults similar to those seen further north along the Wilson Piedmont. This graben is terminated to the north by the Ferrar Glacier.

Samples taken for fission-track dating will be processed at the University of Melbourne and representative samples of granitoid rocks from the area covered will be studied in detail at Victoria University to determine mineralogy and geochemistry.

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GEOPHYSICAL INVESTIGATION IN NVL (K045) - Jean Olson and Richard Kellett

Abstract

The 1984/85 GANOVEX IV geophysical expedition in northern Victoria Land investigated the crustal structure in a large area between the Ross Sea and the Polar Plateau. The main geophysical programme included airborne magnetic and radio echo-sounding surveys using 2 Dornier 228 aircraft, and numerous geophysical surveys in areas of geologic significance and where magnetic anomalies were detected. The programme involved about 40 scientists and technicians based at Gondwana Station, Terra Nova Bay, and at three field camps.

The members of this event were invited to assist in the main geophysical programme, under the direction of the expedition leader. Their work included making gravity surveys, processing aeromagnetic data, and assisting in radio echo-sounding and magneto-telluric surveys.

Programme

The aim of the proposed scientific programme of the 1984/85 GANOVEX IV geophysical expedition in northern Victoria Land was to:

(a) investigate the boundary fault between the Ross Sea and the Transantarctic Mountains;

(b) investigate the boundary fault between the West Antarctic fold belt and the East Antarctic Shield;

(c) investigate the Bowers Zone and its tectonic significance including its extention into the Ross Sea area;

(d) investigate the northern part of the Victoria Land Basin and its connection with the Bowers Zone.

The planned methods and organisation used to carry out the main geophysical programme were:

(a) An aerial survey of magnetics and radio-echo sounding using 2 Dornier 228 aircraft covering approximately a 650 km by 200 km area over the Transantarctic Mountains and the Ross Sea in flight lines about 4 km apart. Part of this research was a joint BGR-USGS co-operation.

(b) Geophysics ground-check groups to make geophysical measurement of areas with a geologic significance and where major anomalies are detected by the airborne magnetic profiling.

(c) A helicopter-supported gravity survey from the Ross Sea to the East Antarctic Shield and in areas where special anomalies are detected. Local radio echo-sounding measurements accompanying the gravity measurements would be made to establish the ice thickness.

The main programme would be carried out by about 35 scientists and technicians based at Gondwana Station, Terra Nova Bay, and in small field camps; a second phase of the airborne programme would be carried out from McMurdo. Transport of the main party and cargo between Christchurch and McMurdo and other logistical support would be provided by the U.S.A. and N.Z.; all other transport would be done with the 2 Dornier aircraft, 3 Squirrel 350 Helicopters, and 3 Skidoos stationed in the field.

The two members of this event were invited to participate in the main geophysical programme, under the direction of the expedition leader.

This work was to be a continuation of the BGR geologic expeditions GANOVEX I and III in northern Victoria Land, using geophysical methods. The results of those expeditions are published in the volumes: "GANOVEX 1979/80" and "GANOVEX III 1982/83"

(Volume 1), N. Roland (editor), each published by the Federal Institute of Geosciences and Natural Resources and the Geological Surveys of the various Federal German States; Volume 2 of the latter, to include geologic maps, is in press.

Introduction

The work carried out by this event, summarised below, was part of a co-operative effort to support the main geophysical programme. An inclusive description of the methodologies and results of the programme is obviously beyond the scope of this report. However, some of the geophysical surveys undertaken by the event members are described below, including a gravity survey of the Browning Pass and upper Priestley Glacier areas made by Olson, and magneto-telluric and radio-echo sounding profiles on the Campbell Glacier which Kellett assisted in. Figure 15 is a map showing the locations of the camps listed below:

Table 10. Summary of event movements and scientific work carried out by K045

OLSON		
16 Nov. - 19 Dec.	Gondwana Station	Tested and installed geophysical instruments, made helo-supported gravity surveys, processed aeromagnetic data.
19 Dec. - 6 Jan.	Priestley Glacier Field Camp	White-out conditions prevented planned helo-supported gravity surveys, made short gravity profile on foot.
6-10 Jan.	Gondwana Station	Processed aeromagnetic data, analysed gravity data.
KELLETT		
15-20 Dec.	Gondwana Station	Tested geophysical instruments, prepared for the field.
20 Dec. - 21 Jan.	Mt Queensland Field Camp	Assisted in radio echo-sounding and magneto-telluric profiles made from skidoos.
22-27 Jan.	Gondwana Station	Helped pack up and winterise camp.

Geophysical Surveys on Browning Pass

Introduction

A geophysical survey was made along part of Browning Pass (Figure 15) to determine the basement structure beneath the ice. The survey, not originally planned in the geophysics programme, was made following a decision to do work near Gondwana Station during periods of bad weather or when helicopters were not available to support planned surveys. Browning Pass was chosen for study because of the suggestion of a fault that extends along the pass, on the basis of differential folding of Priestley schist on each side of the pass (Skinner, 1983). The objective of the survey was to determine whether a fault could be detected using geophysical methods. The survey consisted of gravity, magnetic, and radio echo-sounding measurements, but only the gravity survey is described below.

Method

Measurements were made along a 1 km by 3 km grid oriented orthogonal to the trend of the pass, at points separated by approximately 250 m in each direction of the grid. Positions and relative elevations were surveyed with an EDM instrument. Gravity measurements were made with a Worden gravity meter. Gravity measurements were corrected for drift by linear interpolation of base-station measurement made approximately every 2 hours. Average drift was about 0.25 mgals per 2 hours. Gravity was also corrected for relative elevation, but terrain corrections have not yet been applied.

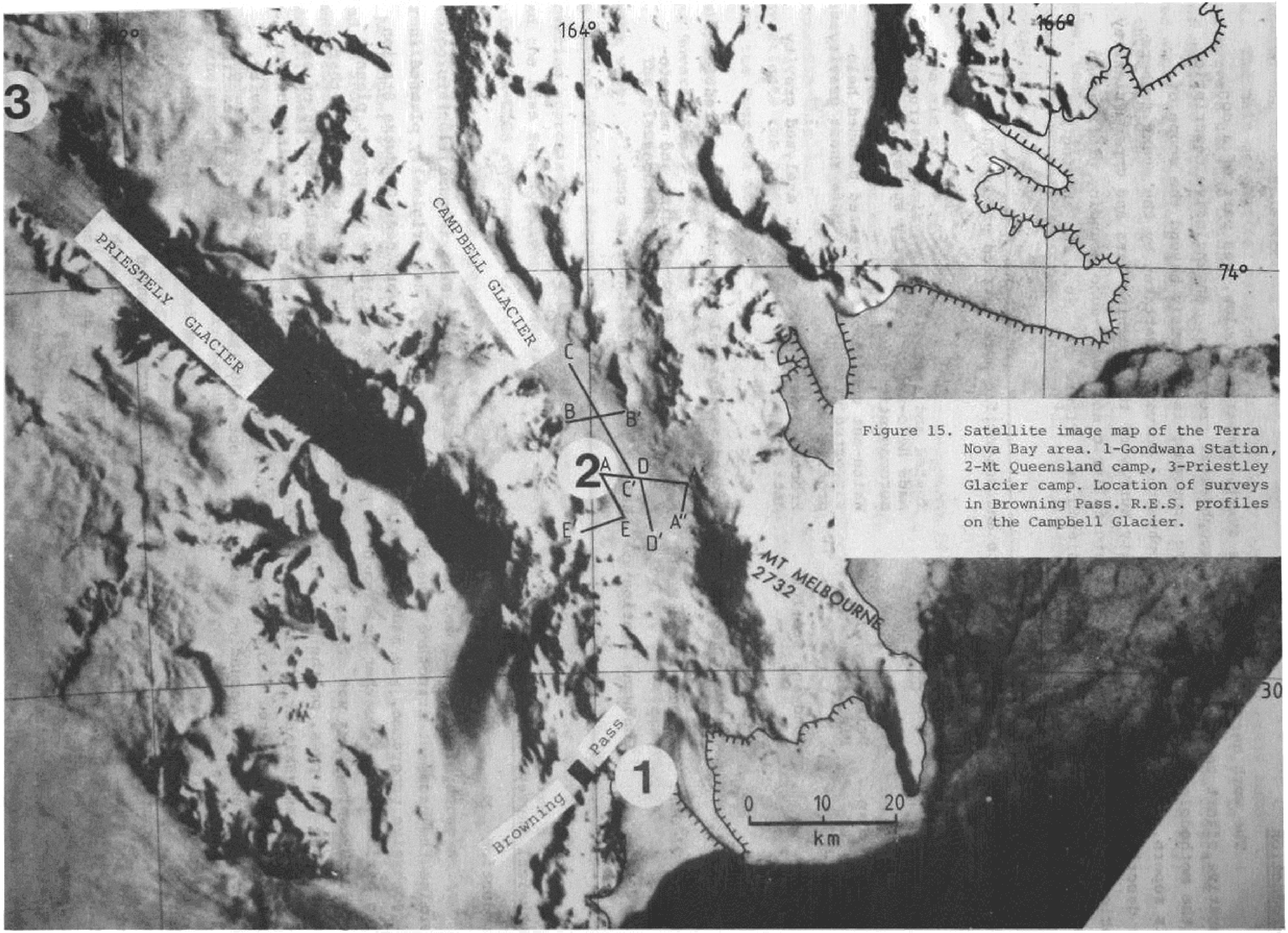


Figure 15. Satellite image map of the Terra Nova Bay area. 1-Gondwana Station, 2-Mt Queensland camp, 3-Priestley Glacier camp. Location of surveys in Browning Pass. R.E.S. profiles on the Campbell Glacier.

Results

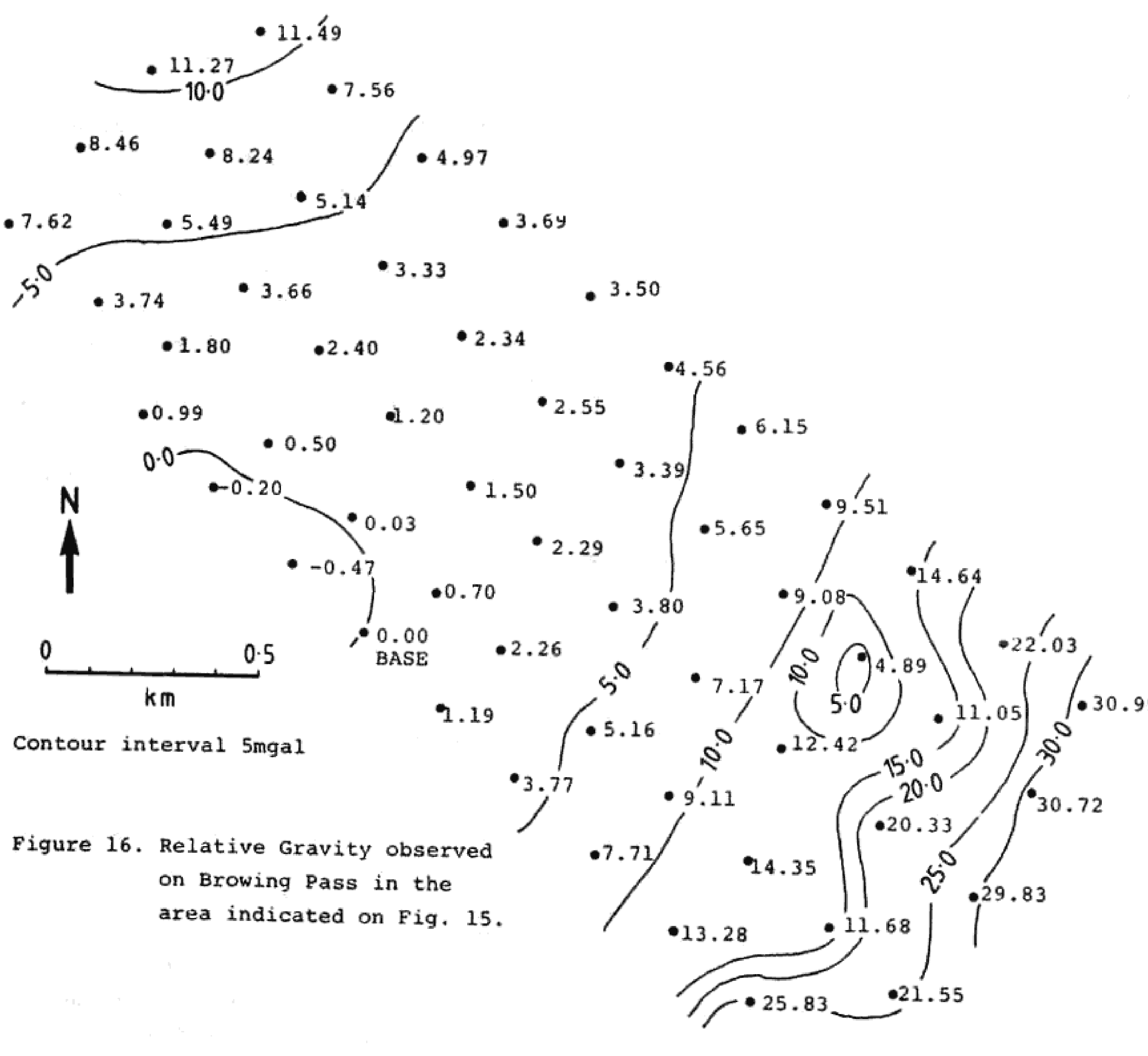
Figure 16 is a map showing the relative positions of the stations and the partially reduced relative gravity observations. Interpretations will be made after the data are fully reduced and modelled in conjunction with the radio echo-sounding and magnetic observations.

Acknowledgement

Other workers involved in this survey were R. Saltus (magnetics and geodesy), G. Druivenga (radio echo-sounding and geodesy), and G. Merkel (geodesy).

