IMMEDIATE REPORT

OF

VICTORIA UNIVERSITY OF WELLINGTON

ANTARCTIC EXPEDITION

1980-81

Compiled by Alex Pyne from contributions by:

D.A. Christoffel
R.R. Dibble
D. Iles
A.R. Pyne
F. Reid
S. Simmons
B.L. Ward

WELLINGTON

June, 1981

This report has been prepared for the benefit of the Council of Victoria University, the University Research Grants Committee, the Ross Dependency Research Committee, Antarctic Division, DSIR, and individuals who have assisted the Expedition in the execution of its research programme. It is not intended as a final publication for scientific results, and if reference is made to this report its interim nature should be made clear.

COVER: Scenes from the different events of this year's expedition. The photographs with captions are also presented in the body of the report.

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PREPARATIONS FOR VUWAE 25

PROGRAMME

Four scientific projects were submitted by Victoria University of Wellington Antarctic Research Centre to RDRC. These projects were approved and passed to Antarctic Division for logistic support where minor modifications were incorporated. The modified programmes are detailed below:

A. McMurdo Sound Sediment Studies - fauna and flora.

The purpose is to collect further sediment samples from the floor of McMurdo Sound in various places so that sediment type and faunal content can be related to present day geography. The coast at New Harbour will also be examined for the sediment and the modern flora. This project continues work on sediments in McMurdo Sound, carried out by VUWAE 23 in 1978, and begins a Ph.D. programme that will concentrate on the Sound's benthic fauna, in particular foraminifera. Foraminifera are sensitive to a wide range of pollutants and "baseline" information on their present distribution may well be useful to help assess environmental impact in the future.

A sea ice-based seismic refraction programme will also be undertaken "off shore" at Butter Point in conjunction with the sediment sampling party. The gravity anomaly found during the MSSTS drilling programme last season (1979-80) will be investigated by seismic refraction and correlated with previous shipboard seismic profiling in the area.

B. Beacon Studies.

The purpose is to sample key strata and rock types for magnetic measurements to determine ancient pole positions. Measurements of samples from the 1978-79 season show that meaningful results can come only from a few rock types, and more samples are now needed.

The Permian coal measure sequence in the Lashly Mountains will be investigated to correlate with the work done during the previous two seasons further north.

C. Basement Studies.

The area between the Miers and Garwood Valleys will be mapped to determine the relationship between basement intrusive and metamorphic rocks. Detailed studies will include the chemical and petrological investigation of the granitic intrusives and specifically the relationship between a granite pluton and the enclosing metamorphic rocks.

D. Erebus Studies.

The purpose is to extend the information base for seismic audio and magnetic studies at Erebus Crater. Dr. Dibble will join an international team of scientists for the International Mount Erebus Seismic Survey, which will this year begin a three year programme of carefully organised data collection and analysis.

FINANCE

A grant of $11,000 was obtained from the University Grants Committee to run the nine man expedition. This covered the major running costs of food, travel and freight, insurance, field clothing and minor scientific supplies. The University's Internal Research Committee provided financial support for five students, a grant towards a Salinity Temperature Bridge, and a Ph.D. research grant with which 1,000 metres of winch wire was purchased. A "Golden Kiwi" scientific grant provided money towards the major items of scientific equipment built for the McMurdo Sound Sediments programme.

EQUIPMENT

Several major items of equipment were specially built and purchased for the sediment sampling programme. The VUW Engineering Workshop built the large diameter sediment corer (sphincter corer) and accompanying sub-sample corer. Boxes for freighting the corer and samples and a specially designed motorised winch to carry the 1,000 metres of 5mm wire rope were built outside the University. The salinity temperature bridge, with 300 metres of cable, was purchased.

The Workshop also built several small items including ice pins to fasten the winch and tents on the sea ice and modified a snatch block to meter the length of cable down the hole.

It was once again necessary to borrow some equipment from other sources. A current meter was borrowed from the New Zealand Oceanographic Institute and 12 inch diameter ice augers from the Soil and Water Section (MOW). The augers did not perform satisfactorily so a set loaned by McMurdo Station was used. Also an orange peel grab from the McMurdo Biolab was used for 2 weeks. The Lands and Survey "Watts theodolite" was used to position sampling sites on the sea ice.

Antarctic Division provided logistic support which included accommodation at Scott Base, most field equipment including tents and food/fuel. Three toboggans, sledges and a Sno Trac (for 1 week) were supplied to the sea ice party. VUWAE 25 personnel were charged $35 per week for food and accommodation by Antarctic Division.

Three new sets of insulated overalls were imported as a substitute for down clothing on the sea ice. Second hand mukluks were once again bought and a down jacket hired from Antarctic Division for the summer season.

STRUCTURE OF THE EXPEDITION

McMurdo Sound Sediment Sampling (Event 14).

Oct.9 - Dec.10	Sediment sampling programme in McMurdo Sound and at the McMurdo Station desalinisation outlet.	
	Alex Pyne (Leader/Geologist)	M.Sc student VUW
	Barbara Ward (Geologist)	Ph.D student VUW
	Paul Fitzgerald (Geological assistant)	B.Sc student VUW
	Bruce Garrick (DSIR assistant)	
Nov.26 - Dec.3	Seismic Refraction from the sea ice off Butter Point.	
	Ray Dibble (Geophysicist)	Reader in Geology VUW
	David Iles (Geophysics assistant)	B.Sc student VUW

Beacon Studies (Event 13).

Nov.21 - Dec.22	Sampling red bed rock sequences at several locations for paleomagnetism measurements.	
	David Christoffel (Leader/ Geophysicist)	Associate Professor in Physics, VUW
	Stephen Bannister (Geophysical assistant)	B.Sc student VUW
	Peter Cleary (DSIR assistant)	
Dec.9	David Iles (to Event 13).	
Dec.11 - Dec.16	Description and paleocurrent measurement of the Coal Measure sequence at the Lashly Mountains (Event 14).	
	Alex Pyne	
	Barbara Ward	
	Paul Fitzgerald	
	Bruce Garrick	
Jan.14 - Jan.20	Further paleomagnetic sampling of basement granites/dykes and Ross Island volcanics. Arranged on an opportunity basis while awaiting the beginning of the "Benjamin Bowring" Geophysical Programme (Event 9).	
	David Christoffel	
	Assistant from Scott Base	

Basement Studies (Event 15).

Nov.22 - Jan.7	Mapping and sampling basement rocks in the Miers Valley to Salmon Valley area.

	Frank Reid (Leader/Geologist)	Ph.D student VUW
	Steven Simmons (Geologist)	M.Sc student VUW
	Greg Mortimer (Geologist/ DSIR assistant)	
Jan.7 - Jan.13	Sampling "type" granite intrusive rocks in the Taylor and Wright Valleys. Steven Simmons Greg Mortimer	

Erebus Studies (Event 5).

Dec.10 - Jan.9	Installing seismic equipment and monitoring Erebus volcano at the summit. Ray Dibble (Geophysicist) (For the other members of the IMESS (Event 5) party see Appendix IIA).

Ross Sea Marine Geophysical Cruise (Event 9).

Jan.21 - Feb.13	David Christoffel (Geophysicist) participated with Geophysics Division (DSIR) scientists on the Benjamin Bowring Cruise in the Ross Sea.

PLATE I   Satellite image map of the McMurdo Sound Region showing locations covered by VUWAE 25 Events. (Map is from USGS Experimental Printing; Sheet: McMurdo Sound Antarctica 1972-1974).

KEY:

McMurdo Sound Sediment Studies (NZARP Event 14).

1. Capes Evans/Royds.
2. Butter Point/New Harbour area.
3. Cape Chocolate area.
4. Lashly Mountains (Mt. Crean).

Beacon Studies (NZARP Event 13).

5. Portal Mountain.
6. Alligator Peak (Boomerang Range).
7. Mount Kempe.
8. Table Mountain.
9. Knobhead.
4. Mount Crean.

Basement Studies (NZARP Event 15).

10. Miers Valley area.
11. Garwood Valley area.
12. Marshall Valley.
13. Salmon Valley.
14. Taylor Valley (near Taylor Glacier snout).
15. Wright Valley (Dias area).

Erebus Studies (NZARP Event 5).

16. Mount Erebus summit.

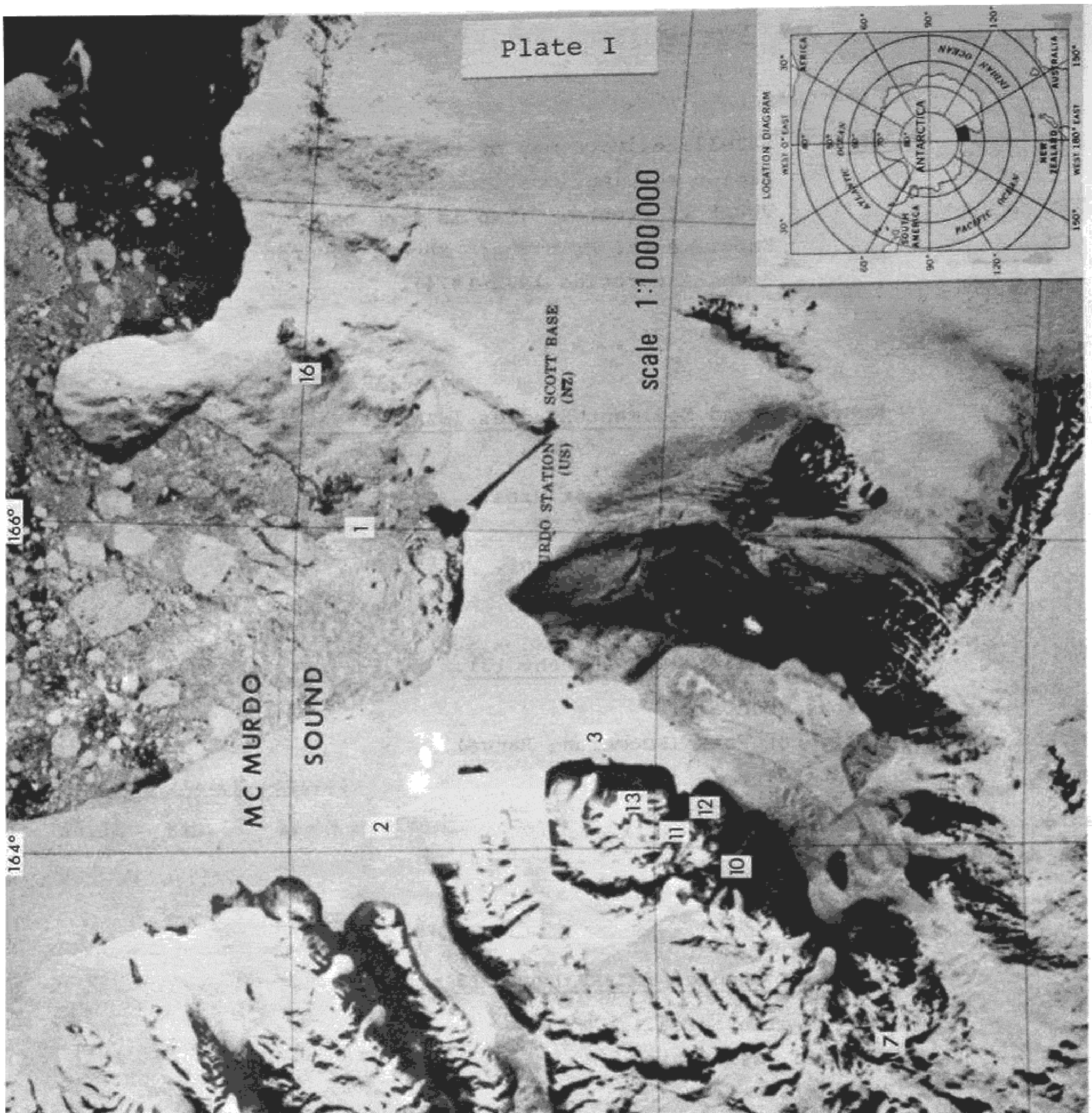
Plate I
MC MURDO
SOUND
SCOTT BASE
(NZ)
STATION
(US)
scale 1:1 000 000
LOCATION DIAGRAM
ANTARCTICA
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164°
166°
77°30'
78°

SCIENTIFIC ACHIEVEMENTS

Sediment Sampling in McMurdo Sound (B.L. Ward).

Sea floor sediments of McMurdo Sound were sampled to obtain material suitable for detailed analysis of foraminiferal populations and their relationships to sediment type and ecological factors. Areas sampled, using the sea-ice as platform, were New Harbour and near the McMurdo Station desalination plant discharge point. Later in the season during January and February, Drs. D. Bennett and F. Davey obtained five gravity cores for this work during a seismic profiling cruise on board the Benjamin Bowring. These were from open-water areas inaccessible from the sea ice earlier in the season. Figure 1 is a map of the McMurdo Sound area showing sample locations for all material collected this past season; depths ranged from 8 to 750m.

A total of 29 core and grab samples were obtained by dropping equipment through a twelve inch access hole drilled in the two metre thick sea ice (Plate II A.B.C.D.). Twenty-seven of these were large enough for analysis. The additional five gravity cores have been split horizontally into one or two centimetre segments to yield 24 samples. The total number of samples to be analysed from this season is 51.

Preliminary examination of material obtained during the 1979-80 season and this past season indicates variation of foraminiferal populations between open McMurdo Sound waters and the embayed New Harbour area. Agglutinated species predominate in the muddier, enclosed New Harbour sediments, while calcareous forms are more prevalent in the deeper open Sound waters. Varying amounts of sponge mat have been found at several sites but these seem to have little effect on the species present.

Next season (1981-82) we plan to continue the sampling programme, using our modified large-diameter sphincter corer, as well as a salinity-temperature bridge, current meter, tide gauge, and underwater camera. The areas to be covered are southern McMurdo Sound and Granite Harbour.

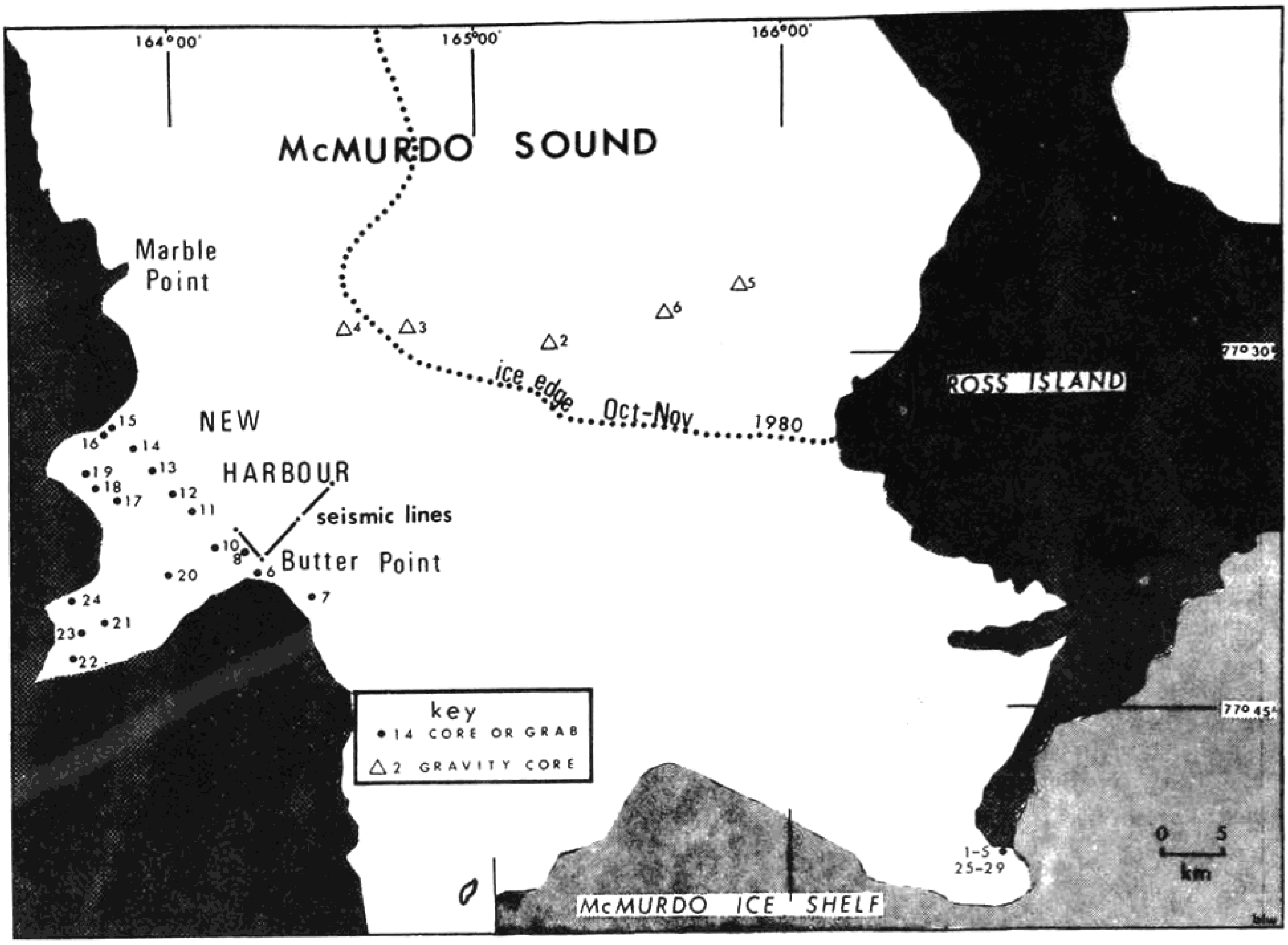


Figure 1 : Map of McMurdo Sound, showing this season's sea floor sampling sites and position of the seismic survey lines.

PLATE II

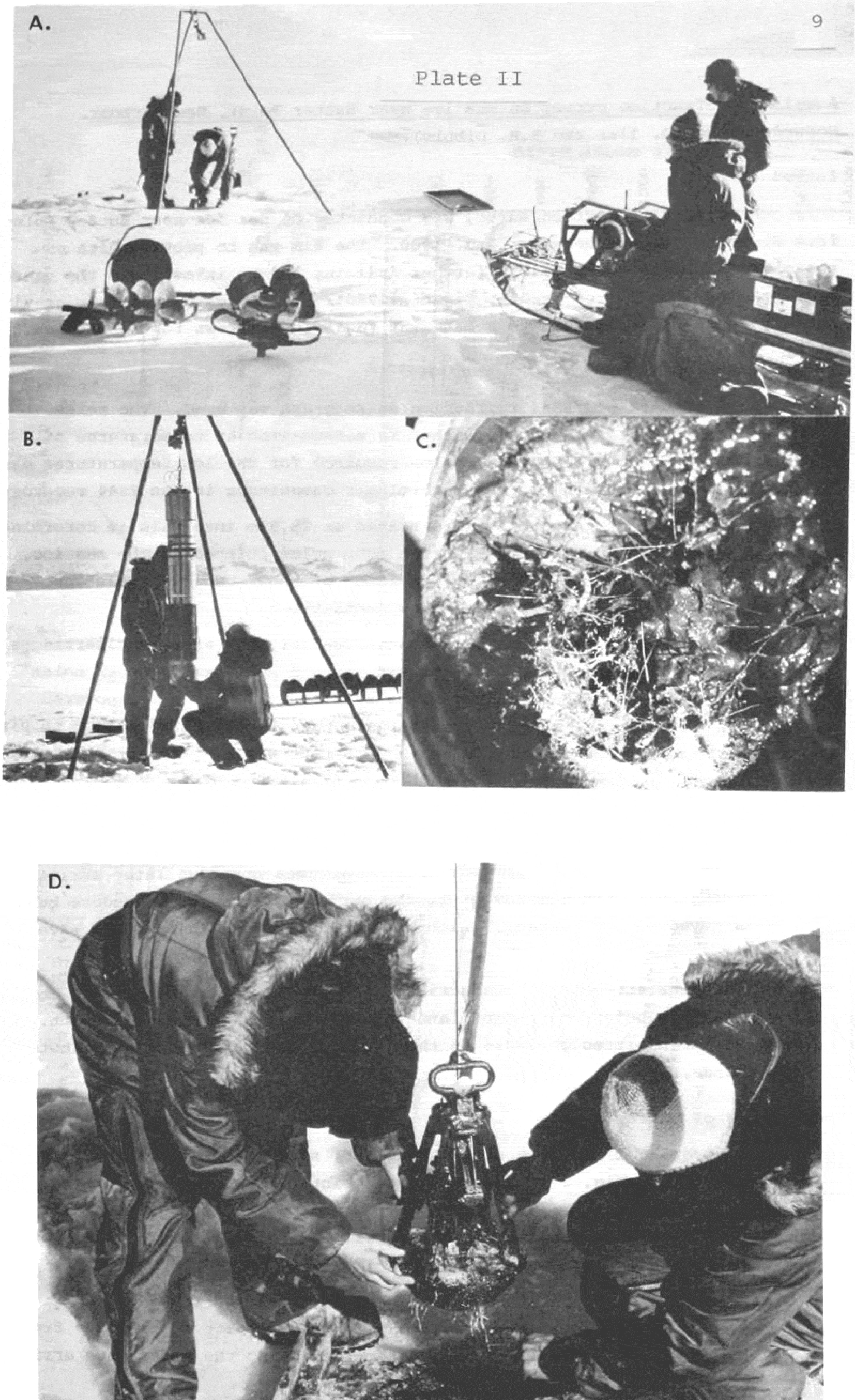
A. The sphincter corer being lowered by winch through the 2m thick sea ice. The winch is mounted and operated on a Tamworth sledge. Twelve inch diameter ice augers and powerhead used to drill the sea ice access holes in the foreground.

B. Assembled corer ready to lower. The sphincter sleeve in the coring head is being checked.

C. The undisturbed top of a core retained in the sphincter corer. The core comprises: muddy sand, silica sponge spicules up to 100mm long and calcareous bryozoan.

D. Sediment and sponge spicules retained in an orange-peel grab.

Plate II



A seismic refraction survey on sea ice near Butter Point, New Harbour, McMurdo Sound (D. Iles and R.R. Dibble).

Introduction:

A seismic refraction survey was conducted on sea ice near Butter Point from November 26th to December 3rd, 1980. The aim was to provide data on sediment thickness for possible further drilling and to investigate the cause of a gravity anomaly reported by Sisson (1980). He suggested that the gravity anomaly could be attributed to a basement fault, downthrown to the northeast.

Instrumentation:

A 12-channel SIE/RS44 refraction seismograph was used. The seismograph was operated by the second author in a Snow-Trac at temperatures of approximately -10°C. The only adaption required for the low temperatures was the replacement of several large electrolytic capacitors in the RS44 recorder.

The 12 vertical geophones were spaced at 29.95m intervals as determined by the geophone cable. They were frozen into holes chipped in the sea ice, which was covered in most placed by 100-200mm of snow. Noice levels were extremely low, even during "blowing snow" conditions.

The explosives used were 1.1kg cartridges of AN60 and 1.6kg cartidges of AN95. They were suspended on detonating cord down 150mm diameter holes drilled through the 2m thick ice by means of a "one man" gasoline powered auger. Plain No. 6 caps and safety fuse were used by the first author to fire the charge. Except for one day, when an assistant was available, the survey was carried out by two people (the authors) using a Snow-Trac, a Snow-Tric snowmobile, and a sledge for transport.

Details of charge size and depth are tabulated in Appendix IA. At the depths used we did get bubble pulses which sometimes obscured later arrivals. However, bringing the charge closer to the surface of the ice to reduce bubble pulses destroyed the shot holes, which we needed to reuse in order to save time.

A shot instant detector (described in Appendix IF) switched on a tone about six seconds before each shot, and terminated it at the shot instant. The tone was transmitted by radio to the recorder and marked the shot instant on the records.

Positioning of Survey:

Two reversed lines were shot, using four shot points (SP.I to SP.IV) shown in Fig. 1 and Fig. 2 . The four shot points were surveyed by Messrs. C. Fink and G. Neale of the N.Z. Lands and Survey Department. Line 2 crosses the positions of the proposed fault at SP.III. Using SP.III both halves of Line 2 were reversed.

The spreads were positioned using a metre wheel and lined up on Trig Herb. Their exact offset distances and angles with respect to the line from the shot point to the spread were then determined using the water wave arrival

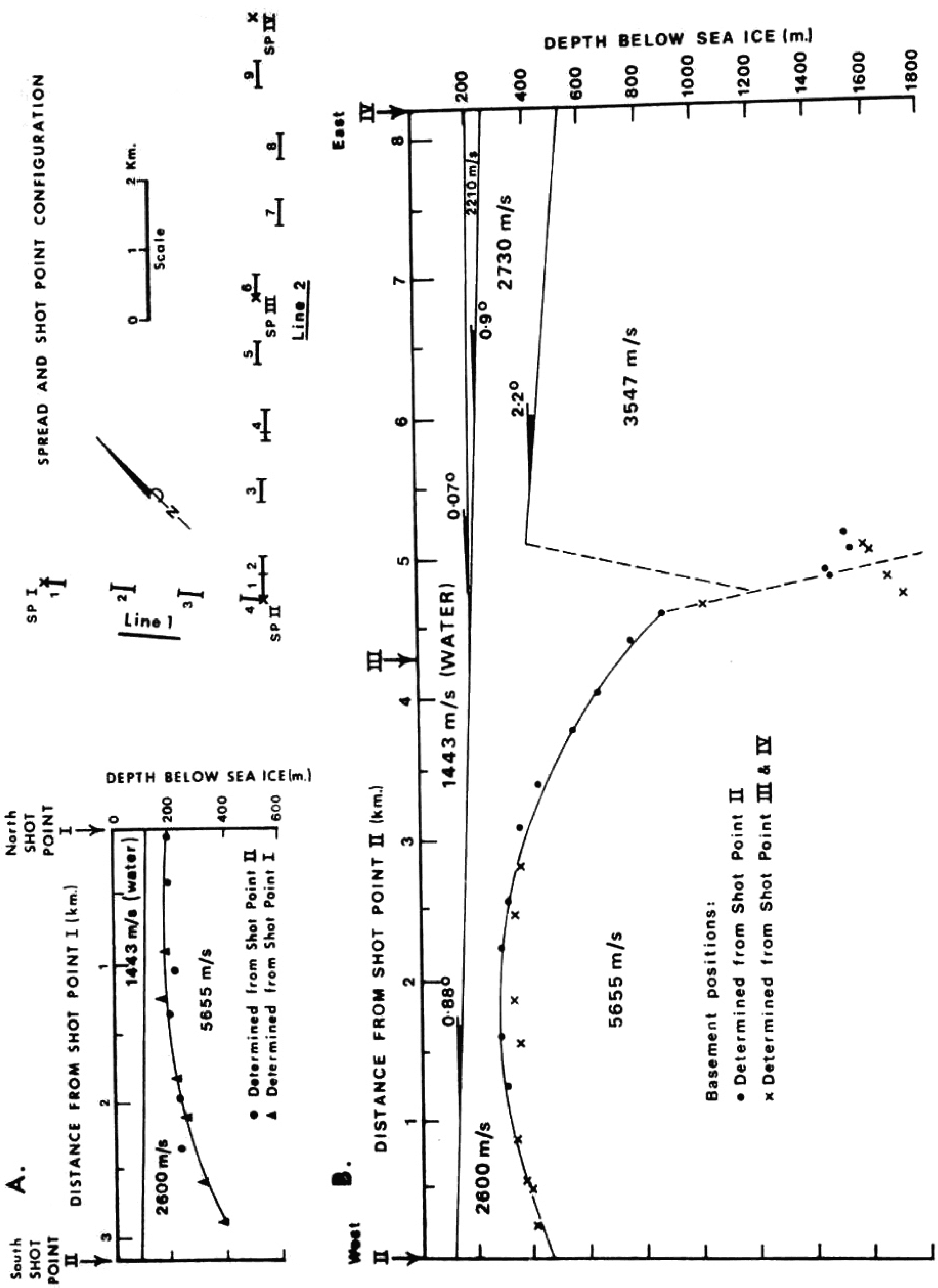


Figure 2 : Interpretations of Line 1 (A) and Line 2 (B).

times to determine the distance from each shot point, which together with the surveyed distances between the shot points enabled us to solve the resultant triangle and, assuming the spread was lined up on Trig Herb, to calculate the angle between spread and shot directions.

The water wave velocity was determined using shots fired from one shot point to another, since those distances were known to within a few metres. The mean velocity was $1443 m.s^{-1}$ over 6 results, which ranged from 1441.2 - $1446.1 m.s^{-1}$.

Results and Analysis:

Appendix IB lists the spread offset distances and the apparent velocities and intercepts of the refraction arrivals. The velocities have been corrected for angle between spread and shot directions.

The time distance graph for line 1 (Appendix IC) shows a single refraction arrival of high apparent velocity typical of basement rock. The interpretation by the first author using a novel ray tracing method (Appendix IG) and a velocity of 5655m.s is shown in Fig. 2A .

Refractions above the basement were not recorded from line 1, but depth sounding data nearby (Ward - this report) require a low velocity layer between the sea floor and basement. The interpretation in Fig. 2A assumes for the layer a velocity of 2600 m.s, the same velocity determined for the sediment layer at SP.III on line 2.

The time distance graph for line 2 (Appendix ID) indicates one sedimentary layer over the basement at the West end and three sedimentary layers at the East end. Guided by the least squares line segments for each spread, straight time distance lines satisfying the theoretical requirements for a plane-layer structure were drawn on (Appendix ID). The arrivals to the East from SP.III are very poor and the $2207 m.s^{-1}$ line has been drawn in using known bathymetry and the time interrupt of the $2322 m.s^{-1}$ line.

The adopted lines for the sedimentary layers were interpreted in terms of dipping plane layers (Fig. 2B), using the formulation of Mota (1954). Then the basement arrivals were interpreted by the first author using the ray tracing method (Appendix IG). An average sedimentary velocity of $2600 m.s^{-1}$ has been assumed on the West half of the line.

The $3547 m.s^{-1}$ layer would appear to be cut off as you move towards the west since the $3681 m.s^{-1}$ refraction was very weak and the arrivals on spreads 6 and 7 from SP.II ($3398 m.s^{-1}$ and $3146 m.s^{-1}$ arrivals) are believed to be basement refractions and their low apparent velocity is not consistent with an intermediate velocity layer with as high a velocity as $3547 m.s^{-1}$, on such a shallow dip. This cut-off is consistent with but not indicated by our arrivals from that layer. The alternative is that the interface between the 2730 and 3547m.s layers has undulationsin it so as to increase its dip to the east below and west of spreads 6 and 7. There is no arrival from SP.IV on spread 6 supporting this, but if it were the case, the basement positions shown between 3750 and 4650m east of SP.II would move westward and downward, and the cross at 4650m east of SP.II would move eastward and downward, i.e. the basement would bend downward more rapidly when approaching SP.III from the west.

A mean sedimentary velocity of 2600m.s was used for analysis of the basement arrivals on spreads 3-7 from SP.II but for the remaining two spreads (8 and 9) the three plane layers were used. The arrivals from shot points III and IV were analysed with $2600m.s^{-1}$ sediment to the west and the plane layer case to the east of SP.III.

The basement velocity of $5655m.s^{-1}$ was obtaining by averaging the slopes of the segments where a basement refraction was recorded from both directions on the same spread. A simplified interpretation by the second author, using plane layer interpretation theory, is given in Appendix IE.

Conclusion:

This survey has defined the shape and depth of the basement-sediment interface for a line east from Butter Point. Nearshore the surface is gently domed, averaging 400m below sea level, but dip increases eastward reaching up to 65^o at 6km from Butter Point. Beyond this distance the data is insufficient but indicates a depth to basement greater than 1.8km.

The present interpretation shows that SP.II (nearshore) is underlain by 300m of sediments ($2600m.s^{-1}$) overlying basement ($5655m.s^{-1}$). SP.IV 8km east is underlain by a thin (60m) layer of low velocity sediment ($2210m.s^{-1}$) another sedimentary layer of 250m ($2730m.s^{-1}$) and a further and thicker sedimentary layer ($3547m.s^{-1}$).

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Paleomagnetic Studies (D.A. Christoffel).

The field work follows on from VUWAE 23 of 1978-79 season when the Beacon sandstones at Mt. Bastion, Beacon Heights and Table Mt. were sampled. From that work, it was found that those rocks were very weakly magnetised and their magnetic direction had been reset at the time of the massive dolerite intrusions during the Jurassic period (160 My ago). The reason for this result is not clear and is the subject of further investigations now that our cryogenic magnetometer is operating.

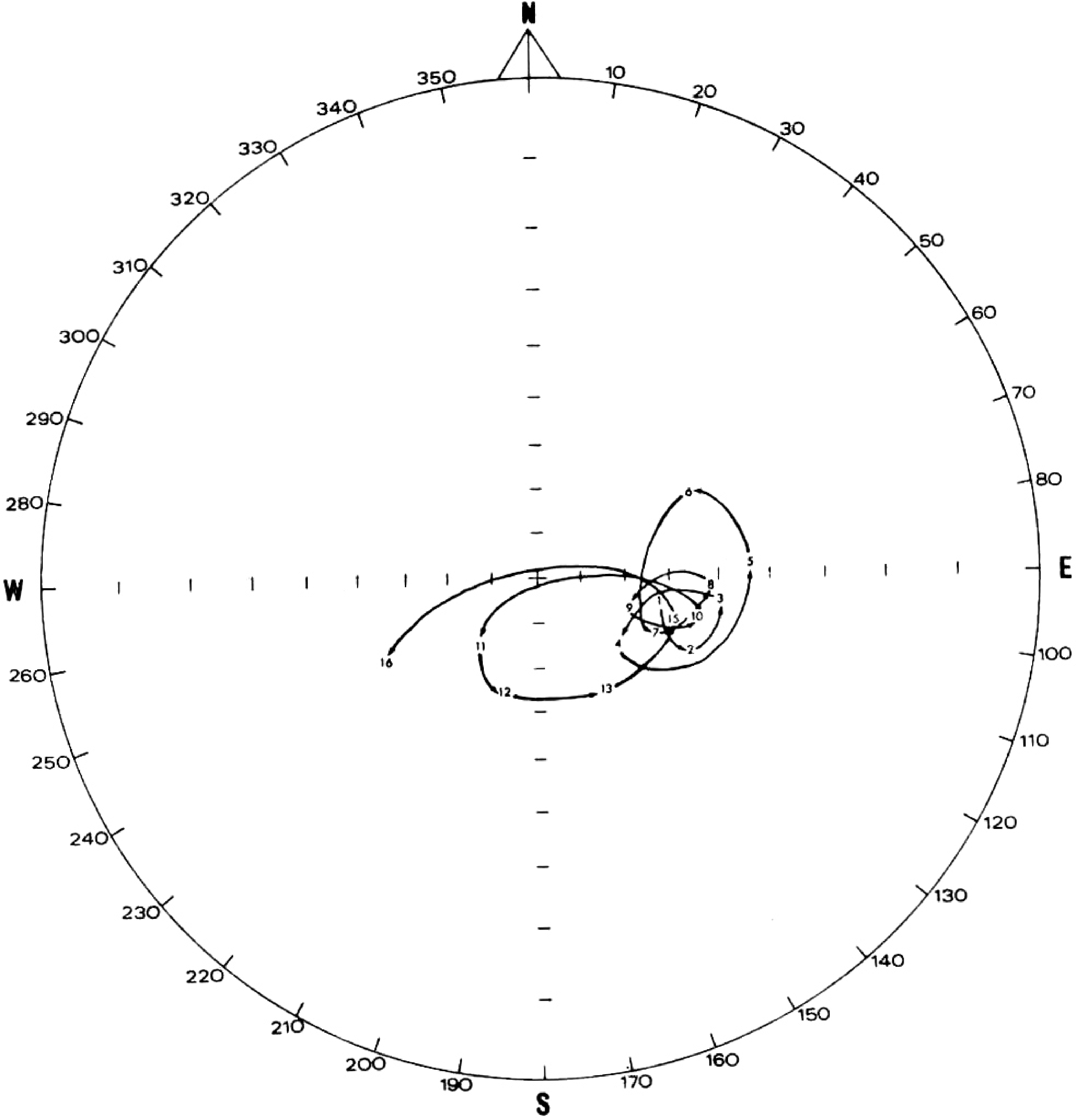
For the above reason, the object was to sample only the red beds which occur at two periods within the Beacon Supergroup. The first period is near the base of the section - the Terra Cotta siltstone and probably Lower Devonian in age (Plume, 1975). The second is in the Upper Devonian, near the boundary with the Permian, called the Aztec siltstone (McPherson, 1976). The red colouring is due to the haematite and is usually more stable magnetically than the magnetite which is the principal magnetic constituent of the sandstones. The Terra Cotta siltstone outcrops at Mt. Kempe, Table Mt. and Knobhead. The Aztec siltstone outcrops at Portal Mt., Alligator Peak and Mt. Crean.

Our rock coring equipment was basically the same as for VUWAE 23, incorporating the modifications to equipment and technique suggested by that work. We used heavier coring barrels than previously and they lasted very well; we used pure anti-freeze which did not freeze in the pipes (although at times it became thick and difficult to pump). It was fortunate that our sampling methods worked so well, as with weather and transport holdups our time at some sites was severely curtailed. We now have a very portable rock sampling system which could have many uses besides sampling for paleomagnetic purposes.

The samples of the dykes (of Ordovician age) in the Wright and Miers Valleys as well as the volcanics of Ross Island, during my second visit, were also valuable additions to our collection.