Reference

Skinner, D.N.B., 1983. The Geology of Terra Nova Bay. <u>In</u>: <u>Antarctic Earth Science</u> (Oliver, R.L.; James, P.R.; and Jago, J.B.; eds.) Australian Academy of Science, Canberra, A.C.T.



Contour interval 5mgal

Figure 16. Relative Gravity observed on Browing Pass in the area indicated on Fig. 15.

Geophysical Surveys near the Priestley Glacier Field Camp

Gravity, magnetic and radio echo-sounding profiles were made near the Priestley Glacier camp, orthogonal to the Priestley Glacier; the profiles could not be extended beyond the moraine of the glacier due to crevasses. These surveys were done when planned surveys were not possible due to bad weather or because of unavailable helicopter support. A contact between schist and gabbro was observed in a spur near the camp, and the aim of the profiles was to detect the continuation of the contact beneath the ice. However, since no significant variations in any of the measurements were observed, it was concluded that the contact probably occurred beneath the glacier.

Measured ice thicknesses were about 700-800 m.

Acknowledgement

Other workers involved in this profile were G. Delisle (magnetics), R. Thierbach (radio echo-sounding), and H. Geipel (geodesy).

Geophysical SUrveys of the Campbell Glacier near the Mt Queensland Field Camp

Introduction

Geophysical surveys of the Campbell Glacier were carried out with radio echo-sounding (RES) and active audio magneto-telluric (AAMT) methods in order to detect ice thickness and structure, and to obtain information of the resistivity of the ice and underlying rock.

This work was planned subsequent to problems which made the original plans unfeasible. The RES equipment was originally to be used in the airborne surveys, but after the Dornier aircraft "Polar 2" was damaged on 16 December, the equipment was salvaged and adapted for ground-based surveys. The AAMT work was originally planned as part of helicopter-supported ground-check group to be based near the polar plateau, but it was found that the temperatures near the plateau were too low for the operation of the instruments and that the equipment was too bulky and heavy to be moved easily by helicopter.

Figure 15 shows the area covered by the survey.

RES Surveys

Method

This method used high frequency signals which are reflected off the ice/rock interface. The data is stored on a video cassette and can be replayed through a printer to obtain an immediate visual record.

The layout of the equipment is similar to that used in seismic surveying. A block diagram of the instrumentation is shown in Figure 17 . The transmitter and receiver were mounted on sledges and the sampler-scope and the recording section were situated on a skidoo which was used to tow the sledges. Figure 18 is a plan view of the whole unit. The skidoo was usually driven at a constant speed of 10 kmph and the signals were received at a rate of 4 per second. This gave a good single fold coverage of any reflector. Experiments were made using damped and undamped antennae to determine the best transmitter-receiver separation. All antennae were dipoles which varied in wavelength from 8-16 m.

Common midpoint profiles were also carried out. This method, described below, allows the records to be stacked and thus provides an enhanced signal-to-noise ratio.

For these surveys, the transmitter and receiver were placed 10 m on either side of a point of interest, and then moved away from the midpoint in 5 m intervals. A two minute sweep was recorded at each interval, as well as a single pulse. The maximum separation from the midpoint was 95 m.

Results

The high resolution antennae picked up many reflecting layers within the ice but were unable to find the ice/rock interface (Figure 19 shows a photograph of a high resolution record). Crevasses produced diffraction patterns in the upper part of the record which masked some of the layers. This was only a problem in the first 4 kilometres of the A-A' profile. Beyond this, we could see down to about 7 microseconds (two-way travel-time) or approximately 600 m. The base was not visible.

On the Mt Melbourne side of the A-A' profile, the base appeared as a strong reflection, at a depth of about 1100 m and rose rapidly to the order of 10 m on the A-A' profile. Using undamped antennae we were able to penetrate down to 1200 m. We found that the base was only visible continuously near the edges of the glacier. An example of an undamped record is seen in Figure 20.

A change in the nature of the reflector at 800 m is indicated by the quality of the reflections which was excellent above that depth and poor below.

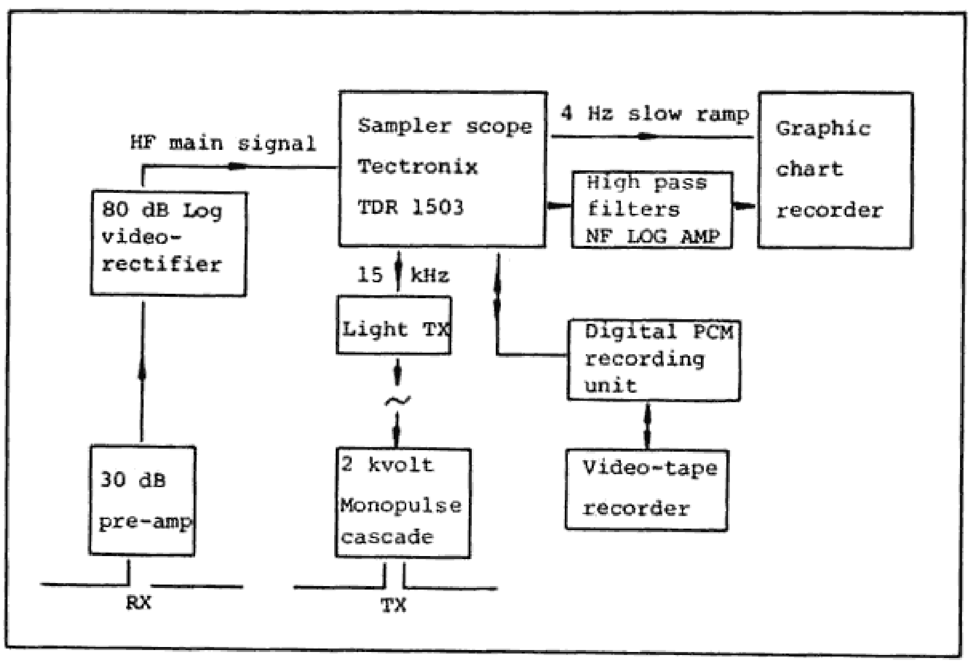


Figure 17. Block diagram of R.E.S. equipment.

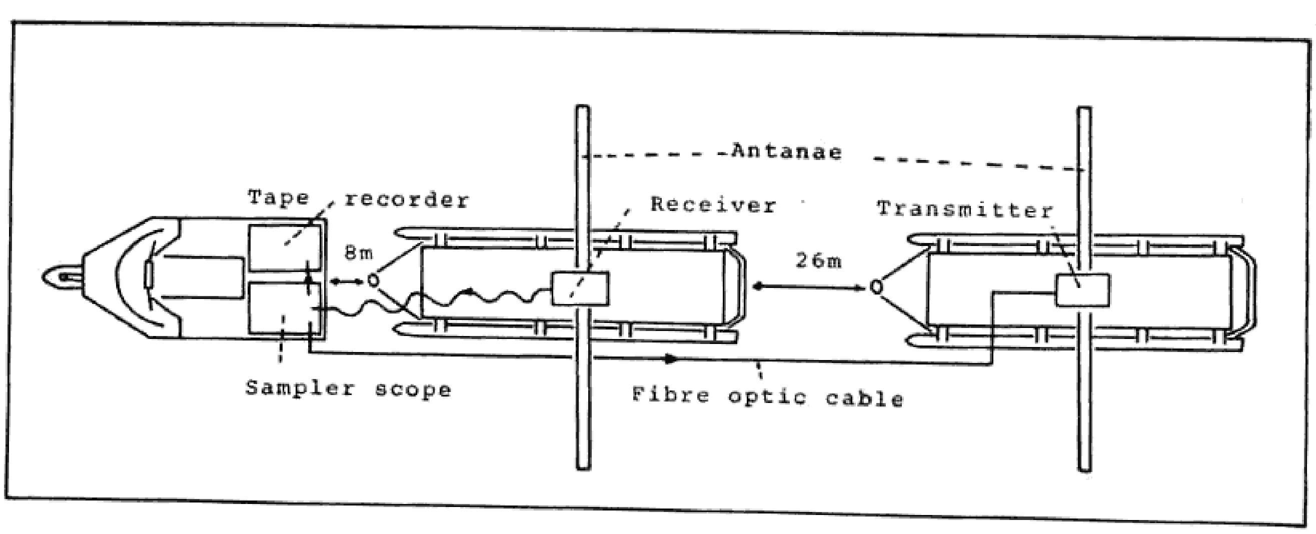


Figure 18. Plan view of the R.E.S. equipment mounted on skidoo and sledges.

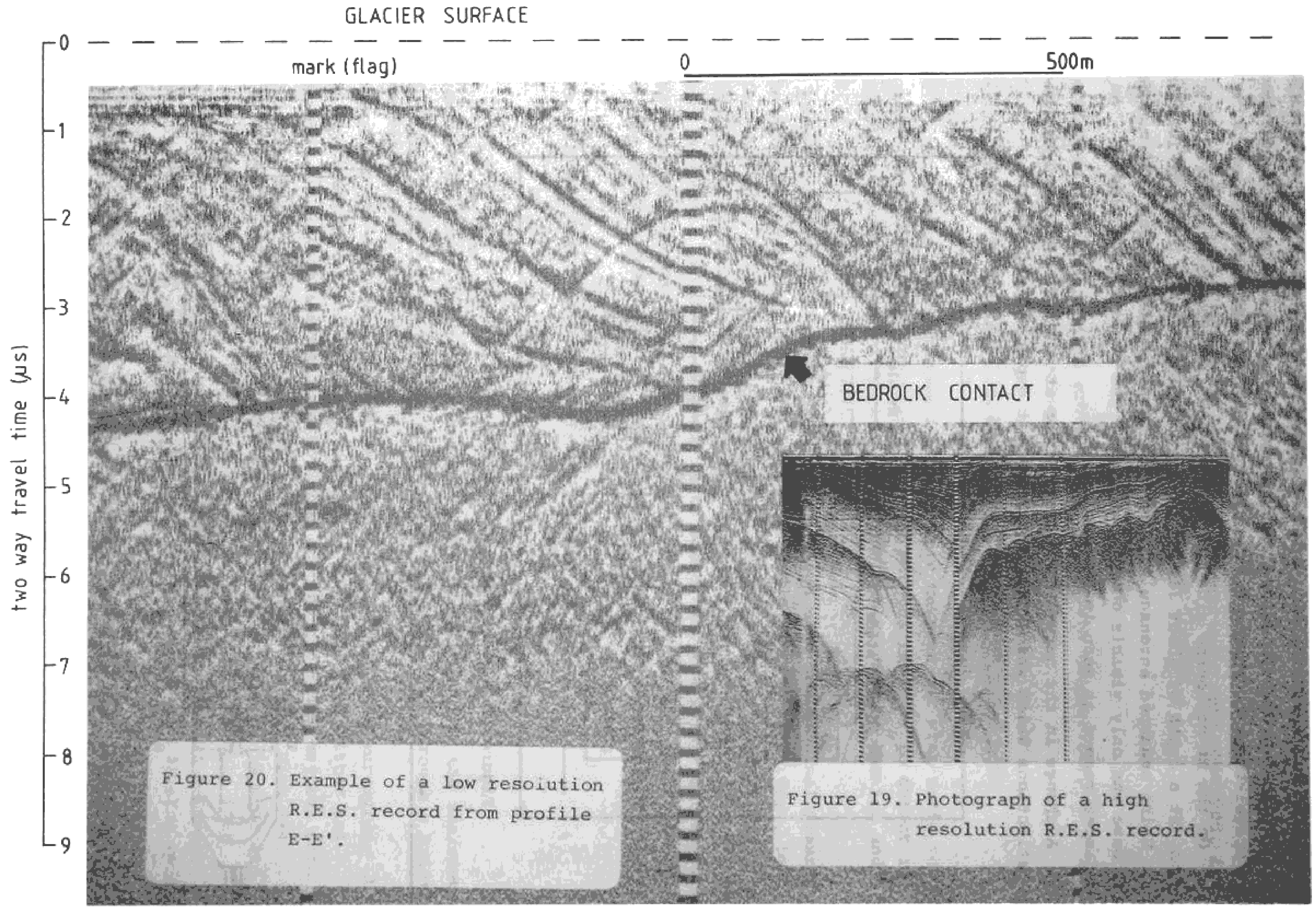


Figure 20. Example of a low resolution R.E.S. record from profile E-E'.

Figure 19. Photograph of a high resolution R.E.S. record.

AAMT Surveys

Method

The AAMT method involves the generation of a magnetic field directed into the earth, using a large transmitter loop. The signal is initiated at low frequency (10 Hz) and is increased in steps to a maximum of 8000 Hz; the low frequency signal is able to penetrate to greater depths than the higher frequency signals. A block diagram of the transmitter is shown in Figure 21 .

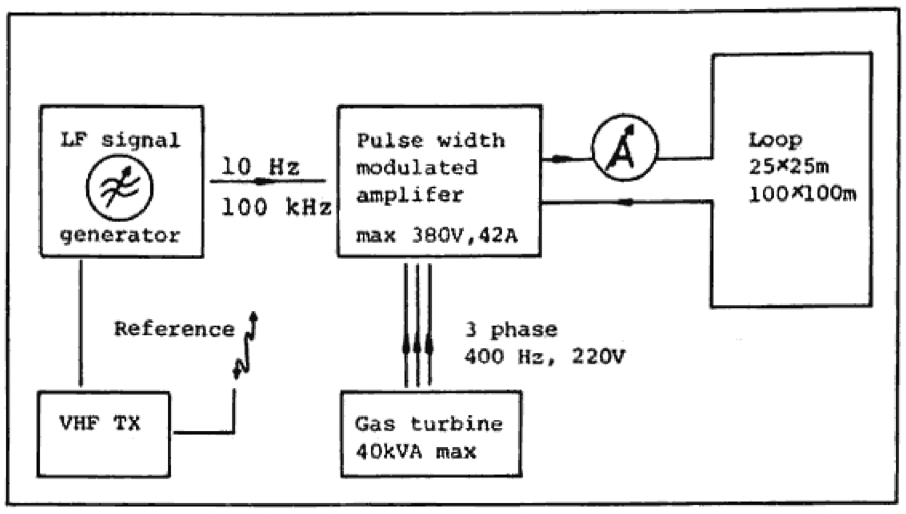


Figure 21. Block diagram of the A.A.M.T. transmitter.