The strongly magnetised basalts from a series of flows on Observation Hill have been measured and analysed. Measurements had previously been made by Kyle and Treves (1974) and Funaki (1978). We have sampled a more complete sequence of flows and although we cannot judge what time period is represented, the Virtual Geomagnetic Pole positions from successive flows show a consistent trend not found by the previous workers. The rocks (1.2 My) are reversed and these measurements make a contribution to almost non-existent information on past patterns of secular variation of the earth's magnetic field in Antarctic regions - see Figure 3.

Pilot measurements have been made in the red bed samples from all localities. They are sufficiently weakly magnetised to require measuring on the cryogenic magnetometer which has operated for a limited period only. Most of the initial measurements on the red samples give the same directions as the Jurassic dolerites, indicating that they acquired a component of magnetisation, either through heating or chemical alteration.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No significant changes are expected until the samples have been thoroughly demagnetised beyond 600°C. There are signs of changes beginning (see Fig. 4) but we have to await the completion of further paleomagnetic measurements before reaching our final conclusions.

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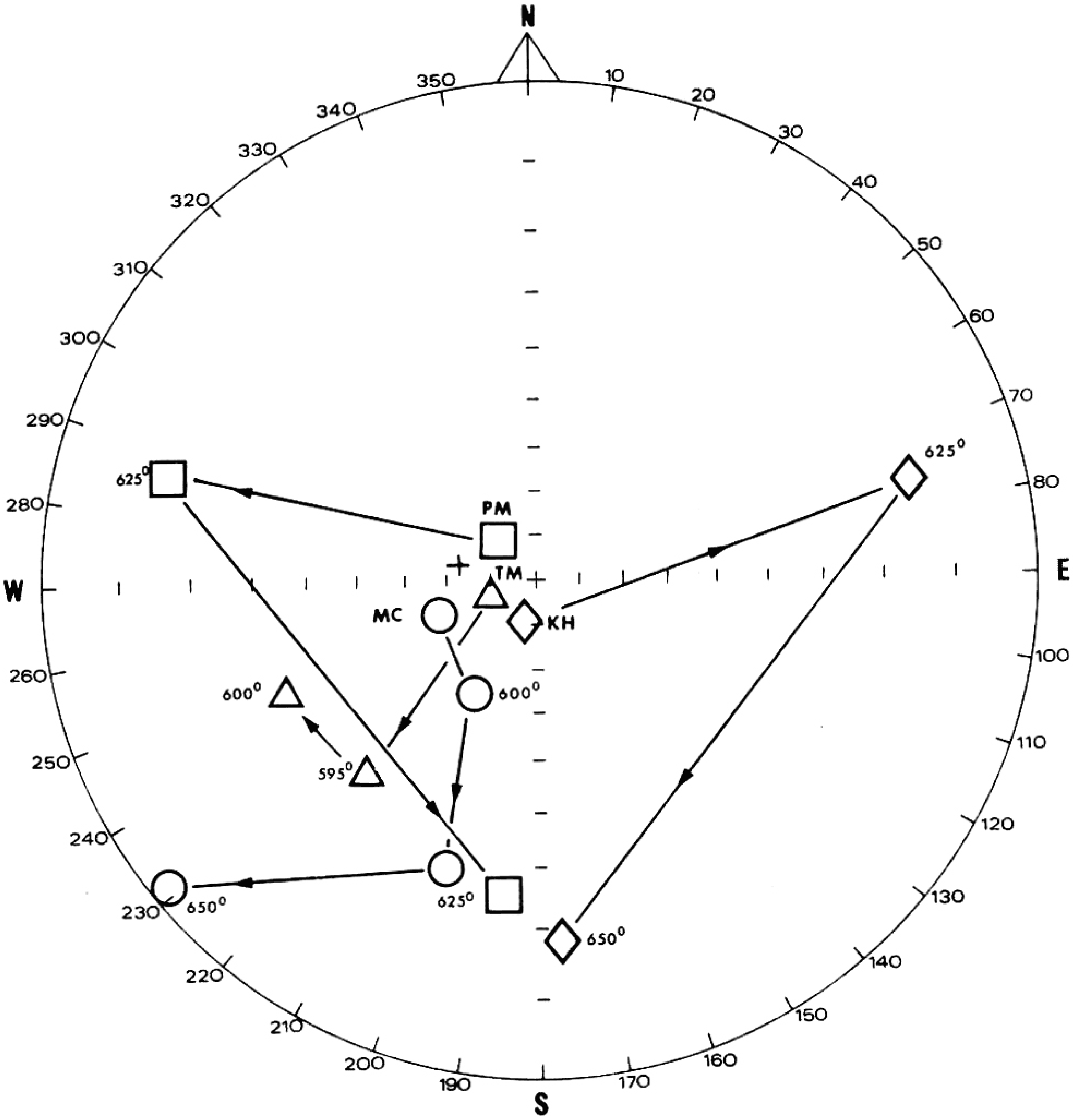

Figure 4: Strike and dip of red bed samples from Knobhead (KH), Table Mt. (TMt), Mt. Kempe (MK), Alligator Peak (AP) and Mt. Crean (MC). Numbers beside the samples show the thermal demagnetising temperatures. The cross shows the mean strike and dip of the Jurassic dolerite.

It can be seen that at the higher temperatures, the samples are beginning to move from dolerite position.

Plate III

A.

Sampling a red bed sequence of the Terra Cotta Siltstone at Mt. Handsley. The red beds have been extensively burrowed.

B.

Two cold paleomagicians sampling a snow-covered section at Table Mountain. Drill holes arrowed.

Granites and Metamorphic Rocks of the Areas between the Miers and Salmon Valleys (Frank Reid).

The area between the Miers and Salmon Valleys has been remapped in greater detail than before and several corrections have been made to the small scale maps of Blank et al. (1963). A simplification of the stratigraphy of the metasedimentary rocks will be proposed and areas mapped before as undifferentiated granitic intrusions have been mapped as different intrusive events. The initial distinction between different granitic bodies has only been made on field relations and hand specimen inspection at this stage, but this is presently being extended to petrographic and geochemical classification. The area has been extensively sampled and it is hoped that this may provide a basis for a coherent nomenclature of some of the granitic rocks in the dry valley region which is at present somewhat confused. Samples were collected from type areas of Granites in the Wright Valley and these will be used for comparison.

At least 5 distinct granite bodies intrude the area and these can be arranged in a time sequence by field relationships between the different granites and the extent of deformation suffered by the different bodies. Four of these granites are shown to be mutually intrusive in the north wall of the Miers Valley (Plate IVA).

Preliminary thin section petrography has established that most of the 'granites' in the area are granodiorites and diorites rather than true granites with different types often having distinctive mineral assemblages, with the presence or absence of hornblende being one of the most important distinguishing features.

There is little evidence of the mineralogy of the granites being affected by the high grade metamorphic events known to have occurred in the area.

Blank et al. (1963) reported that the metasedimentary rocks of the area had undergone regional metamorphism to amphibolite facies. Preliminary thin section petrography has confirmed this but in the section chosen no minerals suitable for geobarometry or geothermometry were found. The metasediments intruded by the later granites show little sign of assimilation and retrogressive metamorphism is uncommon.

References

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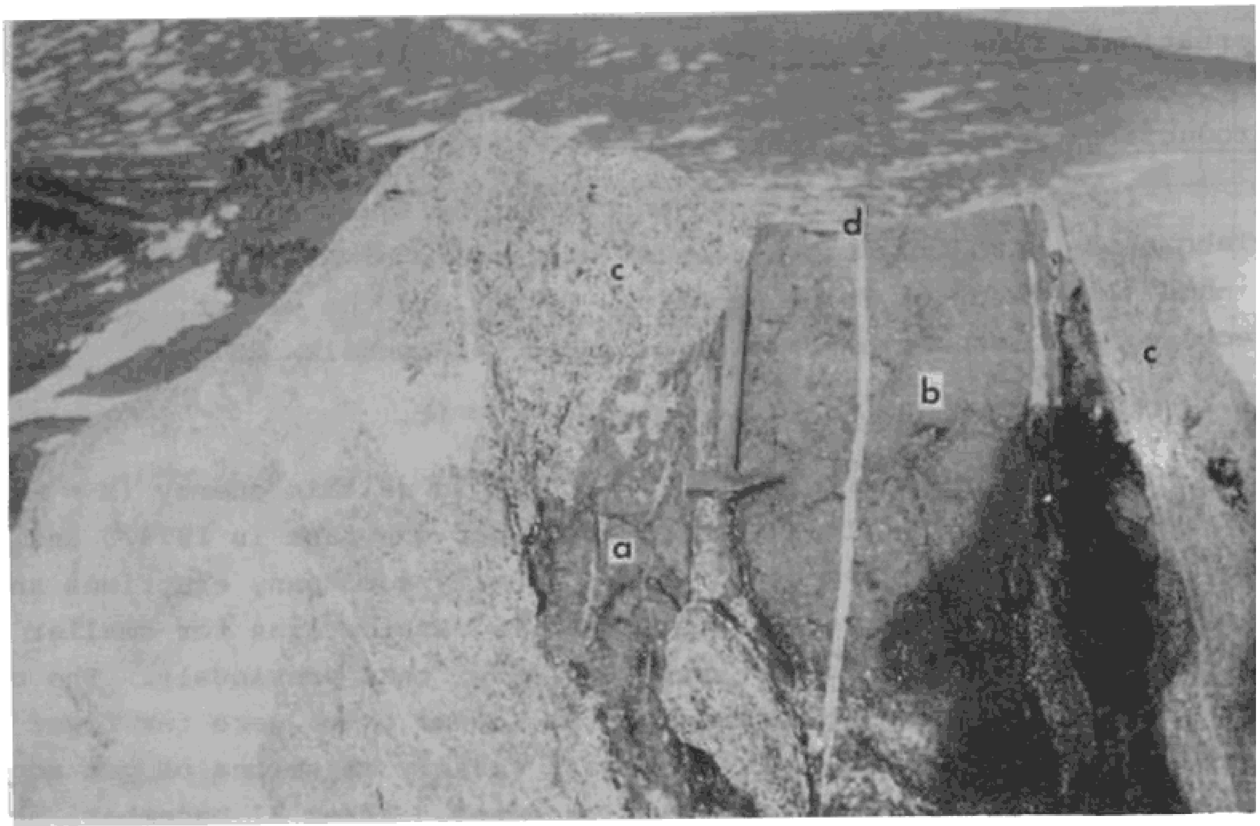
Skarn studies in the area between the Miers Valley and the Salmon Valley (Steven Simmons).

Six weeks were spent in the field sampling and mapping granite-marble contacts. Suitable outcrops of skarn were mainly restricted to the ridge crests where the exposure was relatively free of any scree cover. The coarsely sacchroidal Salmon Marble was often difficult to sample as specimens would readily crumble when struck with a hammer.

Contact aureoles were usually several centimetres in thickness. However, some localised pods, rich in either garnet or sulphides, were some tens of centimetres wide (Plate IVB).

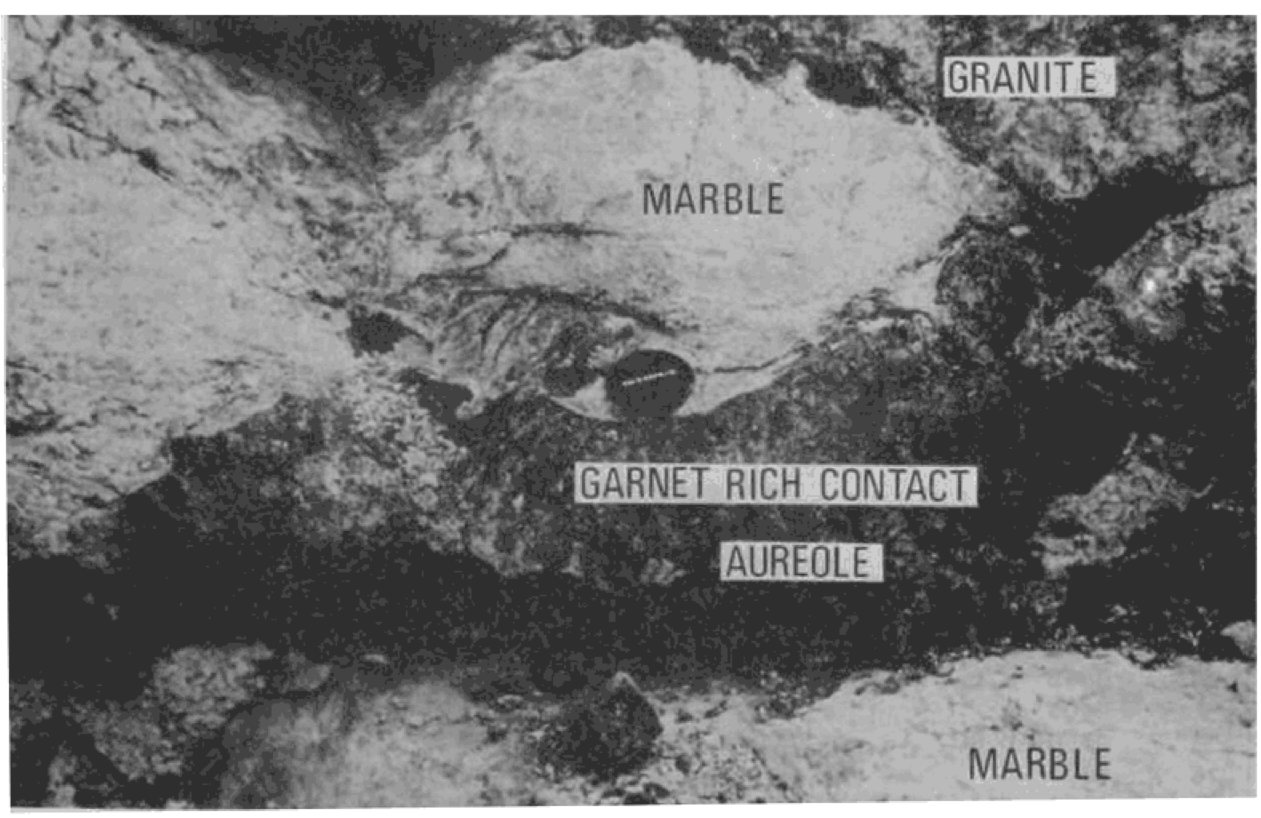
The field work will be followed up at Victoria University with a mineralogical study which aims to evaluate the thermal regime of skarn formation. Preliminary rock sectioning has revealed some striking contact mineralogy; in hand specimen garnet, epidote and some sulphides are identified. Detailed petrological and microprobe studies will be made on the granite-marble samples to determine the parameters (e.g. temperature, CO_2 pressure) involved in the formation of skarn.

Plate IV



A.

Four mutually intrusive granitoid rocks from Miers Valley area. Relative ages are determined by cross cutting relationships, (a = oldest, to d = youngest).



B.

A garnet-rich contact aureole. This example formed by a minor vein of the granite intrusion.

International Mount Erebus Seismic Survey 1980/81 (R.R. Dibble).

Introduction:

IMESS is the brain-child of Dr. Philip Kyle, and was set up in collaboration with Dr. Jurgen Kienle (University of Alaska), Dr. Katsutada Kaminuma (Institute of Polar Research, Tokyo) and the writer. The principal objectives and responsibilities are listed in Appendix 2B.

Results:

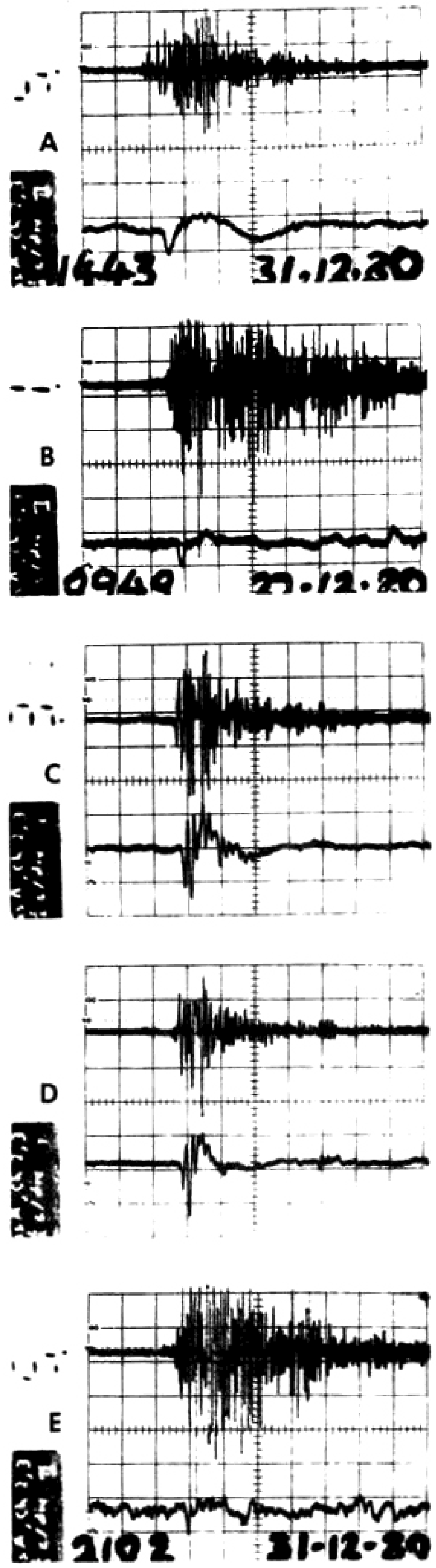
Earthquakes in the range 1 to 10 kJ in seismic energy (M = -2.8 to -0.5) were occurring in 1980/1 at roughly half the rate in 1974/5 and 1978/9. Above 10 kJ, where the events on Erebus usually accompany eruptions and exceed the number predicted by the linear regression line for smaller earthquakes, there were also fewer events in 1980/1 than previously. The clean white snow around the vents in the crater showed there were far fewer bombs ejected. Furthermore, the eruptions were usually emissions of gas accompanied by a loud roar, and without an explosive onset. After 27 December, some of the eruptions were explosive, and Kyle was able to collect a few fresh lava bombs from the crater rim. A list of eruptions is given in Table 1.

TABLE 1: Eruptions of Erebus between 20 December 1980 and 9 January 1981.

Date	Time NZST	Seis. Power kW	Audio level dB	Description and Observer's location	Duration second	Observer
Dec.						
20	2131	NA		Roar, on monitor speaker	-	Dibble
21	0030	NA		Roar, heard in tent	30	Dibble
"	1121	NA	NA	Weak roar, on speaker	-	Dibble
"	1128	NA	NA	Weak HF roar, then strong VLF roar	-	Dibble
"	1345	0.02		VLF roar, overloaded speaker	10	Dibble
"	1427	0.013		" " " "	5	Dibble
22	02+	0.07		(Loud rumble, on speaker	-	Kienle
				(" " , in tent	-	Parish
"	04+	NA	NA	(Loud rumble, on speaker	-	Kienle
				(" " , in tent	-	Parish
"	05+	NA	NA	Rumble, on speaker	-	Kienle
"	0910	NA	NA	Rumble, overloaded speaker	-	Dibble
"	0914	NA	NA	" " "	-	Dibble
"	2255	13		Moderate double rumble, at Nausea knob	-	McIntosh
23	0133	0.05		Moderate double rumble, in Hut	6 + 3	McIntosh
24	1721	NA		Long strong rumble, at crater rim	-	Dibble
"	1949	NA		Long medium roar, on speaker	-	Dibble
25	0058	1.6		Short sharp burst, on speaker	-	Kyle
"	0409	1		Long strong roar, on speaker	20	Kyle
"	0550	0.06		Short roar, on speaker	7 - 10	Kyle
26	0219	5		Moderate sharp roar, on speaker	3	Kyle
"	1229	NA	NA	(Long moderate roar, on speaker	-	Dibble
				(Long loud roar, outside hut	10	Kyle
"	1249	NA	NA	Long roar, on speaker (wind?)	20	Dibble
27	0746	0.02	<-31	Long roar, on speaker	8 - 10	Kyle
"	0949	0.8	<-35	Strong roar, on speaker	18	Dibble
"	1610	-	<-40	Weak roar, at crater rim	2 - 3	Estes
"	20c	?	NA	Explosion and bombs, at crater rim	-	Bulleid

TABLE 1 (contd.)

Date	Time NZST	Seis. Power kW	Audio level dB	Description and Observer's location	Duration second	Observer
"	2055	0.02	NA	Long loud roar, in main crater	-	Terai
28	0748	0.1	-30	Medium roar, on speaker	12	Estes
"	1123	0.04	<-32	" " " "	12	8 people
"	1258	25	-31	(Short bang, on speaker	2	Estes
				(Explosion and bombs, at crater (rim	-	Otway
"	2035	50	-27	Short sharp moderate bang, on speaker	2	Dibble
29	1259	13	-28	(Short sharp roar followed by (long medium roar (wind?), (on speaker	-	Dibble
"	1335	64	-29	Small short sharp roar over wind noise; on speaker	-	Neale
"	21·3		-31	Well recorded but not observed		
30	1241	1	-30	Medium roar trailing off; on speaker	10	Parish
"	1441	6.3	-29	Short moderately sharp bang, on speaker	2	Kyle
31	04·2	0.02	-27	Roar with sharp start, on speaker	-	Bulleid
"	1009	0.4	<-37	Medium roar with sharp start, on speaker	4	Dibble
"	1319	0.32	-33	Moderate roar, on speaker	5	Dibble
31	1443	0.16	-29	(Strong short roar, on speaker	3	Dibble
				(" " " , at crater rim	-	Parish
"	1644	50	-26	(Moderate explosion, outside hut	5	Dibble
				(Sharp bang with bombs, at rim	-	Estes
"	1940	0.16	<-34	Strong roar, on speaker	-	Dibble
"	2259	160	-27	Strong short roar, on speaker	2	Dibble
Jan.						
1	1749	25	-31	Short sharp explosion	2	Prosser
"	2330	0.4	-35	Moderately weak roar, on speaker	5	Dibble
2	0948	0.1	-36	Medium short roar, on speaker	3	Dibble
"	1753	0.6	-39	(Medium long roar, on speaker (and at rim	11	Kyle
"	1850	5	-32	(Short loud burst, on speaker (and at rim	5	Bulleid
3	0121	0.8	-38	Long roar, on speaker and in tent	12	Kyle
"	0139	1	-35	(Long roar, in tent. Loud with (second long roar, on speaker	8,10	Dibble Kyle
"	1503	1	-11	Moderate roar, on speaker	10	Estes
4	0351	1.6	-15	Loud roar, on speaker	10	Kyle
"	0859	5	-13c	Sharp explosion, on speaker	5	Kyle
"	1317	20?	?	Short sharp explosion, on speaker	6	Bulleid
"	1443)	5	-13	(Short, on speaker	2	Estes
"	1445)			(Moderate roar, on speaker	8	Estes
"	1611	50	-14	(Short weak roar, on speaker	-	Dibble
				(Very sharp, at crater rim	1	Estes
5	0440	1.6	-25	Eruption sound, in tent	10	Parish
"	2239	0.25	?	Small explosion, on speaker	2	Estes
6	0200	10	-19	Sharp roar (wind?), on speaker	2	Kyle
"	0208	0.25	-21	(Long loud tapering roar, on (speaker	15	Kyle
				(Possible second small roar 30s (later	2	Kyle
7	0357	NA	NA	Loud roar, in hut (no speaker)	10	Otway
"	1256	NA	NA	Dull explosion with bombs	-	Dibble
"	1902	NA	NA	Long clear rumble, in hut	-	Dibble
8	2057	NA	NA	Long rumble, in hut (heater vibrating?)	-	McIntosh
9	0655?	NA	NA	Short	2	McIntosh
"	0833	NA	NA	Short rumble	3	Prosser



A. Roaring emission of gas at 1443 NZST, on 31 December 1980.

B. Roaring emission of gas at 0949 NZST, on 27 December 1980.

C. Explosion ejecting bombs at 1644 NZST, on 31 December 1980.

D. Sharp roar at 0219 NZST, on 26 December 1980.

E. Earthquake not accompanied by eruption at 2102 NZST, on 31 December 1980.

Figure 5 : Comparison of seismograms and microphone recordings for five events.

A distinction between gas emission and explosion seems to be apparent in the microphone recordings. Roaring gas emissions of short (c. 3s) duration, such as at 1443 NZST on 31 December, were recorded as a compressional air pulse of duration about one second (Fig. 5a) followed by a single oscillation of period 1/7 Hz which is probably the organ pipe mode of the crater. The accompanying earthquake was small (160 J) and preceded the air wave by about one second. Fig. 5b shows another roaring gas emission of about 18s duration which occurred at 0949 on 27 December. The air-pulse onset is similar, but the organ pipe oscillation is not obvious, presumably due to the long duration of the discharge. Explosions which eject bombs, such as at 1644 NZST on 31 December, have a strong oscillatory onset of frequency 2 Hz superimposed on the compressional air pulse, followed by the 1/7 Hz coda (Fig. 5d) but the coda is of shorter period (c. 4s). This event was not observed well enough to know if bombs were ejected at the time.

Earthquakes not accompanied by eruptions, such as the 2 kJ earthquake seen recording at 2102 NZST on 31 December 1980, were not recorded on the microphone (Fig. 5e), whereas in 1978/9 the larger earthquakes were recorded (VUWAE 23, 1978/79 Immediate Report). Possible reasons are obscuration by the high wind noise level in 1980/1, and differences in the microphone. In 1978/9 it was a dynamic microphone in a Helmholst resonator, giving a sharply peaked response, whereas now its response to waves of constant pressure amplitude rises proportional to frequency (6 dB/octave) up to the resonance frequency of about 80 Hz - then flattens off and falls at 6 dB per octave rise up to the frequency for which Q = 1. Above this the response falls at 12 dB per octave rise in frequency. Both microphones also act as ground accelerometers to some degree.

The results expected from the figure of eight induction loop were, (i) the detection of magnetic signals from eruptions of conducting magma in the static magnetic field of the earth, and (ii) the detection of spectral effects in the magnetic micropulsations (dominantly of solar origin) recorded separately from the two halves of the loop. These expectations are not realised in the recordings presently available, due in part to the high static discharge noise prior to 1 January, and a break in the Crater loop between 1 January (when someone ploughed through it) and 4 January when the break was located and repaired.

No signals were detected on the Camp loop which correlated with any of the eight eruptions which occurred when correlation was possible. This result was expected. Of the three eruptions which occurred when correlation with signals on the Crater loop was possible, there was only a doubtful correlation with the eruption at 1749 NZST on 1 January. There was also one possible correlation with an earthquake at 19.0 hours on 5 January.

A comparison between the micropulsation spectra on each loop was made from the recordings between 7 and 9 hours NZST on 5 January 1981, when the signal/noise ratio was excellent. The two spectra (Fig. 7), which were determined with a variable 1/3 octave bandpass filter, have almost the same shape. If anything, the level on the Crater loop falls relative to that on

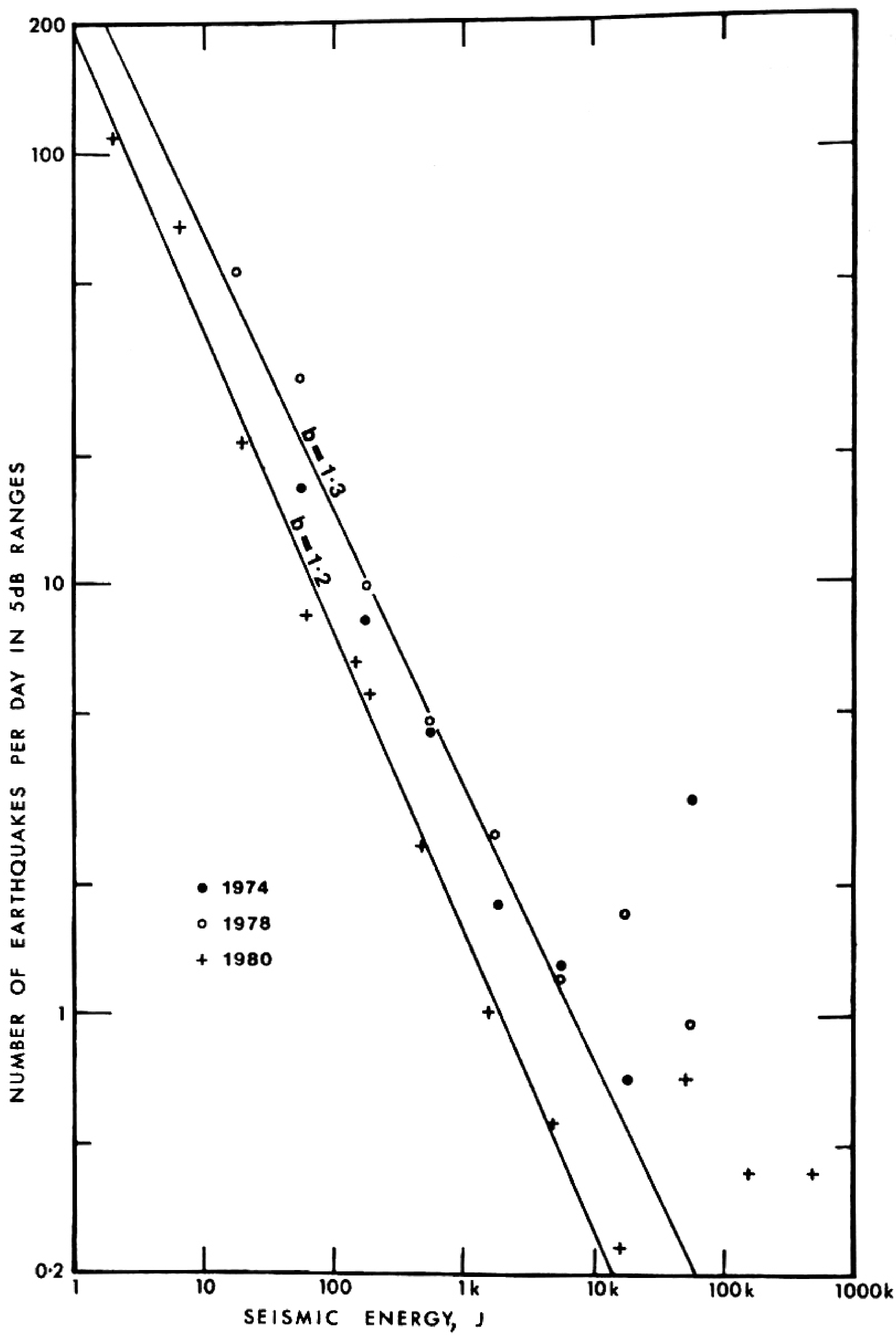


Figure 6 : Frequency of occurrence of Erebus earthquakes of all types versus seismic energy. The frequency in 1980/81 was about half that in 1974/75 and 1978/79.

the Camp loop by about 3 dB per decade rise in frequency between 0.1 and 1 Hz, but this could be due to minor instrumental differences between the two channels. It appears that either the conducting magma has no significant effect on the spectra at 1 Hz and below, or it affects both loops equally. Scale model experiments suggest that the former is the case unless the magma column has radius much greater than 200m and conductivity less than 0.5 mho/m.

Further results must await the processing of the telemetry tape recordings in Japan, following purchase of the playback equipment, and the receipt of tape recordings made over the winter. At the time of writing (12 May 1981) the telemetry signals are still being recorded satisfactorily at Scott Base.

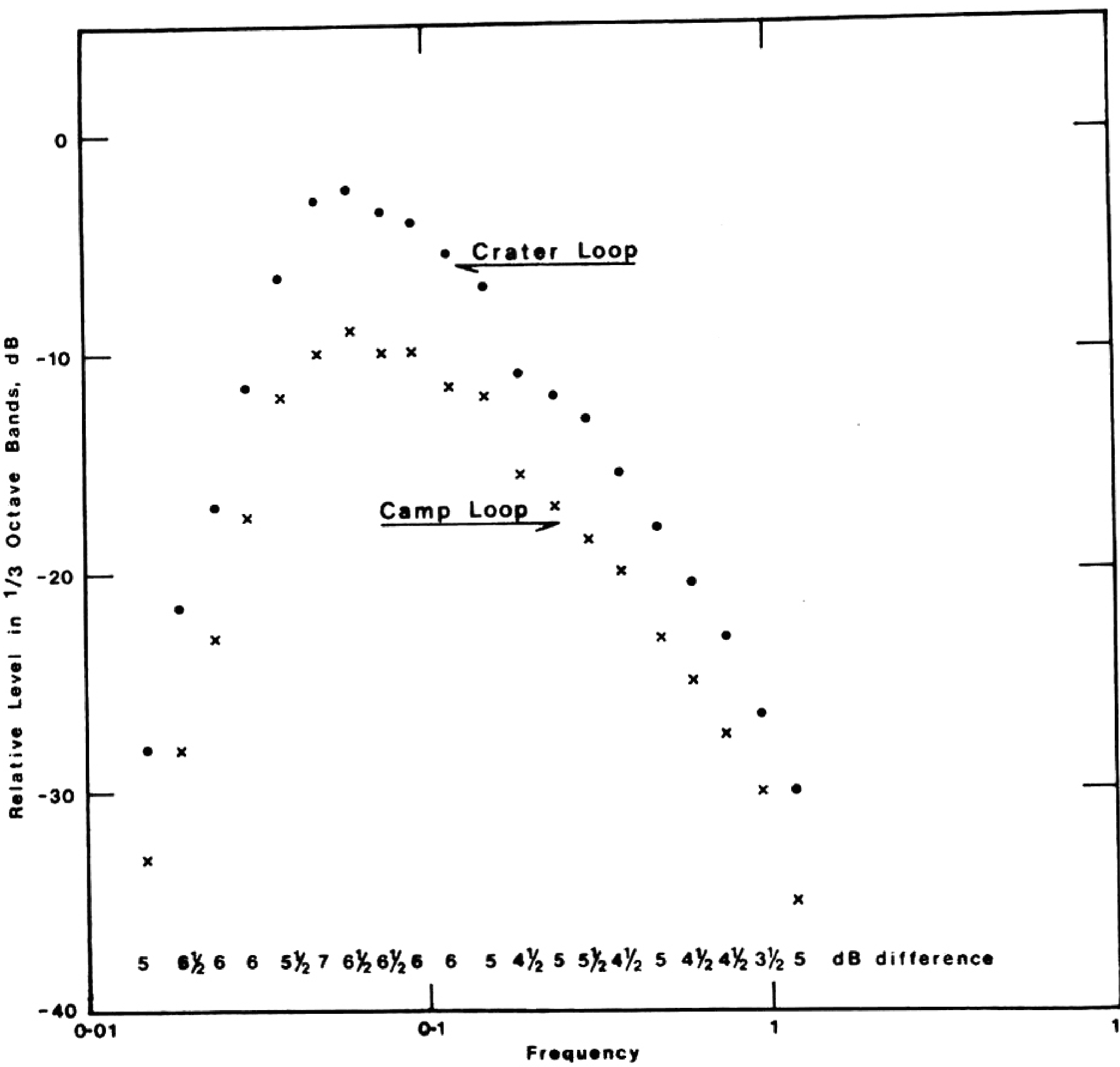


Figure 7 : Spectra of magnetic micropulsations recorded on the Crater and Camp loops between 0700 and 0800 hours NZST on 5 January 1981. Difference in level between the loops at each frequency are given in relative units at the bottom of the figure.

ASSISTANCE TO SCOTT BASE

Explosives for Ice Blasting (Alex Pyne).

Explosives have been used previously by NZARP events working on the sea ice. The main uses have been for seismic studies or to make access holes in sea ice to sample the sea water and sea floor. It was for both these purposes that members of Event 14 participated in an explosives course, arranged through the Department of Labour (Explosives Division), prior to departing for Antarctica.

In previous seasons sea ice thickness has been quite variable. In open parts of the Sound it is between 2 and 3m, but in a few places, notably Explorers Cove and the bay at Ferrar Glacier Snout in New Harbour, the ice has been up to 5m thick because it is several years old. The VUWAE portable motorised 12 inch diameter auger was not expected to penetrate overthickened ice so explosives were to have been used to complete the access holes. This season, however, nearly all the sea ice in the Sound was first-year ice a little over 2m in thickness, which was well within the auger's capability. Consequently, no explosives were used to make sea ice holes but were used for the seismic refraction programme and to blast the Scott Base ice quarry.

The explosives were obtained from the US Navy Support Force stores at McMurdo Station and will be partly replaced by stock donated to the expedition by ICI NZ Ltd. The ICI stock will be used by next year's expedition continuing the work on the sea ice. Electric detonators were not available from the McMurdo stores so plain No.6 detonators initiated with safety fuse were used. Plain detonators were considered to be the much safer option in antarctic conditions where static electricity is frequently developed in the dry air and from blowing snow. A reinforced detonating chord (10g/m P.E.T.N.) was used to initiate the main charges of either AN GD 95 or a 60% seismic grade gelignite.

Ice Quarry

Ice has been excavated from the ice cliff near Scott Base for several years for the base fresh water supply. Since the recent installation of the "reverse osmosis" plant, ice has only been used for the kitchen and as a standby water supply. In previous years the US Naval Support Force has blasted the ice cliff to reduce the ice to manageable size for the Scott Base ice melters.

This season in mid-October it became necessary to blast the ice quarry again when the reverse osmosis unit was inoperative. Event 14 volunteered to set the charges, to experiment blasting hard antarctic ice and to supply ice quickly for the base. The Navy was not expected to be able to do the job for several days. The quarry was blasted on 15 October and again on 19 November.