The two receiving stations consisted of three induction magnetometers set along orthogonal axes. The phase and amplitude of the signal in the R, X, Z directions, relative to a reference signal was measured using an EG & G, BROOKDEAL ELECTRONIC, PRINCETON APPLIED RESEARCH 5206 two phase lock-in analyser. These were placed at distances from the transmitter loop determined by the skin depth.

It is possible to obtain a quick impression of the subsurface by comparing the amplitude of the H(Z) and H(R) components. The H(X) component should be very small if the magnetometer is directed correctly at the centre of the transmitting loop.

Results

This group ran into a series of problems. Firstly, some of the equipment failed due to low temperatures. The lock-in analysers required several hours of warming up to get them into their operating range of 10-40 °C. Eventually, they were discarded and the spectrum analyser was used. This reduced the number of receiving stations to one. The spectrum analyser turned out to be ideal because it enabled the recorder to see the full range of spectral lines over an interval of about 100 Hz. This meant that you could discern the signal from any noise or spurious signals. This was very convenient in the region of 50 Hz where we got a lot of interference from the power generators we were using. The disadvantage was that we lost all the information about the phase of the signal.

Secondly, the ice thickness was greater than had been anticipated. We found it difficult to locate the ice/rock boundary even at a distance of 2 km from the side of the glacier. We decided to abandon the A-A' profile and to experiment in an area where the RES indicated that the ice was less than 500 m deep. The transmitter was located at two different positions and an array of receiving stations was set up (see Figure 22).

A quick analysis of the data produced a graph of apparent resistivity versus depth. This graph corresponds to the subsurface at the midpoints between the transmitter and receiver.

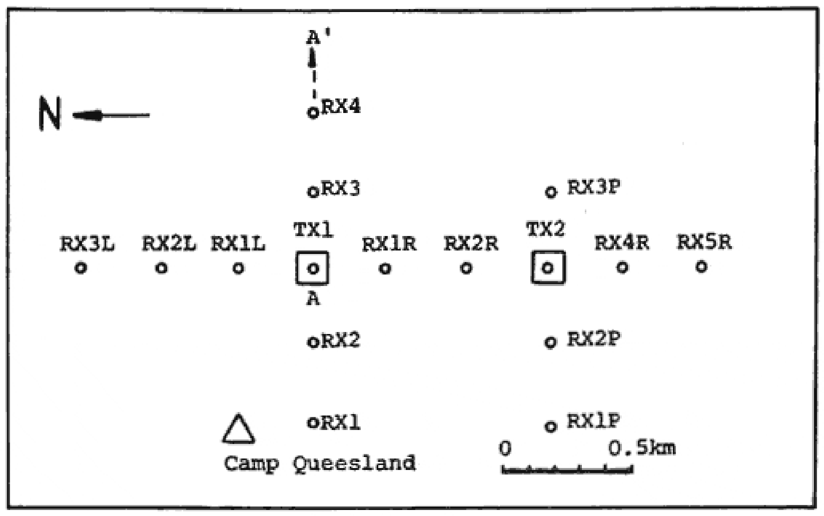


Figure 22. Location of A.A.M.T. stations.

We found that two main types of curve could be distinguished (see Figures 23 and 24). We ran into problems when we set up a receiver less than 400 m from the transmitting loop; this was corrected by using a small loop (25m x 25m) for close readings.

Curves similar to Figure 23 were found at Rx1, Rx2r when using Tx1 and at Rx2r, Rx4r, Rx1p, and Rx2p when using Tx2. These can be seen to tie around Tx2 and towards the edge of the glacier.

Curves like Figure 24 were found at Rx3r when using Tx1 and at Rx1r, Rx1l, Rx2l when using Tx2. There were grouped around Tx1.

All other stations produced data which was too scattered to interpret sensibly.

A model to produce the curve in Figure 23 would require a thin layer of low resistivity (about 100 m) at a depth of between 1000 m and 1500 m. This layer has the effect of displacing the curve to the left. This could be a water layer at the ice/rock contact. The ice appears to have a resistivity of about 10,000 - 20,000 m.

Figure 24 does not curve sharply to the left. Thus the low resistivity layer is missing and we have a two layer case. The resistivity of the ice is about 25,000 m and the rock is about 5,000 m. The resistivities correspond quite well to literature values. However, the depths indicated do not agree with those found using the RES method.

In addition to magneto-telluric sounding the AAMT group observed natural fluctuations in the magnetic field. Polaroid photographs were taken of the Spectrum analyser scope at regular intervals.

A Geo-electric sounding was also performed. This used the Schlumberger electrode configuration with the potential electrodes separated by 10m and the distance L (see Figure 25) varying from 20m to 600m. Figure 26 shows the resulting graph of apparent resistivity verses spacing L. The curve is a two layer case with a surface layer resistivity of 35,000 m. It is difficult to get any information about the underlying layer due to the high resistivity of the surface.

Acknowledgement

Other workers involved in these surveys were W. Giesel (Science Co-ordinator); H. Engelhardt and R. Lamers (RES); E. Blohm and F. Kuhnke (AAMT); G. Merkel (Surveyor).

Publications

The BGR will publish a collection of papers of the GANOVEX IV results in a volume. In addition, an aeromagnetic map will be published by the BGR and USGS, and it is intended that a summary of the salient findings of the expedition be published in the Journal of Geophysical Research.

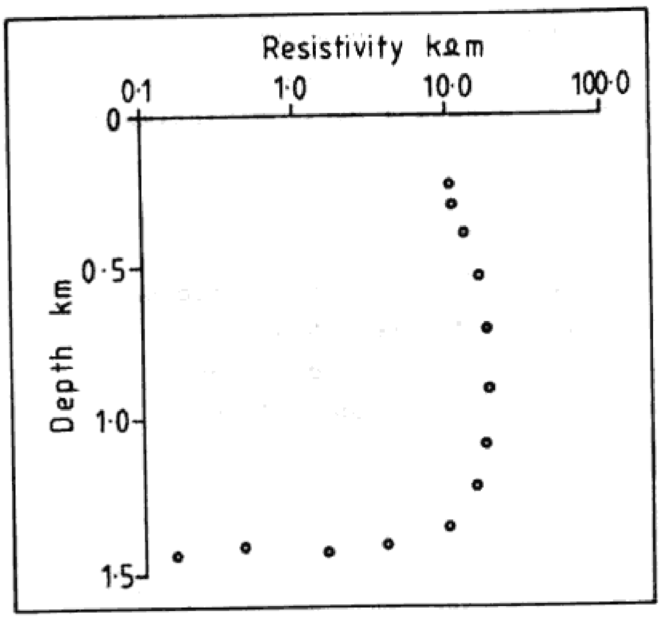


Figure 23. Results of A.A.M.T. sounding.

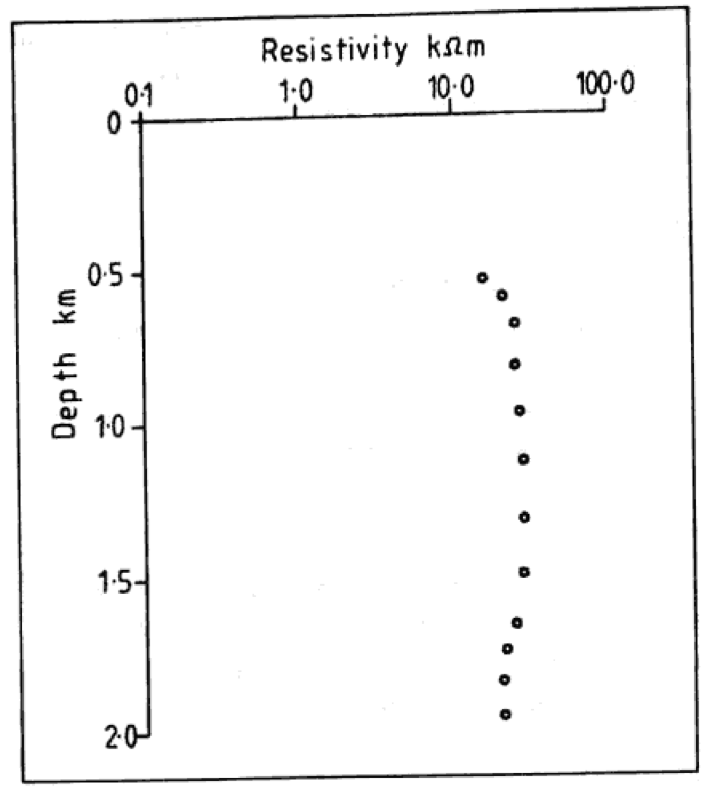


Figure 24. Results of A.A.M.T. sounding.

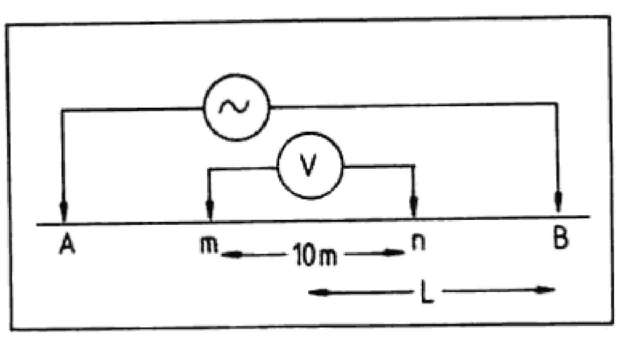


Figure 25. Schlumberger electrode configuration.

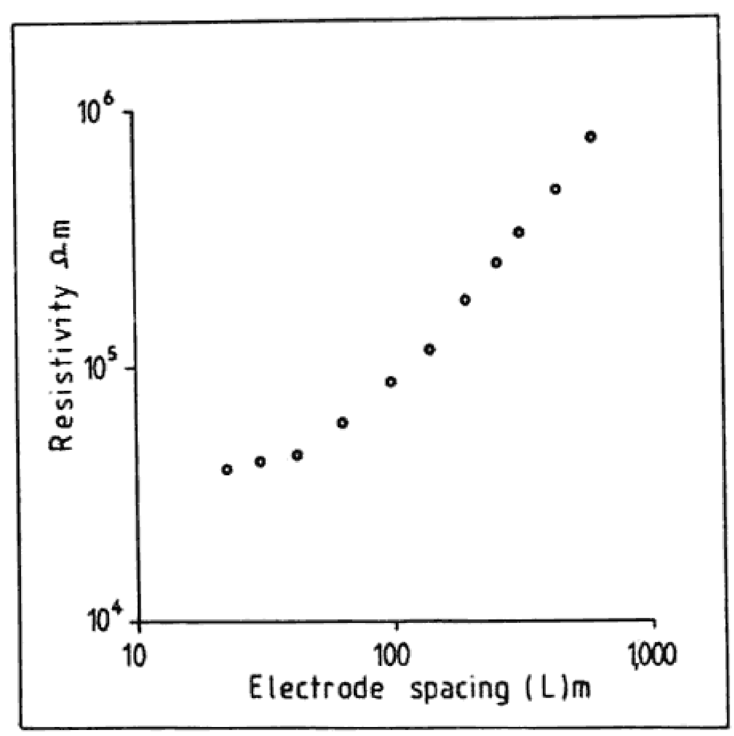


Figure 26. Graph of resistivity versus depth for geo-electric sounding.

Future Research

GANOVEX V, to occur in the 1986/87 season, is proposed to be a ship-based geological expedition of the Pacific Coast area of northern Victoria Land and is to include some further geophysical and geological work based at Gondwana Station, including studies of Mt Melbourne.

Management

The members of this event gained a great deal personally by having participated in the BGR programme and would encourage NZARP to participate in future GANOVEX expeditions as invited. However, from a scientific point of view, it would be more advantageous for NZARP to develop proposals with the BGR for joint or independent investigations associated with the aims of the expedition.

Acknowledgements

We are grateful to the expedition leader, H. Durbaum, and each member of the GANOVEX IV party for inviting us to participate in the programme and for providing logistical support, and the DSIR Antarctic Division for support through the different stages of this event. We thank P. Barrett, R. Dibble, and T. Stern who helped plan the event, and T. Hatherton for the use of a DSIR Geophysics Division Worden gravity meter and barometer. The assistance of G. Ball (Mountain Guide) and J. McConchie (Field Guide) is greatly appreciated. We acknowledge financial support from the Internal Research Committee of Victoria University of Wellington.

FIELD NOTES

CIROS - SCIENCE LOG - A.R. Pyne

AUGUST

Saturday 25 - Sunday 26

Reconnaissance to Butter Point (Saxby, Pyne, Macpherson).

Route: McMurdo Ice Shelf to tip of the shelf; cracks in sea ice off ice shelf did not require bridging for Snotrac 34. Cracks had not spread significantly since Saxby's reconnaissance of 18 August and had refrozen further. Widest crack approximately 1.5 m was crossed about 2 km west of ice shelf tip.

Good smooth ice to Strand Moraines except 3 km wide band of moderately rough ice near the moraines that stretches north past Butter Point. Smooth ice corridor inland of rough ice - good travel to Butter Point.

Butter Point Camp: Heavy snow, drifts as high as buildings on lee side (north). Occupied mess on Saturday night, checked most buildings before leaving Sunday.

Route: Similar route to before except tried to cut through rough ice band nearer north end of Strand Moraines. Not much improvement. Largest ice crack at ice shelf required bridging and had widened about 1 m since previous day. Return on ice shelf route.

Sunday 26

Microscopes: Checked and tested Scott Base stereo and polarising microscopes for use in the drill site science lab.

Tuesday 28

Sea ice route - Scott Base to McMurdo Ice Shelf Tip (Pyne, Macpherson, Stephenson, Brown, Ross).

Good ice route, small low broken ice patches (less than 0.5 m high) closest to McMurdo. Sea ice thickness to ice shelf varied from 32" - 33". Several cracks were mapped around the ice shelf tip. The large crack crossed on Butter Point recce (25-26 August) had grown to a constant width of 4-5 m. Return to Scott Base flagging a possible route. Thickness of ice at edge of large crack was 30".

Survival course for Barrett, Ashby, Ward, Wright, run by Saxby.

Thursday 30

Survival course for all other CIROS personnel run by Macpherson and Fry (Scott Base technician). (Postponed from Wednesday). Overnight, included shelter building, tent erection and elementary snowcraft.

Friday 31

Sea ice route and crack system at Ice Shelf Tip (Barrett, Gupwell, Vardy, Saxby).

Check of crack system showed that the largest crack had closed at the dogleg with two possible crossing sites. The smaller cracks near the ice shelf, however, would be more difficult for the D4. The crack off McMurdo could be bridged with snow.

Sunday September 2

Sea ice route (Barrett, Griffith, Topping, Macpherson, Stephenson).

Cracks at the ice shelf were continuing to freeze up and close. The ice shelf route can be used so that only the McMurdo crack and Barrett's crack need be crossed. The D4 therefore should be able to go to Butter Point.

August 27 - September 2

Science personnel at Scott Base unpacked science cargo and began checking, testing and modification of equipment for the drill site science lab.

All science cargo arrived on the Winfly flights with the exception of the Helium gas and regulator ordered by Antarctic Division.

Surveying equipment checked and calculations begun for drill site surveying.

Analysis of MSSTS core logs begun by Barrett for comparison with CIROS, etc.

Science personnel assisted with other preparation for CIROS at Scott Base.

Monday 3

Preparation of equipment for advance party to Butter Point.

Tuesday 4

Advance party (Pyne, Stephenson, Neale, Miller, Hoburn) left for Butter Point with Snotrac 34 and toboggans 39, 45. Fuel problems with 39 which was left at the ice shelf to be returned to Scott Base.

Poor visibility and weather, partly cleared near Strand Moraines. Dropped track (Snotrac 34) about 1600 and decided to camp 3 km from moraines.

D4 left Scott with cargo, escort Dodge. Left D4 and cargo on ice shelf returned Dodge and personnel to Scott for night.

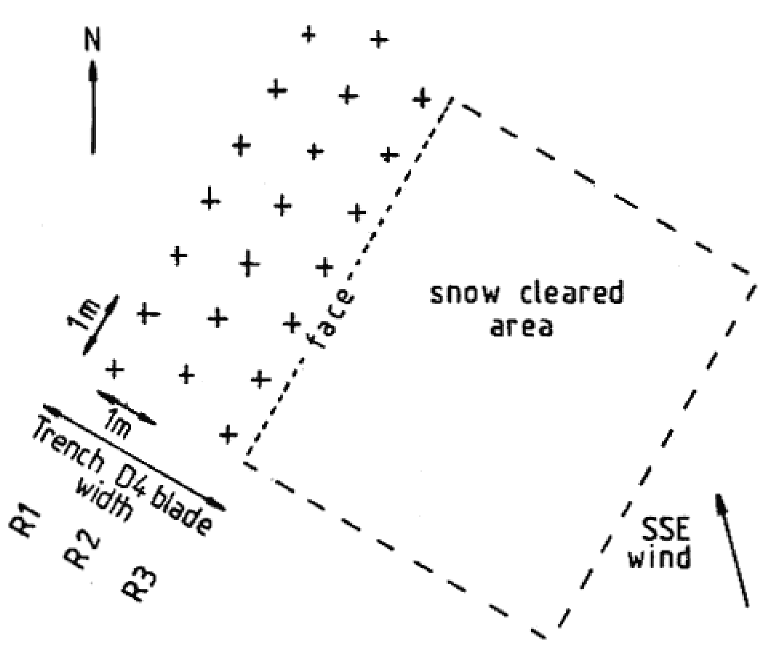
Wednesday 5

Advance party continue to Butter Point arrive at 1430. Generator running by 1630. D4 arrive at Butter Point about 2000 hrs escort by Dodge. D4 and Dodge remain on sea ice for night. Access onto Butter Point requires work with snow bridge over tide crack.

Friday 7

Building access ramp onto Butter Point. Large sea ice block at access on glacier required blasting. Slab 3 m x 2 m x 1-1.5 m thick.

Ice Quarry south of camp blasted by Pyne and Wright. Snow 0.5-0.7 m deep cleared of ice and trench blasted for D4 to clear and expose a working face.



Rows 1&3; 5'-2" holes
2 sticks at bottom

Row 2; 5'-2" holes
3 sticks at bottom

Ice strongly shattered after blast, easily removed with D4. Future blasting for ice blocks try 5' holes with ½ stick at bottom, single row, holes about 1 m apart. For future quarries the trench should be aligned parallel to the SSE wind direction for easier clearing of snow drifts by the D4.

Saturday 8

Dug out Science Lab for inspection at Butter Point.

Sunday 9

Drill site survey (Pyne, Neale) using Hilux 48 in poor weather conditions. Surveyed 8 km from drill site before trigs became clouded. Trig Herb beacon appears to have blown over.

September 3 - September 9

Science personnel at Scott Base continued working on science equipment.

Personnel at Butter Point assisted with camp facilities.

Monday 10

Poor weather, but attempted to continue drill site location with Dodge, however, bad fuel (Mogas) at Butter Point meant did not get away from camp.

Friday 14

Attempt to climb Trig Herb to re-erect survey beacon for drill site surveying. Snotrac 34 (Macpherson, Pilcher, McLennan) could not get to the foot of Herb on the Bowers Piedmont Glacier. Stuck in small crevasse, rescued by Pyne, Neale on IH500 tractor.

Thursday 13

Located drill site approximately 500 m west of SP 130 position. Large flat ice area - ice thickness 3'11". Precise location needs Trig Herb beacon.

Saturday 15

Reset old USGS survey mark on Herb. Drum beacon blown off. (Macpherson, Neale, Pilcher, McLennan). Climbed up Herb in 3 hours from sea ice.

Sunday 16

Resurvey drill site area. (Pyne, Neale, Wright). Area found on 13th looks to be the best position of a large flat ice area.

Attempt to survey ice edge not completed because of rough ice further east. Ice edge estimated 5-8 km east of drill site area. Breakout could be easily seen from Herb and is seaward (1-2 km) of DVDP 15 berg and is estimated to be 12 km east of Bowers Piedmont (half way between Butter Point and Strand Moraines).

10-16

Science personnel assisted around camp. Geology trip to Explorers Cove in New Harbour lead by Barrett on 16th.

Monday 17

Erected prism set on C. Bernacchi for sea ice movement (Neale, Wright). Pyne, Macpherson continued to Marble Point in Hilux 48. Good sea ice close to shore and good ice conditions past Gneiss Point for Cape Roberts work.

Tuesday 18

Prism set erected on flank of Coleman (Neale, Wright, Ashby).

Macpherson began preparation for Cape Roberts work.

Wednesday 19

Prism set on Barnes (Neale, Vardy, Barrett, Ross). Sediment collected from sea ice in New Harbour (Barrett, Ross).

Thursday 20

Drill moved east approximately 200 to 60 m x 40 m ice slab - overthickened 5'5"+.

Set out ice deflection survey for drill site (Neale, Pyne).

Started moving Drill site building with D4.

Friday 21

Survey: Resection of Mess Hutt at Butter Point Camp. Ice deformation levelling at drill site.

Setting up core saw and other equipment in Science Lab at Butter Point.

New motor installed in toboggans for Granite Harbour work.

Saturday 22

Moved survey hut to drill site and set up ice monitoring system. Erected final prism set on Trig Herb for ice monitoring.

Granite Harbour (Macpherson, Wright, Cooper) expedition left but returned after 15 km with broken steering shaft. (Shaft had been rewelded previously).

Shelving installed in Science Lab.

Sunday 23

Survey: Finishing heating system for Rangemaster at drill site.

Moved photography partition in Science Lab.

Picked up Barrett from Scott Base for Granite Harbour.

Monday 24

Granite Harbour expedition left Butter Point (eventually) after starting problems with toboggans.

Drill Site: Deformation survey of sea ice and tested distance measuring equipment.

Built heating parts for tide gauge installation for drill site.

Tuesday 25

Picked up microscope equipment from Scott Base (Pyne, Ashby). Sea ice movement monitoring postponed.

Wednesday 26

Began wiring up Science dry lab. Ward assisting Hoburn.

Started installing tide gauge at Drill Site. Water depth @ 1815 hrs = 196.2 m.

Thursday 27

Completed wiring of Science Labs - now ready for transport and installation at the Drill site.

Granite Harbour return. Sediment traps installed in mid Harbour. Surveying not established because of toboggan unreliability.

Friday 28

Surveying not possible because wheeled vehicles returning to Scott Base in morning. Afternoon snow.

Blasted ice quarry in morning.

Saturday 29

Assisted wiring of CIROS 1 drill site.

Located prism with 2 survey parties @ Herb; and Bernacchi and Coleman with co-ordination with surveyor at drill site. System worked well. First movement monitoring begun today.

Sunday 30

Set up tide gauge at CIROS I. Sea ice monitoring measurements and levelling at Drill site.

Monday, 1 October

Insulating photography area of Science hut. Loaded 1 hut for move to drill site in afternoon (approximately 1600). Sea ice monitoring measurements.

Tuesday 2 October

Second Science hut moved to drill site and began setting up equipment. Sea ice monitoring measurements.

Wednesday 3

Moved fragile science equipment to drill site and continued setting up Science Lab.

Resection surveying at drill site.

Started generator.

Levelling to connect new mark near mud hut with original deformation network at CIROS 1.

Thursday 4

Meeting at Scott Base - to abandon CIROS 1 site and relocate at CIROS 2. Intending to continue monitoring at CIROS 1 for as long as possible.

Friday 5

Began packing equipment and readying Science lab for move to CIROS 2 site.

Located CIROS 2 site and set out CIROS 2 ice deformation network. Strong winds approximately 40 knots from west - network not completed or levelled.

Monitoring at CIROS 1 site.

Retrieved tide gauge from C1 site.

Saturday 6

Completed CIROS 2 deformation network and levelled before site is loaded.

Macpherson and party - preparation for 2nd Cape Roberts trip (Sunday?)

Completed packing of equipment, etc. for move from CIROS 1 to CIROS 2.

Sunday 7

Loaded Science buildings and equipment at C1 site for move to C2. Loading not completed because of high winds at C1 in the evening.

Monday 8

Rangemaster measurements (sea ice movement) at C1.

Tuesday 9

Measured water depth at C2. (209.5 m water level at 1100 hrs).

Science huts moved to C2 and began setting up in late afternoon.

Rangemaster measurements and resection at C1 site.

Wednesday 10

Continued setting up science equipment at C2.

Levelling at C2 and established new level mark.

Thursday 11

Continued with setting up science equipment at C2.

New level marks installed at C2.

Made beacons for New Harbour on shore survey stations.

Rangemaster measurements at C1.

Friday 12

Reducing and plotting sea ice movement and levelling data.

Continued setting up at C2 and installed tide gauge.

Saturday 13

Started science shift work at C2.

Levelling at C1.

Sunday 14

Coring began, 0.98 m of wash sand retrieved from within HW casing.

Rangemaster measurements at C1 (last set).

Monday 15

API casing - floats retrieved because of drilling problems.

Retrieved prisms from NH1, NH2 sites.

Tuesday 16

Retrieved prisms from C. Bernacchi prism site.

Wednesday 17

API casing - floats are lowered again.

Thursday 18

Core retrieved 0.91 m soft sand-mud, but drilling again in difficulty.

Levelling at C2. Ice thickness at original C1 site now 5'1".

Friday 19

Drill string stuck - due to bend in casing. No geologist night shift.

Saturday 20

API casing being retrieved.

Prisms from Coleman (last set) retrieved.

Sunday 21

Events K052, K191 brought out to Butter Point. Pick up K041 Snotrac 34 and proceed to Granite Harbour with K042 (Macpherson, Ashby, Vincent). Stop at Spike Cape en route for K052.

Monday 22

Checking K042 Scientific equipment.

Levelling survey at C2 drill site.

Tuesday 23

Herbie - crew stuck at the drill site.

- Granite Harbour party confined to Cape Roberts camp.

Wednesday 24

Thursday 25

Dr. Komura to BP with equipment.

Friday 26

Survey of proposed USGS drill site in Wright Valley (Barrett, Griffith).

Erect drum beacons on trig Herb for New Harbour suveying (Haanen, McLennan, Wright).

Granite Harbour party (K042 and K191) return to Butter Point. Survey of Mackay Glacier Tongue and Cape Roberts sea ice movement survey for CIROS.

Dr. Komura began setting up gas chromatograph at Drill site.

Core recovered from				Log sheet #	Described
	6.89	to	8.77	2	✓

Saturday 27

Control points on northern shore of New Harbour surveyed and mast beacons erected (NH2 - Mt Barnes rock, NH6 - C. Bernacchi).

Sunday 28

Ward, Vincent, Macpherson assisting Dunbar (USARP) with the installation of sediment traps in New Harbour.

Core recovered				Log sheet #	Described
	12.14	to	13.06	4	✓
	13.20		13.49	5	✓
	16.20		16.69	6	✓
	20.0		20.77	7	✓
				8	✓

Survey of control points continued.
(NH4 - Hjorth, NH5 - Hjorth-Bern, DVDP 10).

Monday 29

Core recovered				Log sheet #	Described
	27.97	to	28.21	9	✓
	28.55		29.17	10	✓

Survey control continued to southern New Harbour (NH1, NH2, F2). CIROS 2 grid levelled.

Tuesday 30

Survey handover Neale - Haanen (reports, computations, data, software, equipment). New Harbour control calculations. Neale depart for SB and NZ.

Wednesday 31

Surveying C. Roberts - Granite Harbour for CIROS associated with K042 until Nov. 4.