The ice cliff is composed of hard blue and white ice layers with less dense ice and granule snow layers composing the upper 4 metres. The layers dip 30° towards the road at the base of the cliff. On 15 October previous quarrying had formed a vertical ice face approximately 8m high and 12m wide.

A snow slope continued away from the top of the face at an angle of 30°.

To blast the face two sets of charges were laid. On the snow slope above, a track (0.5m wide) was dug parallel to the face and 5m up slope from the face edge. Ten vertical holes (4 inches diameter, 2.6m deep) were drilled from the track across the face in the layers of granule snow and thin ice (less than 0.3m). Two cartridges (55m dia.) of AN 95 were lowered to the base of each hole and the holes stemmed with snow and water which quickly began freezing. Thirty-two kg of AN 95 was used for the top ten charges.

Four horizontal holes were drilled 1m above the quarry floor, and about 3m apart across the face. These holes were drilled 2.6m deep into hard ice. Three cartridges of AN 95 were loaded at the end of each hole and also stemmed with snow and water. Setting the charges for this blast took six people most of the day, the major proportion of time being used to drill the holes and set the top 10 charges on the slope above the face. In total 51 kg (two cases) of AN 95 high explosive was used.

The resulting blast removed a slab of snow-ice from across the top of the face which was about 12m long, 5m wide and 3m thick. Large blocks of hard ice were also dislodged from the face by the bottom charges. The blast on October 15 was not as successful as expected but nevertheless kept the base supplied with water for just over a month.

The ice cliff was again blasted on 19 November when a different and quicker method of setting the charges was employed. The floor of the ice quarry was again cleared leaving a vertical ice face about 8m high and 12m wide. The 920 loader was used as a platform to drill 12 nearly horizontal holes, 4m long and 4 inches diameter, into the face. Three rows, each of four holes were drilled about 1m, 3m and 5m above the quarry floor, evenly spaced across the entire face. Thanks to the help from several Scott Base staff, drilling and loading took less than half a day.

Four cartridges of AN 95 were loaded at the base of each hole giving a total loading of 77 kg (3 cases) for the face. The holes were stemmed as previously with a snow and water slush.

This blast on 19 November was very successful. The entire face to 4m deep was dislodged and broken into "loader size" blocks. All of the ice was useful hard ice because contaminant soft snow had been removed in the previous blast. There was very little "fly ice" and it is concluded that the 3 cases of AN 95 was just sufficient for the estimated 400 cubic metres (4×10^5kg) of ice dislodged.

This season's experience has shown that for future blasts an excellent result would be obtained if two sets of charges were used. The smaller set of charges should be loaded into vertical holes (3-4m deep) across the top of the face. These would remove snow and porous ice and perhaps develop a vertical shear plane parallel to the face. The larger set should be loaded into horizontal holes drilled 4 metres deep into the face. This set would dislodge and break up the potentially useful ice. The operation could be carried out relatively quickly if the loader was used.

ICE QUARRY

Plate V

FIELD NOTES

Event 5

NARRATIVE

We were ready to start up Erebus on 4 December, but the weather was unsympathetic to us right from the start.

Between 9 and 19 December, Kienle, Estes and Kaminuma installed the telemetry receiver and recorder at Scott Base, and the geophones and transmitter at Abbotts Peak and Hoopers Shoulder on the flanks of Erebus. The main party of 10 including the writer, flew to the acclimatisation camp at the Fang on 10 December, and 8 of us reached the summit by helo on 17 December.

The second party flew to the Fang on 19 December. Continuous cloud developed there (although the summit remained clear) and they walked up a few at a time, the last arriving at the Summit Hut on 24 December.

In all, 105 man days were spent acclimatising instead of the planned 30.

By 19 December I had installed a low frequency microphone (8 inch Philips Hi Z speaker in 2 cubic foot sealed enclosure) and pre-amplifier in position on the rim between the main and side craters. It was connected by cable to an amplifier and monitor speaker in the Hut. The frequencies below 50 Hz were also recorded on channel 3 of tape seismograph A. Channels 1 and 2 were connected to a Willmore seismometer (Mk 1, Z, T_o = 1s) installed 220m towards the crater from the Hut.

By 20 December, Terai and Osada were recording a 4 geophone array (of 2km diameter surrounding the Hut) on their 2 tape seismographs.

By 23 December a figure of 8 induction loop, consisting of 3.6km of single conductor 1.5mm^2 PVC appliance wire, had been laid around the main crater rim and the Hut area by Prosser, Parish, Summerville, Terai and myself.

The crater rim loop (3) was recording on channels 1 (high gain) and 2 (low gain) of tape seismograph B, and the Hut loop (4) on channel 3 (separate high gain amplifier) as shown in Figure 8.

By 26 December the loops were completely buried c. 50mm deep, eliminating noise due to the wire moving in the wind, but static discharge spikes limited the usable gain until bypassed by 1000 microfarad capacitors across the loops on New Year's Day.

Although Kienle had begun to telemeter signals from his summit geophone to Scott Base on sub-carrier 2380 Hz before Christmas, using a small Gel-cell battery, the main Carbonaire battery, and my three voltage controlled oscillators (VCO) for the telemetry link were not installed until 2 January (when we stopped waiting for the Helo "close support" and carried them). The batteries, the VCO and transmitter were in protective boxes buried in warm ground. In a change of plan, the wide-band frequency signals from the micro-

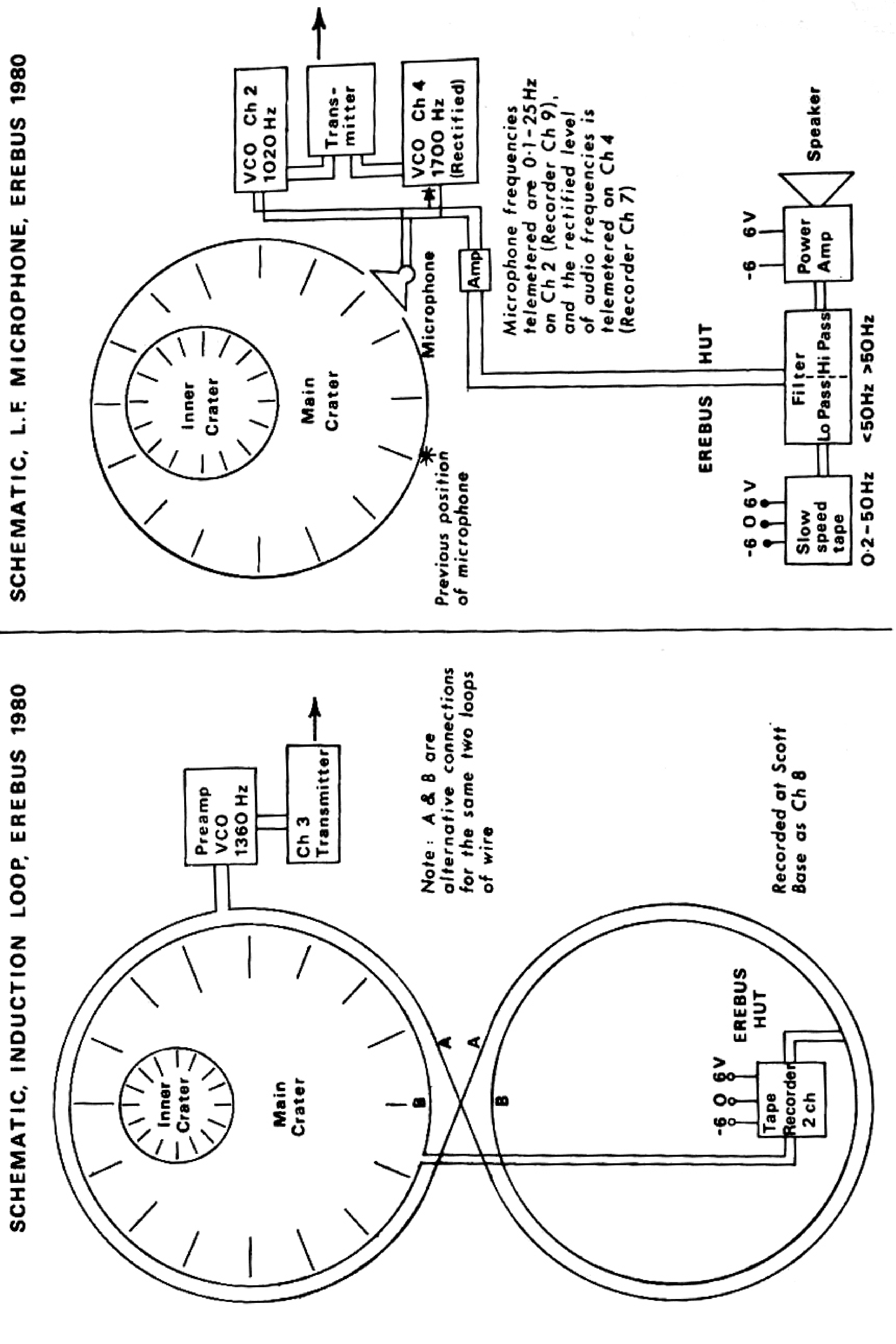


Figure 8 : Schematic diagrams of the author's equipment on Erebus.

phone were rectified and modulated on a 1700 Hz sub-carrier, instead of directly modulating the main carrier.

Scott Base were asked to tune the spare discriminator to 1700 Hz and to monitor the rectifie microphone signal. Subsequently they reported an extremely high level of signal.

On 4 January signals from the microphone were reduced by connecting a 10 ohm resistor across the microphone cable at the VCO box. The modulation of the 1020 Hz sub-carrier (and presumably the 1700 Hz one also) was then peaking at 10% in a 15 knot wind. This was determined at the Summit Hut by means of the Alaska Test Receiver and a 1020 Hz discriminator, and of course an anemometer.

On 5 January the loops were disconnected from tape seismograph B and connected in figure of 8 configuration to the 1360 Hz VCO and transmitter. All signals were then being telemetered, as in Appendix 2C , but our communication radios had failed and Scott Base could not be asked to monitor the signals and report the background level and number and size of events back to us, so that we could optimise the adjustments, and calibrate the system.

The entire party returned to Scott Base on 9 January. The Abbott Peak, Hooper's Shoulder, and Summit geophones were recording correctly, but of my three channels only the 1700 Hz microphone channel was connected, and it was tuned to 3700 Hz instead of 1700 Hz. Generous help from Tom Earle and Stan Whitfield enabled us to get the 1020, 1360 and 1700 Hz discriminators installed and the channels recording as in Appendix 2C (although the 1700 Hz discriminator was noisy due to a faulty component we could not find), and also my cargon packed before returning to New Zealand on 10 January (the last flight in time for my daughter's wedding).

Regrettably, there was insufficient time in which to confirm that good data from the microphone and the loop were being recorded. As expected, the signal levels on a quiet volcano during a calm day were very low - perhaps too low! The weather which trapped the entire party at the summit, and the lack of communications with Scott Base denied us the opportunity to get it right with certainty. Plate VIA, B and C show equipment at the transmitter, the Summit Hut and Scott Base.

COMMUNICATIONS

The party had a compak radio and two VHF hand radios from NZARP, a USARP radio, three Japanese hand radios, two University hand radios, and two Lands & Survey pack sets.

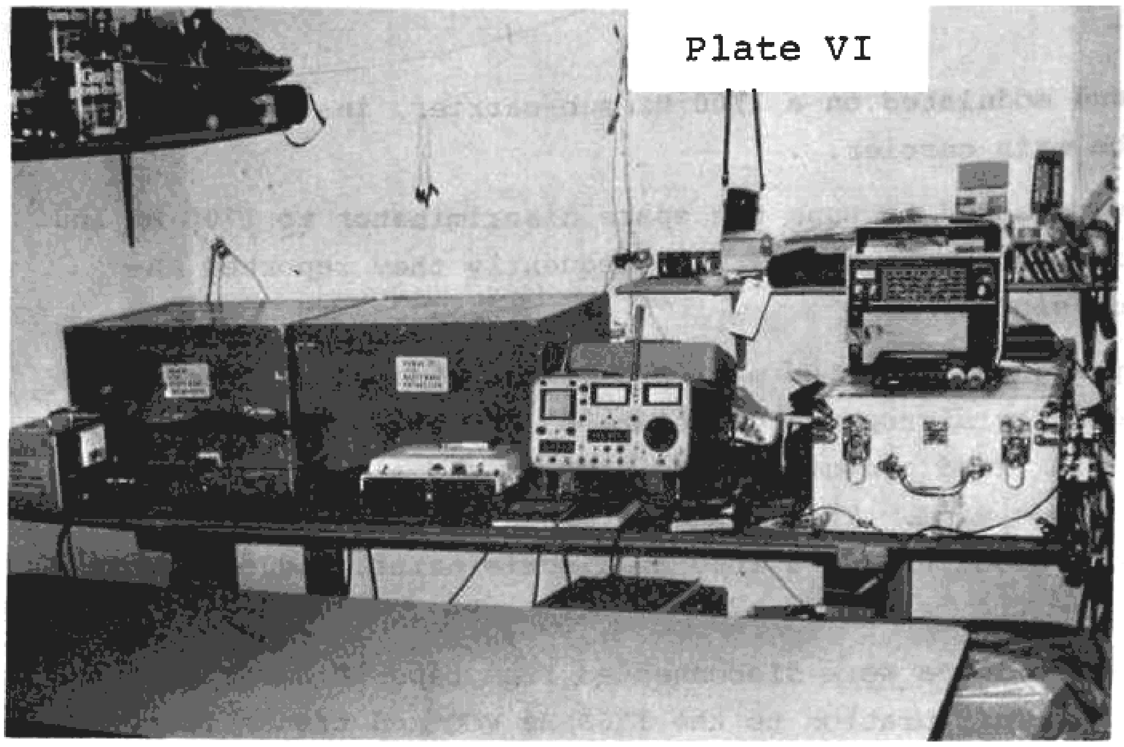
The Compak was not air-lifted from Fang camp as intended, and was finally brought up on foot on 8 January.

The USARP set distorted our transmission so badly that we were never understood.

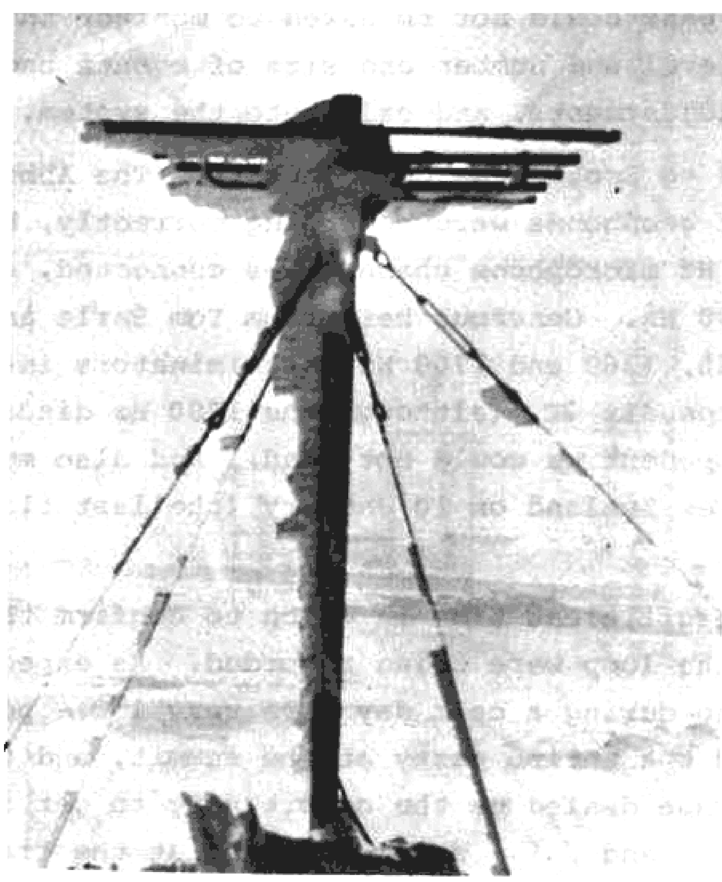
The Japanese, V.U.W. and Lands & Survey sets gave good local communication only.

Thus we relied on the NZARP VHF sets for communication with Scott

Plate VI



A.
Recording Equipment in the Erebus Hut. The large boxes are slow speed tape recorders.



B.
The telemetry antenna at Erebus Summit. Hut Point Peninsula in the background.

C. (below)
Erebus telemetry recording equipment in the Science Laboratory at Scott Base. Mr. Takanami (left) points to the data recorder. Mr. Estes (right) points to the telemetry discriminators below.

Base. In good conditions, they were superb, even inside the Hut. In cloud, it was usually necessary to walk about a km to get a line of sight path. Extensive cloud and snow blocked our signal.

When the batteries were nearly all discharged (and the weather still unflyable) we requested permission to recharge them from our several accumulators. This was denied, and we lost contact with Scott Base at the very time we were completing the telemetry transmitters, and needed to know what was being recorded at Scott Base so that we could optimise the VCO amplifier gains.

The field assistant who had signed the receipt for the VHF radios would not agree to the electronics experts in the party connecting other batteries to them via the exposed terminals on the outside of the case. Days later, he admitted that he believed he was personally liable for any damage to the radio which might result, and would not accept the risk.

Possibly the wording on the receipt form should be changed so that personal financial risk does not overshadow the risk to the whole project incurred through lack of communications.

WEATHER

As seen from Scott Base and New Harbour, the weather at Erebus summit appeared to be good from 22 November to 3 December 1980. The Fang was in cloud and mist most days between 12 and 24 December. When helicopters could get in they came bearing vapour trails.

The summit area was unusually free of snow when we arrived there on 17 December, testifying the previous good weather. Fog and snow-fall began on 23 December and from 25 December on, fog and blowing snow became general as shown in Appendix VI. It appears that the horizontal wind shear boundary, often evidenced by the Erebus plume rising vertically for a short distance and then spreading out horizontally, had descended below the summit level and was creating an orographic cloud cap.

The deterioration in the weather experienced on Erebus after Christmas in 1974/5 and 1978/9 may have been a similar phenomenon.

In my opinion, the best four week period on Erebus is usually 24 November to 22 December.

Event 13

A. TRANSPORT

Our event was very dependent on Helo support. We had 7 moves and especially during the latter part of our field time some set backs were caused to our programme through delays in scheduled helicopter movements.

Our first put-in, to Portal Mt. was close to maximum helicopter range with a full pay load. Nevertheless it was accomplished with little difficulty apart from a slight navigation problem due to our being off the helicopter grid maps. Although no subsequent difficulty with navigation was encountered, we prepared maps with the entire route on one sheet, which we could hand to the helicopter pilot. Our two moves at long range were carried out with two helicopters; Portal Mt. - Alligator peak and Alligator peak - Mt. Kempe. We had suspected they might do this and had budgeted Helo hours accordingly.

From Table Mountain onwards, (5th December onward) weather had deteriorated, so that we had cloudier conditions. A fairly stable pattern did develop, so that it was generally clear in the morning, clouding over about midday. Accordingly, we requested our helo moves for the early morning, but Helo Ops did not appear to take these factors into account since all our moves and attempts at moves were made either in the evening shift or late in the day. Both Hugh Webb (DOIC) and Roger Clark (OIC) were aware of this situation and we are grateful for their efforts on our behalf. This is particularly the case for two incidents - The first was on our move Knobhead - Mt. Crean, when we were picked up together with K32 at 1900 on 15th December, but could not proceed beyond Depot Nunatak because of low cloud over Skelton Nevee. They really tried, but had to abandon the attempt and deposit us at L. Fryxell. A lift was arranged for us early the next morning so that we were at Mt. Crean in the morning and that day had completed over 1/3 of our sampling. This was fortunate as next day the weather deteriorated and we were only just able to get all samples before a blizzard confined us to tents for four days.

Our final move from Mt. Crean - Scott Base also showed some misunderstanding. The intention was to fly us out with one helo making a shuttle flight. It was almost midday when the first flight arrived. It had four crewmen and 7 seats, so under the rules operating could only lift out three passengers, leaving 5 for the following flight. In addition, the weather was rapidly deteriorating, with a cloud bank hovering 1km away on the plateau. Mainly by strenuous intercessions on our behalf by the OIC and DOIC, the helo was persuaded to drop us and a crewman Marble Pt., reorganise its seating and return immediately to collect the remainder of the party. The plan was successful and we all returned to Scott Base by about 1800.

B. MAIN AREAS COVERED

The specific objectives were to sample rocks from two sets of red beds, regarded as overbank and lake deposits in an alluvial plain. The youngest, the Aztec Siltstone is Upper Devonian in age and we sampled at reported suitably exposed outcrops. These were all at the head of the Skelton Nevee, at Portal Mt., Alligator Peak and Mt. Crean. At Portal Mt. we camped on the Nevee at the foot of the Eastern side of the slope and about 100m below the rock exposures. The site was easy to land at and reasonably sheltered on drift snow.

The Alligator Peak site to the South was up a gully immediately at the foot of the rock exposure. It provided a confined landing site and a rather confined campsite on a patch of snow on the side of a slope. Our proximity to the rocks paid dividends as even with our limited time we were able to collect a full set of very friable rocks.

The second set of red lake bed deposits were in the Terra Cotta siltstone of Lower Devonian age. The best outcrops are at Mt. Kempe, Table Mt. and Knobhead.

The Mt. Kempe site at an elevation of 2,600m was on the Kempe Glacier, overlooking the Koetlitz Gl. It was a magnificent site with a view to Ross I. and beyond. We could regularly see Beaufort I, 230km distant. We were about 3/4 hr walk from the rock sections up the N.E. ridge of the mountain.

The Table Mt. site was on a small snow patch in a valley looking out to the junction of the Ferrar and Taylor Glaciers. The rocks were a 20 min walk up a hillside and were exposed mainly under two overhangs.

The Knobhead site was in a rocky valley between Knobhead and Mt. Handsley. These rock exposures were the best and most complete of the Terra Cotta. They showed evidence of extensive burrowing and were more purple than those at Table Mt. We sampled the complete section in two different places. Our camp was in the valley, about 200m below the section. There is a large flat platform on the E. ridge level with the top of the section. It has a commanding view of the Taylor and Ferrar Glaciers and of Mt. Lister in the Royal Society Range. It would make an ideal campsite.

The site at Mt. Crean was on the south shoulder of the mountain. It was almost level with the Polar Plateau to the W. but fell away sharply to the Skelton Nevee on the East. Geologically it was in the Weller Coal Measures of Permian age. We took over the site vacated by Event K14. The Aztec red beds were on the southern buttress of the ridge, about 3/4 hr walk, where we obtained samples throughout the 100m extent of the Aztec exposure. The sun got onto the face at about 1900 hrs but owing to restraints of time and weather most of the sampling was undertaken in the morning or cloudy conditions without the sun. We looked directly down to the Portal, one of the access routes from the Skelton Nevee to the Polar Plateau.

During my second visit to Antarctica this season with Event K9, whilst awaiting the departure of the Benjamin Bowring, I was able to obtain more samples from the following areas:

Wright Valley. Samples were obtained from about 12 lamprophyre dykes outcropping on the south side of Lake Vanda. They are intruded into the granite basement and are believed to be of Ordovician age.

Miers Valley. We landed on the north side of Miers Valley, on a tableland dotted with small tarns, which at that time of year were ice-free and circled by algae. We sampled the numerous dykes which criss-crossed the region and again are believed to be of Ordovician age. Our pick up helo came earlier than scheduled, but we still managed to collect good samples from 12 sites.

C. WEATHER

(See Appendix VI and Transport sections).

D. COMMUNICATIONS

All our sites were at relatively high altitude and we had very little difficulty with communications. The only time was during the blizzard at Mt. Crean, Saturday 20th and Sunday 21st December.

E. LOSS/DAMAGE TO EQUIPMENT

The only trouble we had was with the antifreeze dispenser on our drilling equipment. Despite the care taken with draining the water from the system before entering the field, when we started operating at Portal Mt., the pipes and hand gun were frozen. We thawed the system out with the motor exhaust and primus and flushed through with pure antifreeze. The piston seals on one handpiece were damaged, but after replacement the equipment gave little further trouble.

The calf-length boots with green soles issued to Stephen were very slippery and the soles cracked, so that another pair had to be sent in. The stitching also failed on his used muklaks, requiring replacement.

Our glove combination proved more successful than on VUWAE 23. We used woollen finger gloves with an outer lightweight industrial mesh glove woven from a very tough synthetic thread. They stood up very well to handling the samples, and our hands although becoming a little damp from the antifreeze mixture kept reasonably warm by donning overmitts whenever possible.

We had the customary small amount of trouble with primus seals, but one has learned to be wary of this problem.

F. RECOMMENDATIONS

The VUWAE outer clothing and boots were well used. With the continuously cool conditions we experienced, the older generation clothing caused some inconvenience. The boot problem has been mentioned. Our overtrousers were very still and cumbersome and could not be put on over our boots. We had to anticipate weather conditions before venturing out and for our work, mobility, which was lost with the overtrousers, was a great asset. Our duvets were sufficiently warm but the toggles and zips were either broken or broke in use. Although adequately clothed we were not the most suitably dressed (in contrast to our DSIR field assistant). For high altitude field work, some effort should be made to equip the personnel with up-to-date and relatively new clothing.

<u>Event 14</u>

A. TRANSPORT

Three 4-stroke Snotric motor toboggans (NZARP Nos. 039, 038 and 016 - a single geared older machine) were used on the sea ice in McMurdo Sound by Event 14. Sno Trac 35 primarily assigned to the Lands & Survey surveyors (K3) was also used for a time by this event. From 26 November to 3 December Snotric 016 and Sno Trac 35 were used off Butter Point by the seismic survey party (Dibble and Iles), while the remainder of K14 continued the sediment sampling programme in New Harbour with snotric's 039 and 038. For each vehicle a summary of the mechanical problems, repairs and regular maintenance executed by K14 are presented below. A Vehicle Itinerary is presented in Appendix V .

During the sea ice sampling programme the helicopter hours used, arranged on an opportunity basis, were mainly for fuel and parts resupply. A helicopter was scheduled for K14's move to Mt. Crean (Lashly Mts.) on 11 December; the return to Scott Base executed on 16 December.

Vehicles

Snotric 016: Carburettor gasket replaced after spraying petrol from faulty gasket (21 October).

Nearly one litre of oil added to crankcase (30 October), burning quite a lot of oil (estimated 1 litre per 100km).

The carburettor air intake disk was lost and replaced with a camera lens cap during the trip to Butter Point (7 November). The head manifold elbow sheared off (11 November). A new elbow and carburettor disk were fitted after being flown from Scott Base (12 November), the air filter wired on and 0.5 litres of oil added to crankcase. This finished the one litre synarctic oil field pack with no likelihood of receiving more from Scott Base which had also run out.

The spring anchorage bolt on the front ski sheared and was replaced near Cape Chocolate (14 November).

The front ski quide rail was rewelded and turned 180^{o} (cf. 039), a new spark plug fitted and 1 litre of oil put into the crankcase at Scott Base (17 and 18 November). Also the small inadequate manifold guard was removed and replaced by a larger version which was wired on. This was done to stop the burning of holes in the operator's clothing. The wired-on air filter cover was completely removed during this period of maintenance.

On 21 November the trip from Scott Base to Butter Point was aborted because 016 broke down 20km from McMurdo Station. It could be started by blowing into the tank to get fuel into the fuel pump but would die again almost immediately. The pump and carburettor were removed and the party returned to Scott with 037 and 038 which ran very well with only two passengers.

A new fuel pump and cleaned carburettor were fitted. Fuel was now found to be varporising in the carburettor after a kilometer or so when the engine became warm. The cowling vents were removed to give better air circulation. 016 ran continuously thereafter but readjusting the carburettor did not regain the power the machine had earlier in the season when temperatures were cooler.

During the seismic programme one of the sprocket wheels on the rear axle sheared from the axle destroying a rear bearing assembly. A spare rear axle and bearing assembly were fitted. During this period the petrol tank was accidentally run dry. After refilling the machine would not start until the sump was filled with oil to give sufficient impulse for the petrol pump to operate. The front ski guide rail also sheared again leaving 016 without good steerage on the return to Scott (4 December).

Snotric 039: On 22 October this toboggan refused to start when returning to

Scott Base from the desalinisation plant at McMurdo. A small spark was being generated but the engine did not fire when primed with raw petrol or ether. The machine was towed back to Scott where the condenser was replaced next day. A new fuel pump was fitted at the same time. The two air filter brackets broke as on 038 when returning from Evans to Scott (28-29 October).

All three machines were topped up with oil at Scott Base (30 October) and air filter brackets rewelded.

Oil topped up, 0.25 litres (12 November).

Air filter brackets broke again and manifold broke letting exhaust gas escape (warm knee), similar to 016 (15 November). Major repairs at Scott (17-18 November). New manifold made up (no spares at Scott). New single air filter brackets were made by bending strap steel (1" x 3/16") 270° around the filter pipe and welding, then bolting the bracket to the head with two head bolts. Brackets were made for both 039 and 038. The broken front ski guide rail was rewelded, turned 180° and refitted to the ski. New spark plug fitted and 0.5 litres of oil added to the gearbox. A new variator drive belt fitted (26 November) manifold broken once again (27 November). A new manifold fitting made up at Scott Base was fitted the next day (28 November). Oil topped up also and plug checked.

This machine then ran well up until 6 December when it was relinquished to K2.

<u>Snotric 038</u>: During the trip from Scott Base to Evans (24 October) the two brackets (½" x 1/8" steel) attaching the air-filter to the engine block snapped. The filter was then wired to the engine block but failed within five minutes of travelling. The fuel tank was accidentally run dry from Evans to Royds. Great difficulty was experienced to restart the engine (0.5 hour) and afterwards all machines were topped up regularly to prevent running dry.

Oil topped up and air filter brackets repaired (30 October) at Scott Base. In the field this machine had already become difficult to start, however, it was found to start better in the warmth of the Scott Base garage.

Oil topped up, 0.25 litres (12 November).

Snotric 038 had become increasingly hard to start (10-20 minutes pulling was not uncommon) cold and was also difficult to start hot, requiring ether on several occasions when hot. The machine was adjusted to run warm and once started did run reasonably well.

Air filter brackets broke once again when returning to Scott (15 November) and the spark plug was replaced making the cold starting slightly easier.

At Scott Base (17-18 November) the new airfilter strap was fitted (cf. 039), fuel pump replaced and the fuel line from the tank refitted to stop a primer bulb leak. Topped up crankcase (0.25 litres) and gearbox (0.5 litres) with oil. The new plug and fuel pump made cold starting considerably easier, although the temperatures were much milder than in October. Regular maintenance; oil, plug checked and a new variator drive belt fitted on 28 November. This machine also continued to run well for the remaining time in the field.

<u>Sno Trac 35</u>: Prior to 25 November four new bogies had been fitted to 35. Two of these new bogies from the front right bogey assembly subsequently broke and were replaced enroute to Butter Point (25 November).

A steering clutch splined shaft was stripped during the seismic survey programme. The Scott Base Mechanic (Bruce Scott) flew to Butter Point where he replaced the steering clutch assembly on the sea ice.

Two further bogies were broken on the return to Scott Base from Butter Point (4 December).

<u>General Summary</u>: The three toboggans were in good condition when they were handed over to K14 on 14 October. This was due to the work done in early October by Nevil Clark and Bruce Scott (Base Mechanic). The assistance both these people gave to this event especially when initially testing the toboggans and then later in the season, was invaluable.

Nearly 1,000 kilometres were travelled by all three toboggans on relatively smooth often bare hard sea ice. The hard conditions were probably responsible for only some of the damage incurred, particularly the sheared axle (016) and steering ski guide rail breakages (016, 039). The other damage and mechanical failures which occurred were related primarily to the Briggs and Stratton engine. The vibration from these engines were responsible for the failure of the air filter fittings (once 016, twice 039, twice 038). This recurrent problem was only solved by building an extremely heavy fitting fastened by two head bolts but attached from only one place on the head. This prevented any opposing vibration which may have caused the two bracket mounting to fail. Manifold failure occurred on three separate occasions and can also be attributed to the engine vibration. The right angle elbow on 016 vibrated sufficiently to distort the male thread entering the block, eventually causing it to shear off. The manifold on 039; a threaded nipple pipe welded to a flange broke twice, in one case leaving part of the sheared nipple pipe in the exhaust port.

The carburettor was adjusted to give the best performance when running warm (after about ½ hour from a cold start early in the season). The idling speed was adjusted to prevent the machine stalling even when hot but meant the idling speed was too high for the Salisbury clutch to disengage when changing gears. However, by turning off the engine, changing gears then quickly turning on the engine it was possible to change gears relatively smoothly.

It was always necessary to have at least 2 metres of "slack rope" before being able to start moving a heavy sledge (≈900 lbs) on the flat ice. Snow cover or a slight upward gradient made things even more difficult. The Briggs and Stratton engines have a particularly slow pick up so they were developing less than half revs by the time load came on the sledge. At these revs less than 10 BHP was being produced. If the sledge didn't move the moderate torque caused "track spin" and the toboggan "dug in" and made the situation more difficult. The rope starter makes starting these big engines even more difficult. Even when the engine was warm some of the event members could not start the machines consistently.

Sno Trac 35 seems to specialise in destroying bogey wheels. These were all broken when travelling between 10 and 15km per hour on dead flat smooth bare sea ice, for distances of about 30km. The front bogey assemblies accounted for all the broken bogies which were found to be very hot at the time of breaking. This indicates that they were doing a lot more work than the absolutely cold bogies further aft.

Sledges

Two dog sledges (B5 and B7) and a Tamworth (T1) were used initially to Cape Evans. The dog sledges which did not have keels were replaced by a new Tamworth (T3) and a double-ended Nansen with keels (B4 on 1 November. The keeled sledge towed significantly straighter on hard snow than the previous dog sledges but was just as difficult to control on bare ice as the non-keeled sledges.

Loading: Both Tamworth sledges carried between 800 and 900 lbs for most of the time. This was probably too much for these sledges on bare sea ice, which is far more rigorous than snow. The alternative to distribute the load on tandam sledges was however impractical because; of the much greater difficulty to negotiate rough ice with two sledges, the limited manpower of our event, and the towing capabilities of the toboggans was often not sufficient to tow two moderately heavy sledges.

B4 was loaded to about 600 lb which was a suitable weight for sea ice conditions. The keels however may have been more effective if located further aft especially when close towing on bare ice.

Damage: T1 is an old sledge with non-laminated steamed timber bridges, and already had two cracked bridges on 15 October. The cracks became enlarged and the remaining bridges cracked during the programme. Hose clips provided a very satisfactory repair for the cracked bridges in the field.

T3 is a new laminated sledge which proved very satisfactory. No bridges were cracked but the laminated runners suffered some damage. Delamination occurred on both runners at all ends where the bridges are housed into the runners. This damage seemed to be a result of the design and could be prevented if the top lamination, which houses the bridges, were laminated further into the curve of the runners.

The proud lashing (thong leather) on the Tamworth sledges became worn from the movement of poorly-fitting sledge tanks. The lashings were replaced without much difficulty in the field.

Broken bridges, especially on an old sledge, worn lashings and towing bridles are all damages which should be expected as normal "wear and tear" in a season. The sea ice even though excellent travelling this season is extremely hard on this type of equipment.

B. MAIN AREAS COVERED

The bottom sampline programme undertaken by Event 14 required several traverses across the sea ice in McMurdo Sound. The areas of interest were from

Scott Base to Cape Royds, across to Butter Point and in New Harbour and south to Cape Chocolate. A more detailed account is presented in the Itinerary (Appendix IV).

C. WEATHER

Difficult weather conditions restricted the Event 14 programme early in the season (25-29 October) when several southerly storms caused intermittent blizzard conditions in the McMurdo Sound area. Four days were spent tentbound during this period. "Normal" weather conditions for McMurdo Sound prevailed later in the season during the major period of the field programme. A summary of weather observations is presented in Appendix VI.

D. COMMUNICATIONS

DSIR Compak SSB radios were used for field communications and worked satisfactorily. During the seismic programme two Compaks were used on a free channel (4700 KHz) between the recording station and shot firing point. The radios were also used to record the shot instant on the recording (see Appendix IF).

E. LOSS/DAMAGE TO EQUIPMENT

The major damage occurred to toboggans and sledges; detailed in the Transport section.

Scientific Equipment

No equipment was lost or damaged. However, the sphincter corer, which was an important part of the operation, did not perform satisfactorily.

The sphincter corer was designed to take a shallow (≈300mm long) large diameter (≈200mm) minimally disturbed core and retain the sea floor sediment-water interface intact. The main feature of the corer is a cloth sleeve (sphincter) which cuts the sediment in situ and retains the core with a nearly water-tight seal.

Two major types of problems were encountered when operating the corer. A lack of penetration was evident in some areas of the Sound where the sea floor was stoney, e.g. near Ross Island. Thick sponge mat in some areas also contributed to poor corer penetration. Extra lead weights and a short barrel option will be used to overcome the penetration problem.

The second problem was that caused by freezing sea water in the trigger mechanism. This mechanism consisted of a main pin into which was hooked a sprung detent pin. Both pins were greased and enclosed in a close-fitting steel housing. Sea water on freezing ejects brine and forms "fresh water" ice. This ice does not melt in the sea water, which has a temperature of $-1.9^{o}C$. Because the trigger was enclosed, ice was not flushed out as the corer descended to the bottom. The problem should be solved by opening out the trigger so that it will be self-draining, and can be flushed either in the sea or with alcohol.