Thursday 1 November

Core recovered				Log sheet #	Described
	31.41	to	31.53	11	✓
	31.53		32.17	12	✓
	32.64		34.42	13	✓
	34.47		35.04	14	✓
	37.13		38.19	15	✓

Friday 2

Core recovered				Log sheet #	Described
	39.43	to	39.72	16	✓
	39.72		40.64	17	✓
	40.80		41.86	18	✓
	42.05		42.64	19	✓
	43.6		45.59	20	✓
	46.99		47.28	21	✓
	47.43		47.8	22	✓

Saturday 3

Core recovered				Log sheet #	Described
	49.00	to	49.69	23	✓
	49.7		51.11	24	✓

Sunday 4

Core recovered			Log sheet #	Described
53.15	to	54.40	25	✓
57.75		55.10	26	✓
55.10		55.8	27	✓
56.6		56.83	27	✓
57.6		58.95	28	✓
59.06		61.36	29	✓
61.45		64.54	30	✓
64.59		65.82	31	✓
67.46		68.53	32	✓
68.74		69.83	33	✓
69.83		69.93	34	✓

Monday 5

Core recovered			Log sheet #	Described
70.06	to	72.26	35	✓
72.18		73.64	36	✓
73.64		76.19	37	✓
76.19		79.02	38	✓
79.05		81.44	39	✓
81.54		83.01	40	✓

Surveying. New drum beacon built. Inner control of southern New Harbour completed (NH1, F2, F3) and beacons left. Position of CIROS 2 co-ordinated. Topographical survey of drill site.

Tuesday 6

Core recovered			Log sheet #	Described
82.99	to	86.11	41	✓
89.16		92.11	42	✓
92.11		94.40	43	✓
95.60		97.13	44	✓
97.13		98.83	45	✓

Topographical survey of Butter Point Camp. Position of CIROS 1 checked by resection to monitor movement. Ice thickness at CIROS 1 checked.

Wednesday 7

Core recovered			Log sheet #	Described
98.87	to	101.40	46	✓
101.4		104.43	47	✓
104.4		107.49	48	✓
107.52		110.64	49	✓
110.84		113.25	50	✓
115.9		116.41	51	✓
116.41		116.88	52	✓
117.7		118.5	53	✓
119.47		122.54	54	✓
122.58		125.67	55	✓
125.90		128.87	56	✓
128.87		131.84	57	✓
131.84		134.92	58	✓

Surveying Grid at CIROS 2 relevelled.

Thursday 8

Core recovered			Log sheet #	Described
	134.91 to	138.0	59	✓
	138.12	141.05	60	✓
	143.04	144.12	61	✓
	146.71	147.4	62	✓
	147.72	150.34	63	✓
	150.34	153.47	64	✓
	153.52	156.61	65	✓
	156.67	159.74	66	✓
	159.74	162.71	67	✓
	169.73	165.76	68	✓
	165.76	167.54	69	✓
	167.59	168.09	70	✓

Planned helo work on Mt Marston cancelled. Calculations of New Harbour control station co-ordinates. Travelled with Stephenson to SB for mud.

Friday 9

Vehicle caught in blizzard, spent day at SB researching old survey reports - data.

Storm damage at Drill site - coring discontinued.

Saturday 10

Damage assessment at CIROS 2 site.

NQ rods in hole - checked and found tube or overshot could not pass bend at (or near) sea floor. Logging within casing therefore impossible. Decision to begin recovering all drill rod - casing at CIROS 2.

Sunday 11

Begin clean up operation and recovery at CIROS 2.

K042 (Macpherson, Vincent, Cooper) leave for Granite Harbour to set sediment traps. Return 15 November.

Pyne, Stephenson, Griffith to SB to discuss recovery and pull out operation.

Monday 12

Recovery operation CIROS 2 continued.

CIROS 2 site resurveyed for movement (resection).

No significant movement. Levelled deflection grid.

Tuesday 13

Recovery operation continued.

Science Log ends.

GRANITE HARBOUR SEDIMENT STUDIES (K042)

Narrative:

Macpherson arrived at Scott Base 22 August and worked within the CIROS programme until 19 November. During the period at Scott Base, all field equipment was assembled and transported to Butter Point utilising CIROS cargo trains. Thanks to Eric Saxby, field equipment had already been allocated thus saving considerable time.

The first trip from Butter Point to Granite Harbour was from 24 September to 27 September. This was attempted in temperatures of around -35°C with constant 10-20 knot southerlies. Macpherson, Barrett and Wright departed Butter Point 24 September, after spending two days preparing the snowtric toboggans to run without carburettor fouling and icing at Butter Point. The copper fuel line broke on SM039 on the tank and the party was forced to camp for the night off the Debenham Glacier. After spending three hours the following morning getting the two machines running (including preheating the carburettors and diaphragm pumps using a makeshift alcohol burner), the party continued to Cape Roberts where the vehicles were checked over. Ice thickness/crack width measurements were observed off Cape Roberts. A triple sediment trap was deployed in mid Harbour on 26 September and the party returned to Butter Point on 27 September in extremely cold conditions. SM045 was only able to be driven in first gear due to recurring gearbox problems which were said to have been corrected at Scott Base prior to field work.

From 28 September to 21 October, Macpherson worked with CIROS personnel from Butter Point. A trip to Granite Harbour was planned for 6 to 10 October, but makeshift repairs to the gearbox of SM045 which eventually proved futile and a broken steering shaft, made it necessary to replace that vehicle with another from Scott Base.

Simon Vincent arrived Scott Base on 7 October and spent several days organising field equipment for K043 and assisting K076 with survival courses, before travelling to Butter Point on 17 October.

Macpherson, Vincent and Ashby departed Butter Point 21 October in conjunction with K191 and K052 who were travelling by Snowtrac. K052 were dropped off at Spike Cape and this party continued to Cape Roberts later that day, experiencing only minor problems with vehicles.

On October 22, the party including K191, initiated the offshore Survey Network (CIROS) utilising two Snotric toboggans. Four sites were surveyed over a 45 km circuit SE of Cape Roberts. Mechanical problems experienced are detailed in vehicle appendices.

23 October was lost due to poor weather and the complete party travelled to Cuff Cape (the grounding line of the Mackay Glacier) on 24 October using the Snowtrac of K191. The two easternmost poles of the Mackay Glacier network were resurveyed that day and the remaining poles above the grounding line resurveyed the following day. The party returned to Cape Roberts on 26 October and on to Butter Point the following day.

On 31 October, Vincent, Manson, Belgrave and Haanen travelled to Cape Roberts with SM039 and SM046. (Macpherson was fully engaged with CIROS). The party spent 1 November completing the second CIROS offshore survey, suffering a broken steering shaft on SM039 10 km from Cape Roberts, necessitating their return to Cape Roberts with the vehicles hitched in tandem. Vincent stripped SM039 on 2 November and then assisted K191 with a topographic survey of Cape Roberts. Macpherson and Wright spent 3 November assisting Sierra 216 in the Granite Harbour area and were able to drop replacement steering shaft and fuel to Cape Roberts. K191 departed Cape Roberts for Tripp Bay whilst Vincent and Haanen returned to Butter Point experiencing major variator problems on SM039 and having to tow all gear (2 sledges) behind SM047.

Pillans arrived Scott Base 4 November and was immediately sent to Butter Point where he underwent survival training by Vincent.

Vincent returned to Scott Base on 7 November with SM039 where he engineered a solid steering shaft and swapped SM039 for SM047, returning to Butter Point 9 November.

Macpherson, Vincent and Cooper (CIROS driller) departed Butter Point 11 November and travelled to Cape Roberts without any major mechanical problems. However, upon setting out to deploy sediment traps the following day, the duplex drive chain on SM046 broke and jammed the gearbox, chipping teeth from the drive sprocket in the process.

A set of sediment traps was installed in Avalanche Bay on 13 November and the following day, a further set was installed in Central Harbour. Spare parts for the gearbox arrived on 14 November and SM046 was repaired that day. The party returned to Butter Point the following day, in conjunction with K191 and K052, experiencing only minor mechanical problems. Vincent again returned to Scott Base on 16 November to effect repairs to broken machinery and to engineer a new set of sea ice keels for sledges (as described in Pyne, 1983). Macpherson joined him on 17 November whilst Pillans spent those days effecting repairs to the trailer and sledges.

Macpherson, Vincent and Pillans departed Butter Point in the company of K191 and travelled to Cape Roberts on 19 November, experiencing no mechanical breakdowns but SM046 was losing a lot of gearbox oil. The intention for the following day was to survey a transect along the Mackay Glacier tongue. However, this was abandoned as a result of low cloud and the day was spent at Cape Roberts preparing oceanographic equipment and replacing oil seals and drive shaft on SM046.

On 21 November, the combined parties travelled to Cuff Cape and began a survey of a transect line along the Mackay Glacier Tongue. However, travel proved impossible as a result of the badly crevassed nature of the tongue and the transect was abandoned in the interest of personal safety. The parties returned to Cape Roberts and spent the following day organising equipment and finishing repairs to toboggans.

Vincent and Belgrave completed offshore surveying on 23 November, allowing Macpherson, Pillans and Manson to begin oceanographic work in central Granite Harbour. An attempt to retrieve the earliest deployed sediment trap was not successful.

USARP event S216 arrived at Cape Roberts on 24 November, the day K191 departed for Scott Base. Pillans returned to Scott Base utilising S216 helo. The following three days were spent supporting S216 and beginning oceanographic work at sites close to Cape Roberts. S216 departed Cape Roberts on 27 November with Pillans returning to Granite Harbour on that date.

The period from 28 November to 10 December was spent at oceanographic sites within Granite Harbour. Vehicle breakdowns are listed in the Vehicle Summary. Apart from two nights at Cuff Cape (29 and 30 November), the work was executed during day trips from Cape Roberts. Belgrave arrived by helo on 5 December and was assisted by Vincent and Pillans in erecting a survey beacon on Mt Marston.

Vincent and Belgrave spent a ½ day on 7 December concluding the CIROS offshore surveying allowing Belgrave to depart for Scott Base by helo on 10 December. Macpherson, Pillans and Vincent returned to Butter Point on 10 December, experiencing major mechanical breakdown of SM046, 9 km from Butter Point. The vehicle was subsequently towed to Butter Point.

11 December was poor weather and was spent organising gear for retro to Scott Base by helo.

Macpherson, Vincent and Pillans returned to Scott Base by helo, with under-slung load on 12 December. Macpherson and Pillans depart for New Zealand on 14 December. Vincent assists K043 from that date on.

References

Pyne, Alex R. 1984. Victoria University of Wellington Antarctic Expedition 28. Immediate Report, 1983-84.

Vehicle Summary (refer Table 11):

1. Both allocated vehicles (SM039 and SM045) required approximately 1 day each of workshop time to become operational at beginning of season. These vehicles were then used occasionally to support CIROS sorties to the tip of the dirty ice and proved totally useless if allowed to stop and cool in the conditions experienced at that time of year. Grizzlys were operational at this time but were "not available" for this work.
2. The following listed breakdowns resulted in approximately 65 hours work (mostly for 2 people). This time was over and above that spent on regular maintenance (approximately 1 hour/day for 1 person). Therefore, a total of approximately 170 man hours were spent on vehicle repairs/maintenance. The quality of the science suffered as a result.
3. K042 also used these vehicles to support K052; K181; K191 and S216. Breakdowns flagged thus "*" in the following table occurred during work carried out for CIROS and not for K042.
4. The allocated vehicles were old and possibly past their expected working life. SM039 was seven seasons old. SM045, 046 and 047 were four seasons old.
5. Mileage covered was as follows:

SM039	625 km
SM045	280 km
SM046	1375 km
SM047	1075 km
	3355 km

6. Vehicles were left at Butter Point for retro to Scott Base at the OIC's convenience. The engine on SM046 stopped 9 km from Butter Point at the end of the programme. The engine was burning considerable oil, but still contained oil at the time of breakdown. Apart from the engine on SM046, they were both performing well and would be fine for local use from Scott Base. They are not suitable for extended field seasons.
7. At Winfly, SM045 was found to have a slipping gear change mechanism, the result of worn selector forks for which there was no spares held at Scott Base. The machine was overhauled at Scott Base prior to being assigned to K042 but was eventually returned to Scott Base because of this recurring gearbox problem.

Field Equipment:

Tents: All tents allocated to K042 this season were in a good state of repair and gave no problems. The "New Horizon Dome" again proved very successul in all conditions encountered and is pleasant to live in due to its increased light transmitting capabilities.

Sledges: Tamworth sledges were again used this summer and cracked runners replaced on the oldest mid season. At this stage we interchanged several parts of sledges and fitted two new runners. These sledges are primarily used on the sea ice, and permanent keels were set in the new runners. This proved very successful in stopping "fishtailing" and does not weaken the runner at all as no wood is removed. They are a vast improvement on the traditional "snow keels" for sea ice work.

Wannigan: The "VUWAE Wannigan" at Cape Roberts was used extensively as a base for all Granite Harbour work this summer. It remains in good condition and appears reasonably protected from the sea and winds. The following equipment is left in the Wannigan:

Foodboxes	4 (without perishables) Antarctic Division
Canned fruit	12 boysenberries
Flour	2 bags wholemeal
Breadmaking ingredients	- assorted
Water filtering equipment	
Kerosene	16 gallons
DFA	132 gallons
Isopropyl alcohol (VUW)	1 gallon
Mogas	12 gallons
Synarctic oil	¼ gallon
Depthline (VUW)	400 m on winder
Ice tongs (VUW)	2 pair
Beacon boards (VUW)	6 sets

In addition, basic utensils (VUW) have been left, as have emergency first aid, etc.

Garbage Disposal:

All garbage was returned either to the CIROS camp at Butter Point or to Scott Base. Human waste was returned to CIROS camp where it was deposited in the latrines.