In general the other scientific equipment performed well, particularly the winch. The salinity-temperature bridge was difficult to use in the open where it was impossible to keep unfrozen the water standards used for calibration of the instrument.

Event 15

A. TRANSPORT

All transport for Event 15 was by helicopter and movements between camps was well-timed and efficient with only two delays due to bad weather. Considerable saving of helo time was afforded by good management by Scott Base D.O.I.C. who arranged moves so that flight times from Scott Base to the Dry Valleys was shared by several events moving on the same day.

B. MAIN AREAS COVERED

A single area between the Miers Valley and Salmon Valley from the coast to the Blue Glacier was covered. Five camps were established for the field party which enabled the $200km^2$ area to be mapped and samples in single day trips without having to establish secondary overnight camps.

Approximately ten day camps were established at the following areas:

i) Lake Miers
ii) Upper Garwood valley at Collen Lake
iii) Lower Garwood valley about 5km from the coast
iv) Marshall valley about 5km from the coast
v) Salmon valley

C. WEATHER

Good weather conditions prevailed during Event 15 stay in the area between Miers Valley and Salmon Valley. Weather observations were made and relayed daily to Scott Base. The unfavourable weather that was experienced did not hinder field work; snow falls usually covered outcrops for only a day or two. The weather became more unsettled and cooler in the latter part of the season (mid-December/early January).

D. COMMUNICATIONS

Communication with Scott Base was maintained with a Labgear radio which operated effectively for the entire field trip. On only one day was it necessary to relay to Scott Base via Vanda Station due to ionispheric disturbance. Battery life was excellent due to low power being used for transmission on most days.

E. LOSS/DAMAGE TO EQUIPMENT

A mattress and a snow gaiter were lost in blustery conditions that were prevalent, particularly at the Salmon Valley campsite.

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APPENDIX I - SEISMIC REFRACTION SURVEY

A. Details of Shots Fired.

Shot	Date	Time	Shot Depth	Charge	Shot instant Warning	Fuse Burning Time	Offset*
Line 1							
1	26/11	pm	5m	1.1kg AN60	16 sec.	-	949m
2	26/11	2000	5m	1.1kg AN60	16 sec.	-	949m
3	26/11	2120	3m	1.1kg AN60	9 sec.	-	1898m
4	26/11	2130	5m	1.1kg AN60	5 sec.	-	1898m
5	27/11	1230	5m	1.1kg AN60	-	-	-
6	27/11	1242	5m	1.1kg AN60	5 sec.	29 sec.	1898m
7	27/11	1349	5m	1.1kg AN60	6 sec.	32 sec.	994m
8	27/11	1624	5m	1.1kg AN60	12 sec.	31 sec.	2847m
9	27/11	1830	5m	1.1kg AN60	6 sec.	30 sec.	2847m
Line 2							
1	28/11	1821	5m	1.1kg AN60	6 sec.	29 sec.	334m
2	28/11	1840	5m	1.1kg AN60	6 sec.	32 sec.	334m
3	28/11	2056	2m	1.1kg AN60	6 sec.	-	3700m
4	28/11	2215	2m	1.1kg AN60	5 sec.	33 sec.	3700m
5	29/11	1901	5m	3.2kg AN95	5 sec.	32 sec.	8000m
6	29/11	2124	5m	3.2kg AN95	6 sec.	-	6700m
7	29/11	2225	5m	1.1kg AN60	6 sec.	31 sec.	2700m
8	30/11	0045	5m	0.8kg AN95	7 sec.	33 sec.	2700m
9	30/11	1531	5m	1.1kg AN60 + 1.6kg AN95	5 sec.	32 sec.	5700m
10	30/11	1650	5m	1.6kg AN95	-	31 sec.	5700m
11	30/11	2249	5m	1.1kg AN60	7 sec.	36 sec.	1700m
12	30/11	2350	5m	1.1kg AN60	7 sec.	36 sec.	2300m
13	1/12	1310	5m	1.1kg AN60	6 sec.	32 sec.	670m
14	1/12	1430	10m	1.6kg AN95	8 sec.	35 sec.	4700m
15	1/12	1613	5m	1.1kg AN60	No warning.	33 sec.	3300m
16	1/12	1633	5m	1.1kg AN60	4 sec.	36 sec.	3300m
17	1/12	1940	5m	1.1kg AN60	-	-	-
18	1/12	2042	5m	1.1kg AN60	3 sec.	36 sec.	4300m
19	1/12	2240	5m	1.1kg AN60	5 sec.	32 sec.	4700m
20	2/12	1528	5m	1.1kg AN60	7 sec.	31 sec.	2700m
21	2/12	1630	5m	1.1kg AN60	No warning.	31 sec.	1000m
22	2/12	1642	5m	1.1kg AN60	6 sec.	30 sec.	1000m
23	2/12	1834	10m	1.6kg AN95	5 sec.	36 sec.	5300m
24	2/12	2107	10m	1.6kg AN95	6 sec.	32 sec.	6300m
25	2/12	2159	5m	1.1kg AN60	7 sec.	31 sec.	2000m

A. (Contd.)

Line 2 (contd.)							
Shot	Date	Time	Shot Depth	Charge	Shot Instant Warning	Fuse Burning Time	Offset*
26	2/12	2316	5m	1.1kg AN60	7 sec.	30 sec.	1700m
27	3/12	0026	5m	1.1kg AN60	6 sec.	31 sec.	700m
28	3/12	0116	5m	1.1kg AN60	6 sec.	35 sec.	3000m
29	3/12	0310	10m	1.6kg AN95	7 sec.	33 sec.	7300m

Footnote: - indicates that no value was recorded.
* Distance to nearest geophone.

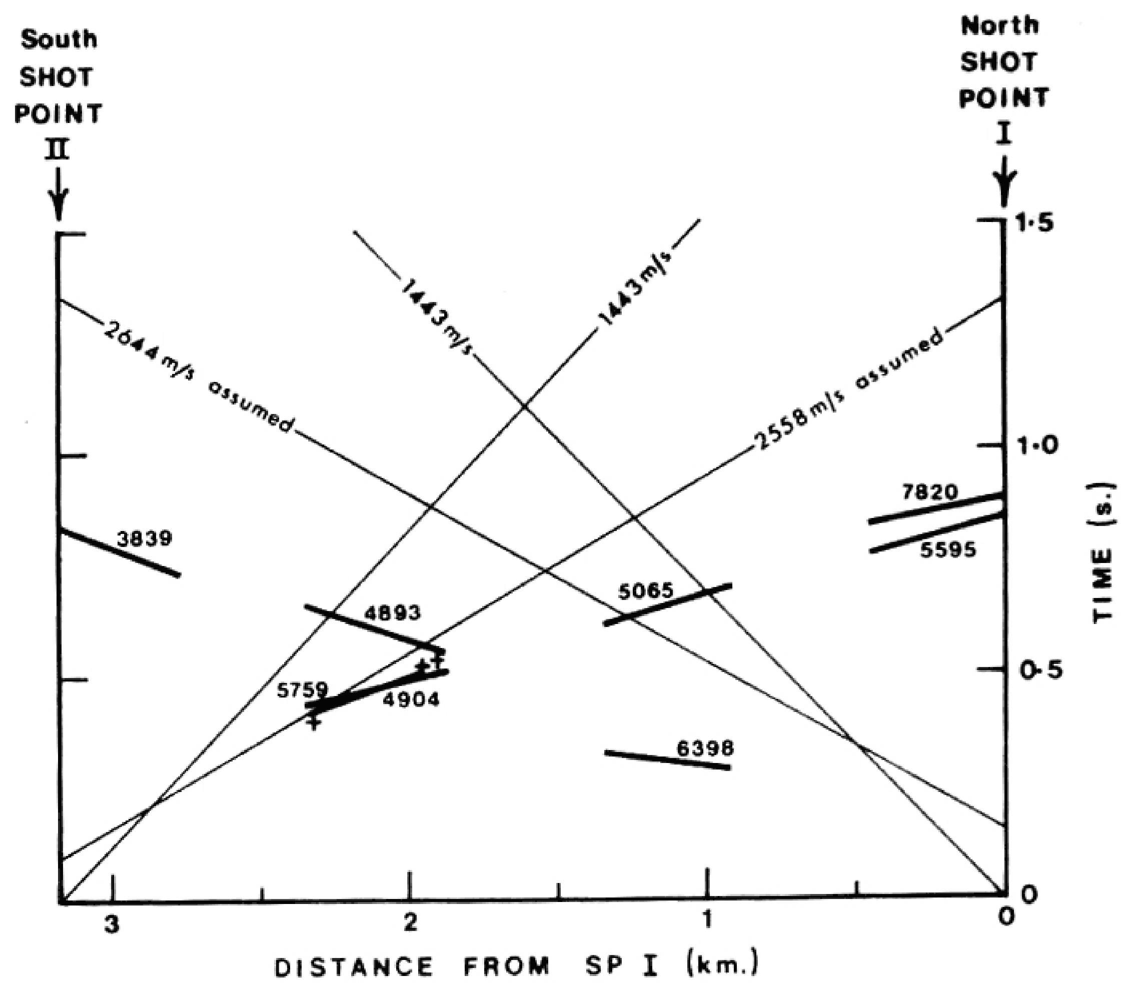
B. Linear Regression Lines for the Refraction Arrivals at each Spread.

Line 1					
Spread	Offset	Shot Point	Apparent Velocity	Intercept	Comments
1	2832m	II	5597 7820	0.276 0.484	
2	1879m	II	5065	0.242	
	953m	I	6398	0.233	
3	1912m	I	4893	0.170	
	920m	II	5759 3246 4904	0.295 0.157 0.258	Channels 1, 2, 12 only weak
4	2832m	I	3839	0.018	

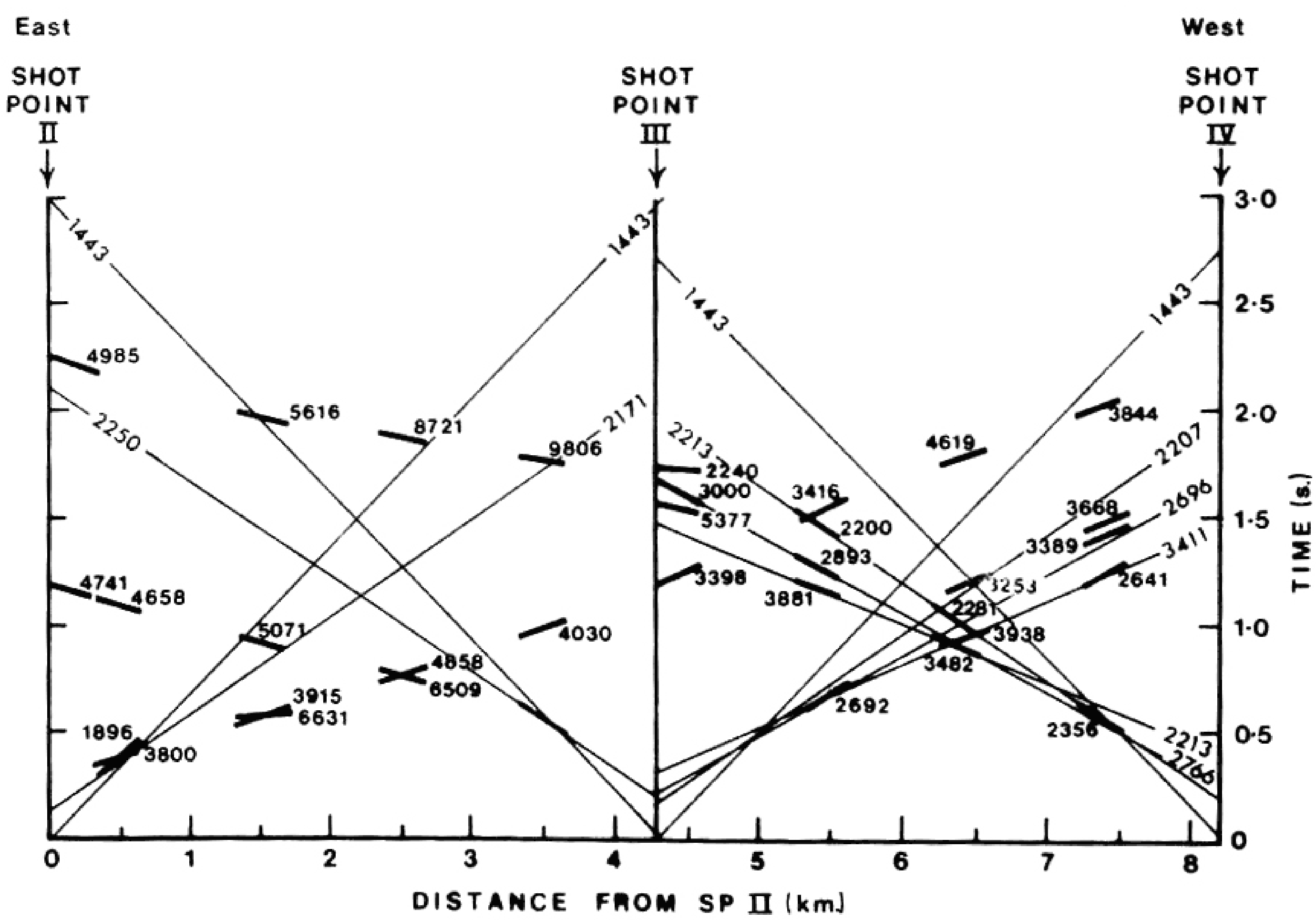
Line 2						
Spread	Shot Point	Angle	Offset	Speed	Intercept	Comments
1	IV	0	7888m	4985	0.604	
	III	0	3966m	4741	0.286	
2	II	0	322m	3800	0.243	
	III	0	3633m	4658	0.275	
3	II	0	1352m	3915 6631	0.191 0.355	Geophones 1-4 and 10-12 only
	III	0	2617m	5071	0.363	
	IV	0	6531m	5616	0.776	

B. (Contd.)

Spread	Shot Point	Angle	Offset	Speed	Intercept	Comments
Line 2 (contd.)						
4	II	0	2345m	4858	0.249	
	III	4°	1632m	6509	0.467	
	IV	0	5545m	5904	2.799	Probably not refraction arrival
				8721	1.208	
5	II	0	3324m	4030	0.110	
	III	0	641m	2322	0.221	
	IV	0	4563m	2987 9806	1.111 1.282	Bubble Pulse
6	II	0	4287m	3398	-0.074	
	IV	0	3608m	5377 3000 22400	0.850 0.373 1.556	Very weak
7	II	3.6°	5293m	3146	-0.205	
	III	17.8°	1041m	2692	0.223	
	IV	7.3°	2636m	2200 2893 3881	0.217 0.308 0.453	
8	II	3°	6269m	4619	0.384	
	III	9.5°	1995m	3253 3930	0.532 0.404	
	IV	8.5°	1671m	3482 2281	0.380 0.220	
9	II	assume = 0	7221m	3844	0.089	
	III	assume = 0	2954m	3389 3368 2641	0.512 0.633 0.063	 Very weak
	IV	assume = 0	659m	2356	0.237	

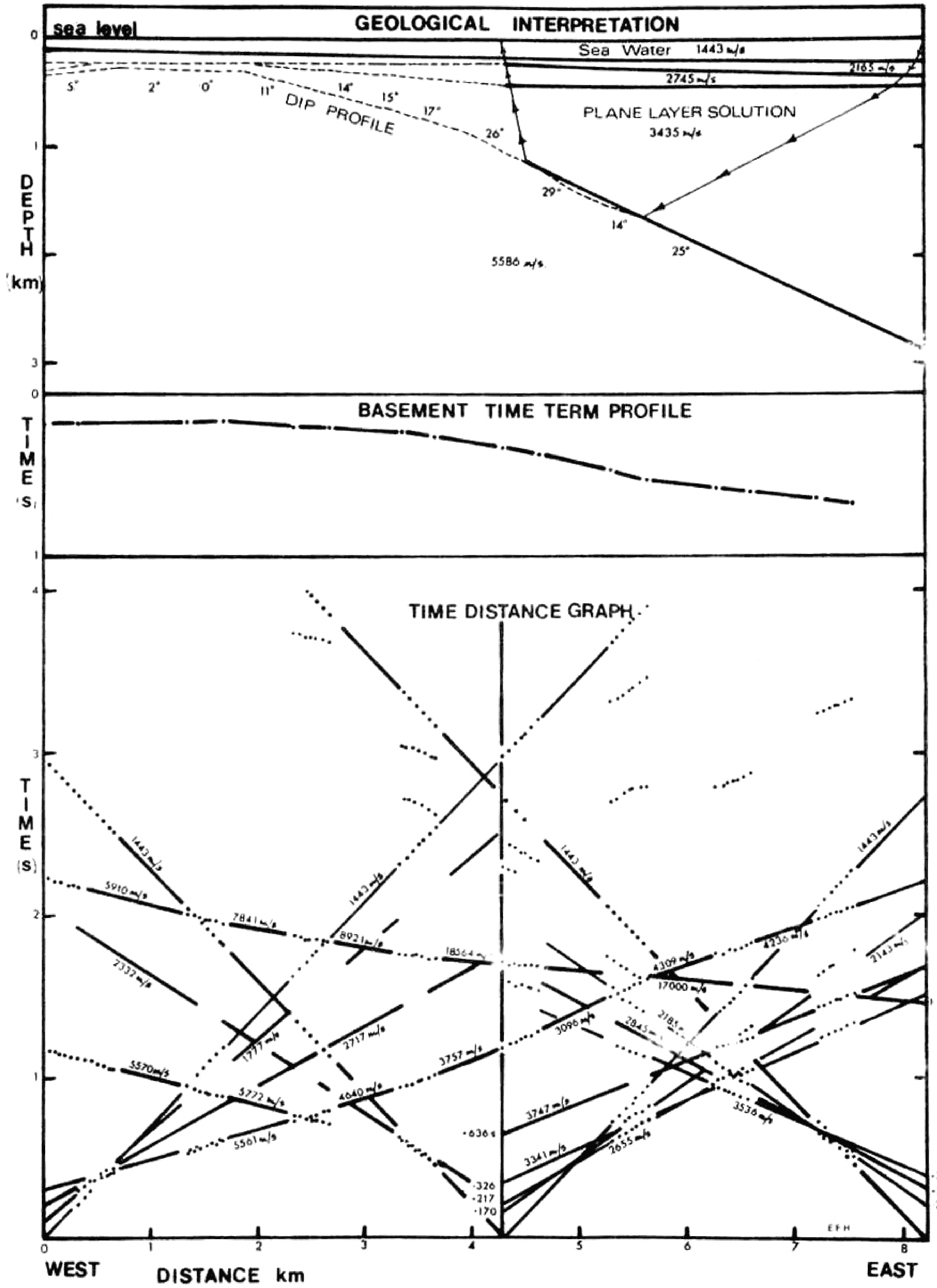


C. Time/Distance graph for Line 1.



D. Time/Distance graph for Line 2.

E. Plane Layer Interpretation



F. Shot Instant Detection

In the survey we used plain No. 6 blasting caps and safety fuse. Because of the uncertainty in burning time of the safety fuse, (over a 24cm length of fuse the burning time ranged from 29 seconds to 36 seconds) a more accurate method of predicting the explosion time was needed so the recorder could be started in time without wasting too much paper.