Communications:

Two 24 volt compak radios were supplied for K042. They functioned well except in the early season when fully charged batteries became flat after two days travel (no use) at temperatures of approximately -35°C. Other minor problems were sticking handsets and blown fuses. No replacement fuses were included in the sets. Fortunately, we were able to use K191 radios until we could be resupplied.

Two Tait hand-held VHF transceivers were also allocated to K042 for early season work and surveying. These proved very successful and much more versatile than the RCA sets in use at CIROS. A report has been supplied to G. Varcoe on these Tait radios in November 1984.

Recommendations:

1. The stocking of Antarctic Division food boxes needs reviewing. An event would have to be parsimonious with many items for one box to last the stated "20 days". Alternatively, many items are oversupplied, e.g. it is now possible to purchase sugar in 500 gm packs, an adequate quantity for 20 man days; this quantity would be one sixth of that presently supplied.
2. For field events not involved in the Dry Valley region, the choice of fresh/frozen meat and vegetables instead of "dehy" should be available. Sea ice events have fewer weight restrictions and could easily utilise frozen foods. This would be a cheaper alternative for Antarctic Division.
3. P.V.C. groundsheets would be advantageous for parties camping for prolonged periods on sea ice, as bedding would be isolated from the damp.

Table 11. Vehicle maintenance summary - K042.

DATE	VEHICLE	PROBLEM	REMEDY	TIME TO FIX
24/9	039	Carb and Diaphram pump icing up	Clean jets and de-ice with alcohol burner	2 hours
	039	Broken fuel line immediately above petrol tank	Install gravity feed tank strapped to engine cowling	2 hours
27/9	045	Not engaging in first gear as selector forks worn	Exchange with new machine after brazing at CIROS Camp proved unsuccessful	6 hours
21/10	039	Lost allen bolt from bogey assembly	Replace and repair assembly	0.5 hour
22/10	039*	Threw bogey assembly	Repair and replace	0.5 hour
	*	Spun track off trailing axle	Repair and replace. Adjust tension.	1 hour
	046*	Loose bolts on steering ski and broken steering ski chain	Tighten bolts, drill ski and install new bolts	1 hour
27/10	039	Broken bogey assembly	Replace	0.25 hour
	045	Carb fell off	Replace, after making and fitting new gaskets	1 hour
28/10	039	Maintenance	Change clutch; remove gravity tank; check over; oil change	2.5 hours
	045	Maintenance	Change variator belt; check over; oil change	2.5 hours
1/11 and 2/11	039*	Broken steering shaft	Return to Cape Roberts in tandem; strip old shaft and replace	4 hours
3/11	039*	Variator slipping (not belt!)	Tow all gear behind 046	
7/11	039		Replaced with 047 at suggestion of OIC. Engineered solid steering shaft; check over 047	8 hours
10/11	046		Install solid steering shaft	2 hours
12/11	046	Sheared master link in duplex drive chain; chipped gear drives	Strip gear box	3 hours
14/11	046		Rebuild gearbox and check over	4 hours
15/11	046	Broke solid steering shaft at weld	Replace with spare shaft	1 hour
	047	Steering shaft/ski bolt sheared	Replace	0.25 hour
16/11			Repair steering shaft at Scott Base	4 hours
	046 and 047		Oil change, etc.	4 hours
20/11	046	Leaking oil from drive shaft	Gearbox and drive shaft stripped and oil seals replaced	4 hours
24/11	047*	Broken exhaust pipe	Repair with tin cans and wire	1 hour
26/11	046 and 047		Maintenance and oil changes	2 hours
3/12	046	Carburettor problems	No needle value spring so replaced	1 hour
	047	Trailing axle bearing siezed		
4/12	047		Repaired trailing axle	1 hour
	046	Broke steering leaf spring set		
	046 and 047		Maintenance; oil changes	2 hours
5/12	046		Repaired ski leaf springs	2 hours
10/12	046	Motor stops	Towed to Butter Point	3 hours
				65.5 hours

ADDENDUM TO 1984 IMMEDIATE REPORT

GRIZZLY DELUXE MOTOR TOBOGGAN

The Grizzly motor toboggan used by K5 during the 1983-84 field season has been extensively reported on by Pyne (1984). However, after speaking to various Antarctic Division staff over the past year, we feel it is necessary to add a few points:

1. Variator belts:

As reported in Pyne (1984), the variator belt was changed twice (at 788 km and 1600 km) whilst towing moderate loads. We do not consider this excessive and are not surprised that one field party using Grizzlys this season did not experience this problem as their total mileage was only approximately 450 km, and another party changed their belts at approximately 500 km (J. McConchie, pers. comm.).

2. Overheating:

In Pyne (1984), it was considered that the cause of damage to the left piston of the Grizzly engine was a result of overheating.

After talking to Rod Vardy (1984 Base Engineer and a qualified motorcycle mechanic) who stripped the engine at Scott Base, it became obvious that the damage was caused by the wrong grade of spark plug and not the wrong fuel mixture. We would like to point out that the total spares issued to an event which was to travel 1800 km was one variator belt and one pair of Champion spark plugs, and that considerable pressure had to be used to have these allocated. R. Vardy considered the spare spark plugs were "several grades too hot and that the damage to the left-hand piston was a direct result of this" (pers. comm., 1984).

We hope these notes help clear up some misunderstanding of K5's use of the Grizzly motor toboggans in 1983.

T. Macpherson
A.R. Pyne

Reference

Pyne, A.R. 1984. Immediate Report of Victoria University of Wellington Antarctic Expedition 28, 1983-84.

BEDROCK STUDIES (K043A)

Narrative:

Korsch and George arrived at Scott Base on the morning of December 15 and after lunch immediately went on the Survival Course. We returned to Scott Base on the afternoon of December 16, spent 1½ days organising field equipment and on December 18 we were transported to the Robertson Ridge in the Lower Victoria Valley by helicopter. We were accompanied by Riedner Gomaro, a Peruvian Guest Foreign Scientist (K077) who was going to spend some time with us in the field observing how field work is carried out in the Antarctic. Gomero is an oceanographer specialising in marine sediments of the Peruvian continental shelf. Later that afternoon Fitzgerald and Patterson of K043B arrived by helicopter from the Miers Valley.

On December 19 Fitzgerald, Patterson, George and Gomero mapped and measured altitudes of dolerite sills between the camp, Lake Vida and the north wall of Victoria Valley. Korsch worked on the Robertson Ridge close to camp and in the afternoon met Chen Tingyu and Zhang Fu Yuan, Chinese Guest Foreign Scientists, who arrived by helicopter from Vanda Station to spend about ten days with us. Chen Tingyu is a petrologist interested in granites and tectonics and Zhang Fu Yuan is a marine geologist interested in Holocene sediments. Over the next two days we made reconnaissance trips around Robertson Ridge and the north wall of the Olympus Range. Bad weather on December 22 postponed the planned move of Fitzgerald and Patterson to the Blue Glacier and K043A lost half a day in the field. On December 24 Van den Bos (Scott Base medic) arrived by helicopter to act as field assistant for Tingyu, Fu Yuan and Gomero, and Fitzgerald and Patterson were transported to the Blue Glacier.

Between December 23 and 27 Korsch and George collected detailed structural data and a representative suite of rock specimens from the Robertson Ridge, whereas the guest foreign scientists, accompanied by Van den Bos examined various aspects of the geology of the lower Victoria Valley, Robertson Ridge and the north side of the Olympus Range.

On December 25, after working for half a day, the six of us crowded into a polar tent to celebrate Christmas with the resupply provided by George Moir (Scott Base chef).

On December 28, Korsch and George were relocated by helicopter to the lower Wright Valley. Because of the steepness of slope, it was not possible for a campsite near the Hart Glacier and instead we were put in at the Meserve Refuge Hut. The helicopter then returned to Robertson Ridge and transported Van den Bos, Gomero, Tingyu and Fu Yuan back to Scott Base.

For the next two days we collected structural data and geological specimens from the ridge between the Hart and Meserve glaciers and then on December 31 we walked to Vanda Station, stayed overnight and collected two large (35 kg) samples of granitic material.

From January 2 to 9 the weather conditions were such that we were able to work every day. It was mostly overcast and windy (usually less than 20 km/hour) but this was offset by warm temperatures. We collected detailed structural readings and a representative collection of the metamorphic rocks from the ridge between the Hart and Meserve glaciers and from the ridge between the Hart and Goodspeed glaciers. The run of good weather meant we were able to finish our data collecting earlier than we had anticipated and we were transported back to Scott Base by helicopter on January 10.

During our stay at the Meserve Hut we were visited by a lone skua on three separate occasions (December 28, January 5, January 6) and by John Alexander and Ian Laird on January 3 during their return by foot from the Lower Wright Glacier to Vanda Station. The Asgard Rangers, Lloyd Smith and Pat Sole, visited us from their Bartley Glacier camp on January 8.

At Scott Base we cleaned our field gear, packed rocks and equipment for shipment back to New Zealand and commenced report writing, Korsch leaving Antarctica on January 15 and George on January 16, arriving in Christchurch and then Wellington on January 16 and 17 respectively.

In the field all garbage was stored in plastic garbage bags and returned to Scott Base. Plastic garbage bags were used for our campsite toilet and the excreta also transported back to Scott Base.

The field season was an extremely successful one with the major aims being achieved. This could not have been possible without the excellent support of the staff at Scott Base, and in particular the OICs, Peter Cresswell (before his return to New Zealand), and then Jim Cowie.

Weather:

Good weather conditions were experienced throughout the field season with the loss of only half a day due to wind and whiteout conditions. The warm temperatures enabled us to continue working even though it was cloudy for a large proportion of the time with an almost constant wind of up to 20 km/hour from the northeast. The decision of the NZ Meteorological Service not to provide field parties with instruments and a Weather Log Book is regretable as this information takes little time to collect and would be of interest to future field parties.

Communications:

A Labgear radio was provided for the daily radio skeds with Scott Base. Unfortunately, this radio only functioned for a short time due to a problem with the relay contacts. However, at this time K043B were also at Robertson Ridge and we were able to use their Compak radio for the skeds. The Labgear radio was replaced with a Compak radio on December 24 and it performed well for the remainder of the field season.

A problem in the past has been the short life of the batteries, but this seems to have been solved by the provision of solar panels which seem to work very well, even in overcast conditions.

Communication with Scott Base was usually excellent, due in part to little ionospheric disturbance but mainly to having a professional radio operator running the skeds at Scott Base. The supply of information on helo movements was very good.

Transport:

All transport in the field was by helicopter, with the put-in to Robertson Ridge, transfer to Meserve Glacier and return to Scott Base all being on schedule. This was due to good weather, and the efficiency of VXE-6 and the OICs at Scott Base. One minor problem was the lack of Hercules flights from McMurdo to Christchurch due to the requirements of the Beardmore Glacier Antarctic Treaty meeting, and meant spending 5-6 days at Scott Base after finishing fieldwork.

Field Equipment:

The quality of the clothing provided by VUWARC is now excellent, the one exception being the short life of the woollen finger gloves due to handling of rocks. Equipment provided by Scott Base was also excellent, and in this respect the Storeman and Doghandler are thanked for their assistance.

Some thought could be given to the composition of the NZARP food boxes for the field. In particular, now that these are considered to be 20 man-day allocations rather than 14 man-days, extra drink ingredients such as coffee and Refresh should be provided. The "dehy" provisions should be substituted with frozen meat, for all field parties with the exception of those with rigorous weight limits (e.g. deep field sledging parties).

Refuge Hut:

Korsch and George spent 12 nights in the Meserve Refuge Hut in the Lower Wright Valley. The hut is in good condition although over the past few seasons it appears to have not been used very much. Provisions are adequate but limited, and we only used food brought with us from Scott Base. Its location was ideal for our work between the Goodspeed and Meserve glaciers. Although we collected some of the garbage from the vicinity of the hut there is still a lot of wood, metal, etc. within 200 m of the hut. Some thought could be given to toilet facilities (e.g. a fixed frame to use with removable plastic garbage bags) because the Dry Valley adage "There's one under every rock" holds true for the area near the hut. Nevertheless, our stay in the hut was much appreciated as the space and equipment (e.g. table and chairs) made the night-time writing up of field notes an easier task.

Guest Foreign Scientists:

We were privileged to have three guest foreign scientists join us in the field for the duration of our stay at Robertson Ridge (ten days). They were the Peruvian Reidner Gomero (an oceanographer) and two Chinese, Chen Tingyu (a petrologist) and Zhang Fu Yuan (a marine sedimentologist). We enjoyed their company and found them easy to work with. Nevertheless, we would like to make the following suggestions for the future:

1. Guest foreign scientists be affiliated with the Event closest to their own research interests. In our case, Gomero and Zhang Fu Yuan would have found it much more profitable to accompany Event K042 (Granite Harbour Sediment Studies). Hence the dates when the guest scientists visit Antarctica need to be closely co-ordinated with the relevant events.
2. As much advance notice, to the Events, of the possible inclusion of a guest scientist would be appreciated. If possible, this should be arranged at the Tekapo training camp.
3. The scientists should have workable English because the lack of ability to speak English makes communication extremely difficult and could lead to problems in potentially dangerous situations in the future.

Itinerary:

December 15	Korsch and George arrive Scott Base in morning. Commence survival training in afternoon.
December 16	Complete survival training.
December 17	Preparation of field gear.
December 18	Korsch, George and Riedner Gomero (Peruvian Guest Foreign Scientist - K077) helo to Robertson Ridge (lower Victoria Valley). Fitzgerald and Patterson arrive by helo later in afternoon.
December 19	Fitzgerald, George, Patterson and Gomero work in Lake Vida area. Korsch works in proximity of camp. Zhang Fu Yuan and Chen Tingyu (Chinese Guest Foreign Scientists - K077) arrive by helo in afternoon.
December 20	Entire party to reconnaissance work on Robertson Ridge.
December 21	Fitzgerald and Patterson map dolerite elevations in Olympus Range. Rest of party do reconnaissance work on north side of Olympus Range.

December 22	Bad weather. Korsch and George work half-day on north side of Olympus Range.
December 23	Fitzgerald and Patterson map dolerite elevations to south of Lake Vida. Rest of party on Robertson Ridge.
December 24	Fitzgerald and Patterson depart on helo for Blue Glacier. Arend van den Bos (Scott Base medic) arrives to act as field assistant for Tingyu, Fu Yuan and Gomero. Party works on Robertson Ridge.
December 25	Christmas Day. Korsch and George work 3 hours in morning.
December 26	Korsch and George work on Robertson Ridge. Rest of party to Lake Vida, Lower Victoria Glacier.
December 27	Korsch and George work on Robertson Ridge. Rest of party to north side of Olympus Range.
December 28	Korsch and George helo move to Meserve Hut in Lower Wright Valley. Rest of party return to Scott Base.
December 29-30	Work on slopes between Meserve and Hart glaciers.
December 31	Walk to Vanda Station. Collect 35 kg samples of Dais Granite and Theseus Granodiorite.
January 1	New Years Day - return to Meserve Hut.
January 2-9	Work between Meserve and Hart glaciers and between Hart and Goodspeed glaciers.
January 10	Return by helo to Scott Base.
January 11-15	Sorting, cleaning and packing gear. Packing rocks and cargon ready for shipment.

Days at Scott Base	8
Travel	4
Work days	19
Tent days	1
TOTAL	32

BEDROCK STUDIES (K043B)

Narrative:

Fitzgerald and Patterson arrived at Scott Base on December 3. During the next two days Fitzgerald prepared field gear, whilst Patterson attended to the survival course. Due to poor visibility and blowing snow we did not leave Scott Base in Snotrac 35 until 1200 on December 6, arriving at Butter Point at 1750, breaking one bogie en route. The road to Butter Point at this time was in good condition although there was almost no snow left on it and there were a few slushy patches. Camp was established in the mess hut of the CIROS camp.

Weather over the next two days was abnormally warm and still. We worked on the east end of the Kukri Hills on December 7 and the south side of New Harbour on the 8th. A knocking noise in the engine prompted us to abandon our planned trip to Mt Coleman and Hjorth Hill on the north side of New Harbour on the 9th. This, plus the uncertain state of the road due to the high temperatures, prompted us to return to Scott Base that night, leaving Butter Point at 2100 and arriving at Scott Base at 0300. The condition of the sea-ice road was less than ideal; however, it was not possible to leave the road to look for better conditions because in a lot of places between Butter Point and the "dirty ice", previous travel had compacted the ice leaving "causeways" across large, almost continuous meltpools. Where the "causeway" had broken down it was necessary to drive through these meltpools which in some cases were 2-3 feet deep. Just off the "dirty ice" we were forced to leave the road and pick a route further to the north. Once past here conditions improved dramatically. The snotrac crankshaft was later found to have elongated holes where it fits onto the crankcase, hence causing the knocking.

December 10 and 11 at Scott Base were spent preparing more field gear. Helicopter delay on the 13th, but on December 14 we flew into the Miers Valley with a precautionary putdown on the sea-ice en route due to the windscreen above the pilot's head coming loose. This was repaired with some of our fibreglass tape, but despite this we were charged 1.5 hours. From December 14-17 we worked in and around the Miers Valley, and along the ridge between it and the Marshall Valley from the coast to almost as far west as spot height 1430.

On December 18 the helicopter arrived at 1430 to move us to Robertson Ridge to join Korsch and George (K043A). Aerial photography of the east side of the Kukri Hills and samples from Hjorth Hill, Mt Coleman, Mt Falconer and Mt McLennan was completed en route, arriving at 1730. We had requested a morning helicopter flight to get good ground perspective with the sun to the east. Unfortunately, an afternoon flight meant we were shooting directly into the sun. From December 19-21 we worked in the lower Victoria Valley, along Robertson Ridge and in the Olympus Range. Bad weather on December 22 and a Sunday on the 23rd delayed our move to the Blue Glacier until December 24. Vincent (ex. K042) and Hall (K071) plus one sledge and underslung Grizzley were flown in to the upper Blue Glacier. The helicopter then picked up Fitzgerald and Patterson from Robertson Ridge and moved them to the upper Blue, returning to Scott Base with rocks and retro before returning with the second sledge and Grizzley. A brief but severe storm blew up that evening from the south.

December 25 was spent sorting gear, putting sledges back together, organising crevasse rescue kits for both vehicles and sledges, as well as instigating maintenance schedules for the Grizzlys (SM053 and 054). That afternoon we travelled to spot height 1430 where we took a 30 kg sample of granodiorite for Korsch and another smaller one off the summit. A vertical sampling profile was done on spot height 1890 on December 26. Due to the extra weight of the Grizzlys (740 lb) compared to the older Snotrics (450 lb) which had been in our original planning, we had been unable to bring in as much as we wanted in the original put-in. Therefore, a resupply of mainly fuel was deemed necessary. Planned at short notice for December 28 we found out on the morning of the 27th that it was coming on that day in conjunction with K054A's move to the Garwood Valley. Bad communications and an inability to raise Scott Base the previous morning had led to our resupply requirements not being passed in full until that morning, too late to be processed for that day. While we waited for the resupply that never came we practised methods of travel on crevassed country and crevasse extraction of a Grizzley. It was our intention on the 28th to work on the ridge north of the Salient Glacier but bad weather forced us back to camp. On December 29 we made our way up the true left of the Salient Glacier before crossing over and travelling up the true right as far as the 1600 m contour. From here we were able to work on the upper reaches of the ridge to the south of the Salient Glacier. The next day we worked on the lower reaches of the ridges, to the south and north of the Salient Glacier. The weather was bad on the 31st but cleared enough on January 1 to enable us to sample several small peaks across the south end of the Blue Glacier.

We moved camp down-glacier to Granite Knolls on January 2, travelling in deep snow for most of the way. Weather on the next two days was low overcast and occasional snow storms, reducing visibility but with very flat light conditions, making safe travel tricky and slow. We sampled spot height 1243 on January 3 and on January 4 whilst Hall and Patterson waited in case the resupply came, Fitzgerald and Vincent sampled across the tops of Briggs Hills. On the morning of January 5 we packed rocks and did an extensive overhaul of the Grizzly s and then while Hall waited for the resupply (which arrived at 1500 with 20 gallons 2-stroke plus a small amount of food), Fitzgerald, Vincent and Patterson worked on the foothills of the Royal Society Range beneath Chaplins Tableland, returning at 2200. On January 5 we attempted to cross Blue Glacier a few kilometres to the east of Granite Knolls but were turned back by a river running down the centre of the glacier. Unfortunately, the lead toboggan and sledge got stuck in the slush on the edge of this river resulting in a few hours delay and wet feet for some. A 4:1 Z-pulley system using the second toboggan was used to pull the lead toboggan out. From here the river cut in close to the north side of the lower Blue Glacier under a set of ice-cliffs, barring any travel further down the Blue Glacier. Bad weather on January 7 cleared up sufficiently at 1400 to enable us to travel across to start work on the ridge north of Lister Glacier but closed in again soon after. January 8 we moved back up the glacier intending to camp as far up the Hooker Glacier as possible, but snow and poor visibility caused us to camp fairly low down. Work on the ridge north of Lister Glacier was finished en route. January 9 it snowed heavily all day. In misty weather conditions we moved camp back to Granite Knolls on January 10 working en route on the ridge between Hooker and Salient Glaciers and taking a sample off the small peak on the east side of the Blue directly opposite Williams Peak. In more bad weather on January 11 we packed rocks and prepared sledges for return to Scott Base. January 12 the helicopter arrived at 1415 for one hour's close support: sampling Mt Barnes, Mt Herb, spot height 1204 and then the small peak southwest of Williams Peak. We returned to Granite Knolls and did two shuttles to Scott Base taking a sledge and underslung Grizzley each time, finishing at 1615. Gear was cleaned and returned, rocks sorted and the cargon packed on January 13 and 14. On January 15, Vincent and Fitzgerald flew to Granite Harbour with Belgrave (K091 - surveyor) to assist in the surveying of the Mackay Glacier tongue for Macpherson (K042). Fitzgerald, Vincent and Patterson flew out to New Zealand on the evening of the 16th, arriving at Christchurch on the morning of January 17. They were then debriefed at Antarctic Division.

The season was a successful one with all major objectives being achieved. The lack of mechanical problems in the field certainly contributed to this, but it could not have been done without the support we received from the staff of Scott Base.

Helicopter Movements:

19 hours in total were allocated to K043 this season, 13 of those to K043B. We were charged 1.5 hours for our put-in to the Miers Valley, but after this, hours charged were difficult to gauge as they were grouped in with K043A. Approximately 4 hours were charged for our move from Miers Valley to Robertson Ridge: this included aerial photography and close support in New Harbour. Our put-in to the upper Blue Glacier cost us approximately 5 hours and our eventual return to Scott Base another 4.5 including one hour's close support. Our total for the season would not have exceeded 14 hours.

Weather:

The 1984/85 season appeared to be one of unsettled weather patterns. Whilst at New Harbour from December 6-9 the weather was abnormally warm, resulting in accelerated deterioration of the sea-ice. However, in the Miers Valley it was always overcast with a prevailing easterly of 10-15 knots. At Robertson Ridge it was often fine but windy, only one day being bad enough to halt a planned helicopter move. Weather in the Blue Glacier was one of contrasts; beautiful sunny days early in our stay with wind, snow and whiteouts dominant towards the end. In all, four days of helicopter delays were experienced because of weather, and four working days lost in the field, not to mention those marginal days when some work was done.

Communications:

We were supplied with a Compak radio, spare battery and solar panels. The radio performed satisfactorily in New Harbour, Miers Valley and Robertson Ridge. However, within a few days of arriving in the Blue Glacier, high power ceased to function. This made communication with Scott Base almost impossible at times, necessitating relays through Vanda and K078 at Cape Hallett. This was replaced by another Compak on January 5.

We appreciated the efficient, professional manner in which radio schedules were conducted this season.

Recommendations:

Due to the often bad atmospheric conditions, communications this season were not the best. This was not improved by the problems a lot of field parties experienced with their HF radios. The issue of VHF radios to field parties operating in the Dry Valley area in line of sight with either the Crater Hill or Mt Newall repeaters would go a long way towards improving communications. As an added safety factor, their small size means that they can be carried in the field on a day-to-day basis as well as allowing within-party communication should the party split up. An adaptor enabling recharging from the solar panel would be essential for any event spending some time in the field.

Itinerary:

December 3	Fitzgerald, Patterson arrive Scott Base.
December 4-5	Fitzgerald prepares field gear. Patterson survival course.
December 6	Travel Scott Base to Butter Point using Snotrac 35.
December 7-8	Work around New Harbour, east end of Kukri Hills.
December 9	Return to Scott Base.
December 10-11	Continued preparation of field gear.
December 12	Helicopter delay.
December 13	Fitzgerald, Patterson helicopter to Miers Valley.

December 14-17	Work in Miers Valley area.
December 18	Helicopter move to Robertson Ridge - close support on Hjorth Hill, Mt Coleman, Mt Falconer and Mt McLennan en route. Join K043A (Korsch and George).
December 19-21	Work in the lower Victoria Valley, Robertson Ridge and Olympus Range.
December 22-23	Helicopter delay.
December 15-23	Vincent at Scott Base. Checking vehicles and field preparation for Blue Glacier.
December 24	Vincent and Hall helicopter into upper Blue Glacier from Scott Base. Fitzgerald and Patterson join them from Robertson Ridge.
December 25	Reassemble sledges, prepare crevasse rescue kits. Instigate vehicle maintenance schedule. Work on .1430 and take 30 kg rock sample for Korsch.
December 26	Work on .1890.
December 27	Wait for resupply. Practise crevasse extraction of Grizzleys and methods of travel on crevassed country.
December 28	Bad weather.
December 29	Travelled up true left of Salient Glacier. Worked on Frio Peak and ridge along south side of Salient Glacier.
December 30	Worked and sampled ends of ridges on both north and south side of Salient Glacier.
December 31	Bad weather.
January 1	Worked south end of Blue Glacier.
January 2	Move camp to Granite Knolls.
January 3	Set camp altitude from Granite Knolls trig. Sample .1243.
January 4	Fitzgerald and Vincent work Briggs Hills. Hall and Patterson wait for resupply.
January 5	Toboggan overhaul and rock packing in morning. Fitzgerald, Vincent and Patterson work on ridge beneath Chaplins Tableland. Resupply arrives 1500.
January 6	Attempt to cross Blue Glacier in order to work on Mt Kowalczyk and Williams Peak. Turned back by river running down middle of glacier.
January 7	Bad weather. Cleared up sufficiently at 1400 to work on ridge north of Lister Glacier.
January 8	Move camp to Lower Hooker Glacier in deteriorating weather.
January 9	Bad weather.
January 10	Move camp back to Granite Knolls. Work on ridge between Hooker and Salient Glaciers. Sample peak on east side of Blue Glacier opposite Williams Peak.
January 11	Bad weather. Prepare Grizzlys, sledges and rock samples for tranport back to Scott Base.
January 12	Helicopter arrives 1415. Close support, then 2 shuttles to return to Scott Base.
January 13-14	Return field gear. Packing cargon.
January 15	Fitzgerald, Vincent assist in surveying of Mackay Glacier tongue for K042.
January 16	Fitzgerald, Vincent, Patterson return Christchurch.

Days in field -	work	19
	travel	9
	bad weather	4
	helicoter delay	4
		36
Days at Scott Base		9
TOTAL		45

NOTES on TRAVELLING with TOBOGGANS - Simon Vincent (F/A K042, K043)

During 1984/85 season while working with K042 and K043 distances travelled included 1700 km on the sea ice and 300 km on the Blue Glacier. In each of these trips 2 toboggans and sledges were used. From this hopefully something was learnt and the following notes may be of use:

Sea Ice

As the Snotrics are being replaced discussions concerning their problems are of little use. Suffice to say much time was lost attempting to keep them alive through the 3355 km.

Notes

1. A 1.2m x 1.6m trailer was often used. It was attached to the toboggan by a light steel pipe drawbar and supported on 2 skis of approximately 2.2m length. This proved excellent on very rough sea ice off Cape Roberts and was quick to pack when travelling from site to site.
2. It is suggested that people who have considerable experience of travelling on sea ice be encouraged to pass on some of their expertise to the Survival Training Event personnel. Mountaineers from New Zealand cannot be expected to have a working knowledge of sea ice travel. Checking depth of ice at pressure ridges, shelter building and general survival training were handled very well.

   However, the following were all areas where experience of previous years should be capitalised on:

1. Determining whether a crack is or is not active.
2. Local knowledge of regularly occurring cracks and safe crossing of same.
3. Ascertaining safety of crossing large surface melt pools.
4. Tide crack problems.
5. Basic navigation when 15-20 km off the coast.
6. Basic vehicle preparation and safety.
7. Suggestions of methods of crossing very rough sea ice.

   This should be in the form of a more thorough briefing of survival training personnel and a simple publication on travelling in Antarctica. The latter would result in lessons learnt in the past being available to new staff, function as a focus for safe and practical practices and be revised every 3-5 years as plant is replaced and new methods of travel prove successful. The information could include travelling on sea ice and crevassed areas, methods of applying rope brakes and repairing lashings on sledges, etc.

Blue Glacier

The two Grizzly toboggans (No. 53 and 54) performed exceptionally well. Each vehicle travelled 300 km, averaging 12 km/gallon fuel consumption. The only part replaced was the variator belt of machine No. 54 - this was partially worn from use prior to this event. Both machines always started on the electric start, very little appeared to vibrate loose and track tension required little adjustment.

Notes

1. The rear of the machine was lifted onto a box each morning so that the tracks could be run unloaded and cleared of ice. It proved very worthwhile to do that at night also as the snow was uncompacted at that time. As the Grizzlies weigh 740 lbs (much heavier than the Snotrics) it is suggested that a simple lever jack and 2 props are provided with each machine making it realistic for a field party to service the vehicle in this manner. It would also greatly assist when checking track tension and running gear. The writer would be quite happy to provide sketches of what is required.

2. A number of exercises was done with respect to linking the vehicles together for safe travelling in crevassed areas. When travelling daily to work site from camp we generally used toboggan linked to tamworth sledge (with breakman) linked to the second toboggan. This provided excellent protection travelling uphill but we found that the second toboggan could provide only negligible reverse load when travelling downhill. Hence, when travelling downhill in suspect areas the sledge had up to four rope brakes fitted and keels lowered so that it required a strong positive pull of the lead toboggan to move it. This also left the tamworth brake as additional stopping power if the front toboggan fell through a bridge rather than using it to control the speed of the sledge travelling down the hill.

3. The only spare variator belts available to be taken into the field were Bombadier models acquired from McMurdo.

4. A two-stroke fuel mix of 30:1 was used. This proved adequate except when travelling roped together; the second toboggan (not loaded) would begin to oil the plugs after a while, this was generally alleviated by swapping the vehicles. Apparently, the manufacturer recommended 50:1 and possibly this is too lean. A 30:1 mix certainly ensured there were no overheating problems but perhaps 35:1 mix would alleviate these problems. The lack of a service manual made tuning and general maintenance more difficult in the field.

5. The quality of new sledge runners and bridges leave much to be desired. Many show signs of delamination and cracking prior to being taken off the shelf. Perhaps also the means by which keels are fitted needs some revision as the two old runners that were replaced both failed in this area.

Suggestions

(a) The gap in the runner through which the keel drops to be as narrow as possible.

(b) That the load from the keel to the runner to be transferred onto the base (running surface) rather than onto the top of the runner. At the moment on hard ice the keels provide a large delaminating load to the top of the runner.

These points could be discussed with the manufacturer.

6. The grizzly toboggans were not underslung by helo until this season. Initially, a four-point anchor system was used but the load would not hang straight below the helo and maximum speed was 70 knots. Later, we removed the battery, drained the fuel tank (it is easily removed) and underslung the toboggan by two small frames attached to the rear of the machine. The Bombadiers are underslung with a simple sling from the rear square tubular framing; this is probably inadequate for the grizzlies as (1) they are heavier; and (2) the square tubular framing is lighter than that on the Bombadiers. Hanging vertically from the two rear support points the toboggans travelled directly behind the helo at 100 knots.

Summary

1. Experience gained by previous field parties with respect to: travel, safety, local conditions and method of travel in difficult areas should be more readily available to new staff. This could be in the form of simple booklet covering items mentioned earlier.

2. The Grizzly toboggans functioned exceptionally well on snow-covered terrain. It is also felt there is no reason why they can not be used successfully on sea ice even though they are not designed for ice travel. However, it must be recognised this will result in reduced functional life of machine and, in particular, all track running gear (and hence considerably more maintenance will be necessary). Because of this it is suggested that two particular machines are always used on the sea ice with the newest ones being kept for the easier snow travelling.

This report is offered in a positive manner and the writer would be keen to provide any further information or assistance.

Notes on travelling in the Blue Glacier area

The main body of the Blue provided excellent travel conditions with very few obvious crevasses. Good snow cover was encountered right down to below Granite Knolls.

In the upper area good access to near 1430±, north ridge of 1890±, and other outlying peaks. Reasonable access was gained up the true left of the Salient Glacier to a height of 1800 m.

Around Granite Knolls area excellent access to top of Descent Bass, near Bettle Peak and across to east ridge of the Pimple. Early in the season, reasonable vehicle access is also likely to Goat Mountain area. However, by January a river up to 20 m wide and 300 mm to 500 mm deep flows down the middle of the glacier below Granite Knolls and then heads left as it approaches Bowers Piedmont.

Notes on Field Equipment

The 3-man North Face Dome tent (larger than the New Horizon) proved excellent as a cook-house and 'day hut' for the 4-man party. Generally, field equipment was good. Nylon windproofs are very useful and less bulky than NZARP anoraks to wear.

Vehicle Itinerary - Grizzly toboggans SM053, SM054

Date	Location	Distance travelled	Fuel added	Comments
25 Dec.	From camp in Upper Blue to Saddle south of 1430±	9 km	-	Pulling 450 lbs. All running gear checked in evening on 053.
26 Dec.	From Camp to below 1890±	9	2 galls	Pulling 450 lbs. Adjusted choke on 053 in evening. Was running too rich. All running gear checked 054.
27 Dec.	Around Camp.	2	-	Crevasse rescue practice.
28 Dec.	From Camp down glacier	6	-	Travelled 3km before weather closed in.
29 Dec.	From Camp up true left of Salient Glacier	20	2 galls	053 running better. New variator belt in 054.
30 Dec.	Lower ridges each side of Salient Glacier	20	$1^1/3$ galls	Both running well.
31 Dec.	NO TRAVEL			
1 Jan.	To top of Blue Glacier from Camp	10	1 gall	- Travelling on good snow. Running gear checked in evening.
2 Jan.	Moved Camp from top of Blue to Granite Knoll	26	2 galls	- Towing 1100 lbs. Breaking through snow to 250 mm. Hard work but they travelled well. Snotric wouldn't have made it.
3 Jan.	From Granite Knoll to Descent Pass	21	$1^1/3$ galls	- Both running well.
4 Jan.	From G.K.to Briggs Hills	30	2 galls	- Towing 950 lbs. General good snow conditions and few crevasses.
5 Jan.	From G.K. to east ridge of the Pimple	20	$1^1/2$ galls	- Got toboggans up to first saddle in ridge.

(Contd.)

Date	Location	Distance travelled	Fuel added	Comments
6 Jan.	Tried to get from G.K. to Mt. Goat	20	2 galls	- Tried to cross 'Blue River' - got stuck - set up 4 to 1 to pull toboggan out.
7 Jan.	To ridge south of Lister Glacier	19	$1^1/2$ galls	- Towed 900 lbs - running gear checked in evening.
8 Jan.	To above and then to bottom of Hooker Glacier	25	2 galls	- Towed 600 lbs - both running well.

Diary ends.

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Val Hibbert typed the report.

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Distribution of modern benthic foraminifera of McMurdo Sound, Antarctica - B.L. Ward (PhD).

Abstract: This thesis presents the results of a study of benthic foraminifera from McMurdo Sound, Antarctica. The sound is 50 km across and more than 900 m deep, and is ice-covered for at least 9 months of the year. However, salinity and temperature of the bottom waters are constant (35‰ and -1.8°C). Sea floor sediment is mainly fine sand and mud with a little ice-rafted gravel.

The aim of the study was to document the distribution of living and dead foraminifera and to determine the factor(s) controlling it. The twenty-six sites in water from 76 to 856 m deep were sampled by gravity corer and grab, and nearly 40,000 specimens (2334 living and 36,875 dead) were identified. Three present day assemblages can be recognised:

1. Shallow open water assemblage (SWA): Trochammina glabra, Cribrostomoides jeffreysii, Trifarina earlandi, Ehrenbergina glabra, Fursenkoina earlandi and Globocassidulina crassa.
2. Deep open water assemblage (DWA): Reophax pilulifer, Reophax subdentaliniformis, Portotrochammina antarctica, Textularia antarctica and Miliammina arenacea.
3. Harbour/enclosed basin assemblage (HA): Reophax subdentaliniformis, Portotrochammina antarctica, Textularia antarctica, Fursenkoina earlandi and Globocassidulina crassa.

The composition of the assemblages is controlled largely by the calcium carbonate compensation depth (CCD). Calcareous species are abundant and varied (84 calcareous species) in the SWA above 620 m, but are virtually absent from the DWA, which is found in deeper water. The dominance of agglutinated foraminifera in the HA indicates an even shallower CCD (about 230 m) in restricted coastal settings.

Death assemblages have a similar species diversity to corresponding life assemblages and are reasonably respresentative of them, except for the 200 m zone above the offshore CCD, where death assemblages are depleted in calcareous taxa. The diversity of the agglutinated component of each assemblage remains nearly constant in all habitats and at all water depths, even though shallow water samples include a range of calcareous species. Thus competition from calcareous species appears not to be a stress factor for agglutinated species, which are considered to have reached the limit of their evolutionary potential in these waters.

The structure and origin of the Strand Moraines, Antarctica - P.J. Currie (BSc Hons).

Abstract: The Strand Moraines is a stagnant ice-cored moraine. It is a glacial remnant of the last Glaciation (20-5 kyr ago) and is grounded against the Bowers Piedmont Glacier on the west coast of McMurdo Sound, Antarctica.

The surface topography of the Strand Moraines is controlled and related to the structure of the underlying ice. The structure indicates that the Strand Moraines is a homogeneous ice body that has undergone two periods of folding deformation. The mechanism of fold development can be equated with cylindrical folding mechanisms and formed during glacial movement processes.

Oxygen isotope analysis determined that the Strand Moraines ice core is a mixture of alpine glacier ice and seawater derived ice. The seawater is considered to have been incorporated into the original ice body by glacial processes associated with a grounded and thickening ice sheet. The presence of a mirabilite salt bed supports this. Mirabilite is precipitated from freezing seawater.

Englacial and surficial debris present at the Strand Moraines are genetically related. The surficial debris is derived from the englacial

debris by surface ablation. It has a coarser texture because the fine sediments are removed by wind deflation and meltwater winnowing. The debris originated in a subglacial environment and moved to an englacial position by glacial processes.

The debris has a mixed provenance and indicates a continental source for the Strand Moraines.

Evidence from this study suggests that the Strand Moraines was formed 6.8 kyr ago at a time when the grounded ice sheet present in the McMurdo Sound during the last Glaciation was in recession. Ice flow models for the ice sheet have been postulated. It is considered that the ice sheet is as likely to have flowed into the McMurdo Sound from the south in a northward direction as flowed around the northern end of Ross Island and in a southern direction as proposed by earlier authors.

APPENDIX 1. VUWAE 29 CARGO

CARGO TO ANTARCTICA

CIROS - Winfly cargo

1.15 m^3)		
1.15 m^3) - scientific and core logging equipment		
0.81 m^3)		
0.66 m^3 - core saw equipment	≈	1050 kg (2300 lb)
Gas chromatograph (JARE): 90 kg		
Surveying equipment (L&S): ≈ 140 kg		
Fragile scientific equipment (VUW): ≈ 120 kg		
		350 kg (770 lb)
		1400 kg (3070 lb)

GRANITE HARBOUR STUDIES - October cargo

1.2 m^3 - scientific equipment	≈	545 kg (1200 lb)

BEDROCK STUDIES - November cargo

0.72 m^3 - scientific and field equipment	≈	180 kg (400 lb)

GANOVEX (VUW participation) - November handcarry

- Gravity meter and equipment	20 kg (50 lb)
TOTAL	2145 kg (4700 lb)

CARGO FROM ANTARCTICA

CIROS

0.73 m^3 - scientific equipment:	270 kg	
0.66 m^3 - core saw equipment:	214 kg	
2 x 0.81 m^3 - core samples to Lower Hutt:	609 kg	
- survey equipment est.:	140 kg	
- scientific handcarry:	50 kg	
		1283 kg (2800 lb)

GRANITE HARBOUR STUDIES

0.3 m^3 - corer equipment:	228 kg	
1.15 m^3 - hydro winch and equipment:	560 kg	
1.15 m^3 - echo sounder and science equipment:	331 kg	
0.12 m^3 - scientific equipment:	45 kg	
- frozen samples:	22 kg	
- handcarry equipment:	40 kg	
		1226 kg (2700 lb)

BEDROCK STUDIES

0.72 m^3 - science and field equipment:	240 kg	
0.97 m^3 - rock samples to Wgtn:	526 kg	
0.62 m^3 - " " to Dunedin:	370 kg	
" " to Melbourne:	395 kg	
		1541 kg (3390 lb)

GANOVEX

- handcarry	20 kg (50 lb)
TOTAL	4070 kg (8954 lb)