To give a 6 second warning we taped an ordinary silicon diode to the safety fuse, 8cm from the detonator - as the fuse burned past this diode the temperature was raised, changing the forward voltage drop over the diode. This change in voltage triggered an oscillator tone which was transmitted to the recorder.

When the detonating cord fired, a piece of wire taped to the cord was broken, terminating the tone. This termination was recorded and gave us our shot instant on the records.

The operation was satisfactory, although there were problems with feedback when using the radio on high power but this could be easily remedied with better screening. Also if the wire broken by the explosion was engulfed in sea water thrown up by the explosion, the tone returned, sometimes in a few tens of milliseconds. Uncertainties in shot instant times are probably less than 0 milliseconds.

G. Ray Tracing Analysis

The analysis used here is suitable for this situation where the refracting interface being mapped is sharply curved, so ray paths don't travel along the interface and leave at the critical angle, but instead cut through the bulk of the material.

You need to know the structure above the interface and the depth of the interface either under the spread or the shot point, as well as the velocity below the interface. In the present case the interface was the basement surface, and was fairly flat near shot point II (SP II) and its depth Z_A was obtained from the time intercept as SP II.

METHOD

Using the plane-layer structure already determined for the overlying sediments, and the apparent velocity of the spread, the ray path can be calculated back to the point B on the bottom plane refractor, and the co-ordinates of B, the time to get from B to G (T_{BG}) and the angle θ_{n-1} at which the ray arrived worked out.

Also for the point A co-ordinates and time T_{SA} can be calculated from the known structure at A, assuming critical refraction. For the case where q is large compared to the depth the point A is fairly constant for all spreads since the angle of the ray path along q changes very fast with a change in the incoming ray angle near the critical angle.

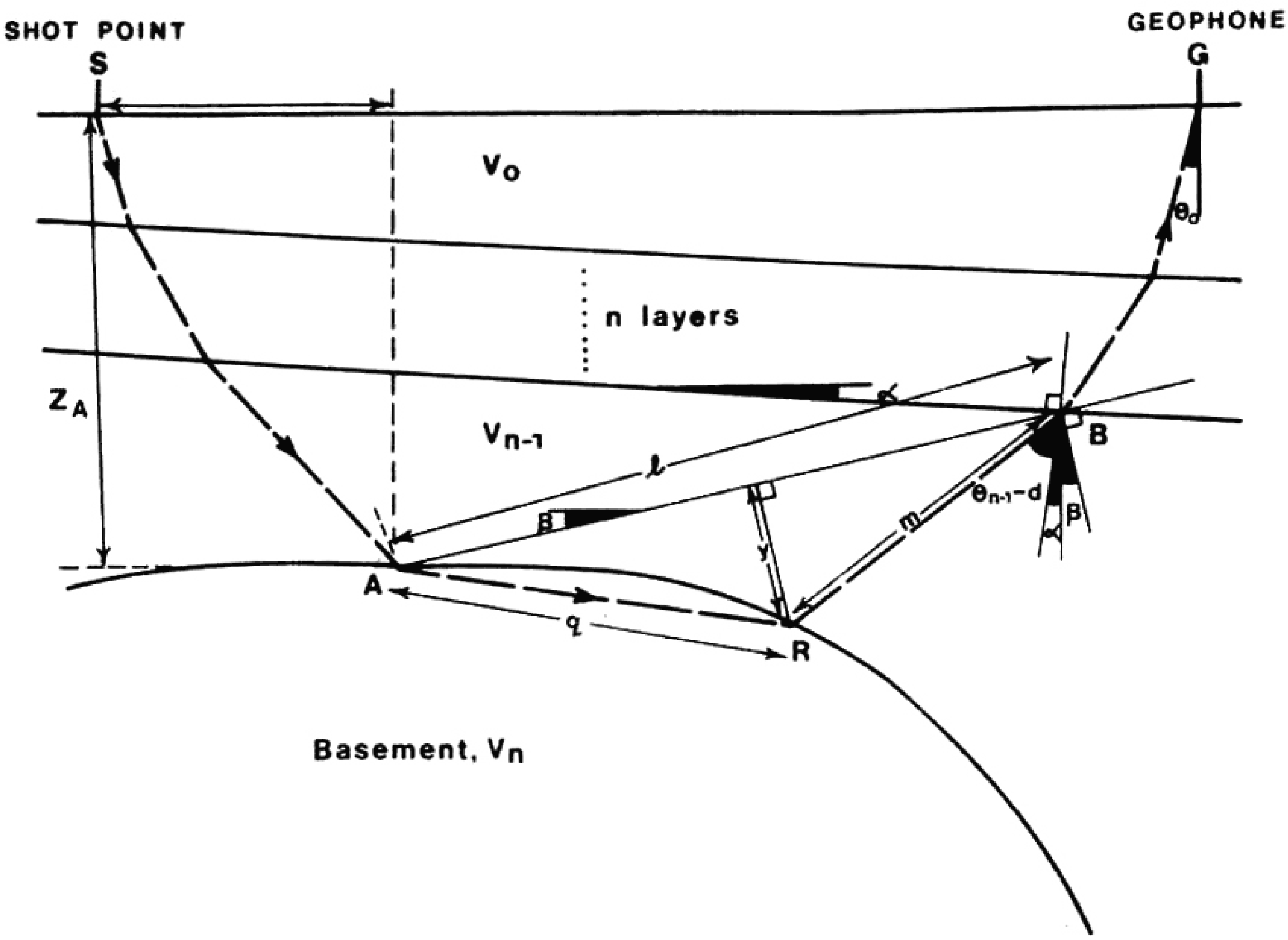


Diagram illustrating the Time Term Analysis Method.

Having calculated the co-ords (X, Z, T) of points A, B, and the angle Θ_{n-1} you can set up simultaneous equations and solve a quadratic for Y and hence the position of the basement.

$$T_{AB} = T_{SG} - T_{SA} - T_{BG}$$

$$q = (T_{AB} - \frac{m}{Vn-1} V_n \qquad (1)$$

$$m = Y/\cos\ (\Theta_{n-1}+\beta) \qquad (2)$$

(2) into (1) $q = (T_{AB} - Y/\cos\ (\Theta_{n-1}+\beta) Vn-1)\ Vn$ (3)

and $q^2 = (l - Y \tan\ (\Theta_{n-1}+\beta) + Y^2$ (4)

$(3)^2 - (4)$ $0 = (T_{AB}^2 V_n - l^2)$

$$+ Y\ [2l \tan\ (\Theta_{n-1}+\beta) - 2\ T_{AB}\ V_n^{\ 2}/V_{n-1} \cos$$

$$(\Theta_{n-1}+\beta)] + ((V_2/V_1)^2-1) \sec^2\ (\Theta_{n-1}+\beta))Y^2 \qquad (5)$$

(5) is a quadratic in Y and is readily solved from which the sensible value of Y is taken and the co-ordinates of the basement refraction point R can be worked out.

This method was used for arrivals on spreads 3-9 from shot point II and on spreads 1-4 from shot point III to obtain the structure between shot points II and III. This structure was used, together with arrivals on spreads 1, 3, 4 and 4 from shot point IV, to locate the basement refraction point on the descending ray from shot point IV, assuming that the ray had the same angle in the water as the reverse rays from shot point II to spread 9, which was only 660m from shot point IV. The ray path from the shot point was traced down to the bottom plane layer refractor and the equation (5) solved.

The solutions gave the group of X's marked down at approximately 1500m depth on the profile diagram. Using the mean position of these points as the true position of the basement refraction point on the descending ray path from SP IV and using the single 2600 sedimentary layer in order to be consistent with the 3398 and 3146 arrivals, the equations were solved for the 22400 arrival and this gave the X marked at 1026m depth.

APPENDIX II

INTERNATIONAL MOUNT EREBUS SEISMIC SURVEY

A. Participants in the first IMESS expedition 1980-81:

Dr. Phil R. Kyle (Ohio State University).
Mr. W. (Bill) C. McIntosh (University of Colorado).
Dr. Jurgen Kienle (University of Alaska).
Mr. Steve A. Estes (University of Alaska).
Mr. Kei Terai (National Institute of Polar Research, Tokyo).
Mr. Tetsuo Takanami (Hokkaido University).
Mr. Noburu Osada (Tokyo University).
Dr. R.R. Dibble (Victoria University of Wellington).

Other members of the expedition were:

Mr. Peter Otway (Geological Survey, DSIR).
Mr. Gary Neals (Lands & Survey Department).
Dr. Hugh Morgan (University of Waikato).
Dr. Roy Daniell (University of Waikato).

The Antarctic Division DSIR field assistants to the expedition were:

Mr. Jon Prosser.
Mr. Roy Parish.
Mr. Pete Summerville.

B. IMESS Program, Three years starting in 1980/81.

Experimental Responsibilities

Field Set up:

1. Permanent 3-partite short period vertical seismic array on flank of Erebus			Kienle	
2. Permanent summit 3-component short period seismic station			Kienle	
3. Telemetry of 1 and 2 to Scott Base through relay station on Hut Point Peninsula			Kienle	
4. Portable temporary 3-partite summit seismic array operated during summit visits	Kaminuma			
5. Portable temporary 1-component summit seismic station operated during summit visits		Dibble		
6. Acoustic sensor, locally recorded for 1 month and then readied for telemetry		Dibble		
Telemetry to Scott Base			Kienle(?)	
7. Figure 8 induction coil, locally recorded for 1 month and if feasible readied for telemetry		Dibble		
Telemetry			Kienle	

Recording:

8. Demodulation and recording of seismic and induction (?) data on magnetic tape at Scott Base	Kaminuma			
9. Single channel recording of seismic data on Helicorder			Kienle	
10. Single channel recording of acoustic data		Dibble		
11. Space, timing and record-keeping		DSIR-Scott Base		
12. Magnetic tape playback, seismograms to all Principal Investigators	Kaminuma			

Scientific Responsibilities

1. Microearthquake location in space and time, magnitudes and energy release	Kaminuma	Dibble	Kienle	
2. Harmonic tremor	Kaminuma			
3. Explosion energetics		Dibble		
4. Induction		Dibble		
5. Correlation of acoustic and induction events with seismicity		Dibble		
6. Teleseismic P-delays		Dibble	Kienle	
7. Temporal patterns of seismicity, explosions, tidal triggering(?)			Kienle	
8. Plumbing of magma lake	Kaminuma	Dibble	Kienle	Kyle

C. Specification of Telemetry Equipment for Erebus Summit.

Sensor	Make	Type	Preamp/VCO	Gain Setting	Signal Frequency Hz	Modulating Frequency Hz	Centre Frequency Hz	Transmitter Input	Discriminator	Recorder Channel	Recorder Range V
Geophone	Mark Products	Z, 1 Hz	Teledyne, Series 40				2380	"Internal"	Teledyne, 46.12		
Induction Loop	3.6km of 2.5mm^2 PVC Appliance wire	Figure of Eight	J302, USGS pattern	90 dB (9)	0.01-10	0.1-30	1360	"External 1"	USGS pattern	8	4
Infrasonic Detectors	Philips Speaker	8 inch, 620 ohm with 10 ohm shunt	" "	42 dB (1)	0.01-30	0.1-30	1020	"External 2"	" "	9	5
Audio level Detector	" "	" "	" plus diode detector	42 dB	0.01-1000	Variable DC, rupple to 30 Hz	1700	"External 3"	" "	7	0.2

Main Battery 30 cells of Edison Carbonaire (ST22, ST33) to give 3300 ampere hours at 12 V, negative earth.

Transmitter Monitron T16F20, RF power 100 mW, RF frequency 166.421 MHz, ± 5 kHz modulation.

Antennae Yagi, 5 elements on c. 2m mast.

Receiver Monitron R16F.

Recorder Sony Instrumentation Tape Recorder UFR-11400L, 14 data plus 2 timing channels, low speed FM, 0-30 Hz.

Recorder San-ei Sokki long-term chart recorder 8D01. Single channel, 240mm/minute.

Clock Citizen Quartz digital clock 9031A-06.

APPENDIX III - FLIGHT REQUIREMENTS OF VUWAE 25

Date	Event	Purpose	Origin	Destination	Aircraft
Oct.12	14	Aircargo 3	Chch	SB	C-141
18	14	Reconnaissance of sea ice	SB	SB	Helo
Nov. 7	14	Aircargo 1	Chch	SB	C-141
16	13,14,15	Aircargo 5	Chch	SB	C-141
21	13	Put in 3	SB	PMt	Helo
	15	Put in 3	SB	MV	Helo
22	14	Opportunity, 2 to abandoned sledges	SB	(sea ice)	Helo
24	14	Opportunity, return corer	BPt	SB	Helo
25	13	Transfer 3	PMt	AP	Helo
Dec. 1	13	Transfer 2	AP	MtK	Helo
		Take out 1	AP	SB	Helo
3	14	Put in 1 SB Mechanic	SB	BPt	Helo
4	13	Put in 1	SB	TMt	Helo
		Transfer 2	MtK	TMt	Helo
8	15	Transfer 3	MV	LC	Helo
9	13	Put in 1	SB	Kh	Helo
		Transfer 3	TMt	Kh	Helo
11	14	Put in 4	SB	MtC	Helo
15	13	Attempt transfer 4, aborted	Kh	LF	Helo
16	13	Transfer 4	LF	MtC	Helo
	14	Take out 4	MtC	SB	Helo
19	15	Transfer 3	LC	GL	Helo
20	14	Aircargo 3	SB	Chch	C-130
22	13	Take out 4	MtC	SB	Helo
23	13	Aircargo 3	SB	Chch	C-130
26	15	Transfer 3	GL	MhV	Helo
Jan. 2	15	Transfer 2	MhV	SV	Helo
		Take out 1	MhV	SB	Helo
5	15	Aircargo 1	SB	Chch	C-130
7	15	Transfer 2	SV	TV	Helo
9	15	Transfer 2	TV	VS	Helo
13	15	Take out 2	VS	SB	Helo
14	13	Aircargo 1	Chch	SB	C-130
17	13	Put in (a.m.)	SB	VS	Helo
		Take out (p.m.)	VS	SB	Helo
19	15	Aircargo 1	SB	Chch	C-130
20	13	Put in (a.m.)	SB	MV	Helo
		Take out (p.m.)	MV	SB	Helo

Date	Event	Purpose	Origin	Destination	Aircraft
Feb.13	9	Aircargo 1	SB	Chch	C-130

Abbreviations:

Chch	Christchurch	LC	Lake Colleen
SB	Scott Base	Kh	Knobhead
PMt	Portal Mountain	MtC	Mount Crean
MV	Miers Valley	GL	Garwood Lake
BPt	Butter Point	MhV	Marshall Valley
AP	Alligator Peak	SV	Salmon Valley
MtK	Mount Kempe	TV	Taylor Valley
TMt	Table Mountain	VS	Vanda Station

APPENDIX IV - ITINERARIES

Event K13 - Beacon Studies.

Nov.	16	Bannister, Christoffel to Scott Base.
	16-19	Survival course.
	19-20	Preparing field gear.
	21	Christoffel, Cleary, Bannister to Portal Mt.
	22-24	Work on Aztec red beds, Portal Mt.
	25	Helo move to Alligator Peak.
	26-28	Work on Aztec red beds, also repair equipment.
	29-30	Helo delay. More sample collecting and climbed Alligator Peak for altitude check.
Dec.	1	Christoffel, Bannister to Mt. Kempe. Cleary to Scott Base for treatment of abscess.
	2-3	Surveying and collecting Terra Cotta siltstone samples.
	4	Cleary return. Helo move to Table Mt.
	5	Work on Terra Cotta section at Table Mt.
	6	Snow and strong winds. Tent day.
	7-8	Work on section.
	9	Joined by Iles. Helo move to Knobhead.
	10-11	Work on Terra Cotta, Mt. Handsley.
	12-13	Helo delay.
	14	Heavy snow. Tent day.
	15	Helo wait. Joined by K32. Attempt move to Mt. Crean aborted. Off-loaded at Fryxell.
	16	Event 13 moved to Mt. Crean. Work on section. Joined by K32.
	17	Work on section and filming.
	18	Work on section.
	19-21	Blizzard. Tent days.
	22	Events 13 and 32 to Scott Base (eventually).
	23	Christoffel, Bannister, Iles to Christchurch.

Days in Antarctica	36
Days at Scott Base	5
Days in field	31
Travel	7
Tent days and Helo waits	8
Work	17

Jan.	14	Christoffel to Scott Base.
	16	Paleomagnetic sampling at Castle Rock.
	17	Fly to Vanda (a.m.). Paleomagnetic sampling granites and dykes at Vanda. Return to Scott (p.m.).
	18	Paleomagnetic sampling at Observation Hill.
	20	" " granites and dykes in Miers Valley.
	21	Christoffel boards Benjamin Bowring for Event 9.

Jan. 21 - Feb. 12	Geophysical work on board "Bowring" in Ross Sea (Event 9).
13	Christoffel to Christchurch.

Days in Antarctica (Jan.-Feb. 1981)	30
Paleomagnetic work (Event 13 cont.)	6
"Bowring Cruise" (Event 9)	22

Event 14 - McMurdo Sound bottom sampling programme.

Oct. 9	Ward, Pyne and Fitzgerald to Christchurch.
12	Ward, Pyne, Fitzgerald and Garrick to Scott Base after two days delay in Christchurch.
13-14	Preparing and checking field gear, scientific equipment and vehicles (Toboggans).
15	A full day spent by the whole party drilling and blasting the ice quarry for Scott Base water supply.
16-18	Continued with field equipment preparation, testing toboggans and sledges on an overnight survival course (17-18).
18	Ward, Pyne and Scott Base Leader (Clark) on helo reconnaissance of the sea-ice conditions during an afternoon training flight to Cape Royds, Butter Point and Cape Chocolate.
19-21	Remainder of the field equipment checked. Ice recon. photographs developed.
22	Testing the coring device at McMurdo Station Desalination effluent site. Corer malfunctioned, returned to Scott Base in the evening.
23	Repairs to both corer (butterfly valve) and toboggan executed.
24	Ward, Pyne, Fitzgerald and Garrick departed Scott Base for Cape Evans (morning). Camp established on the ice edge at Evans (North Bay). Evening reconnaissance to the ice edge at Cape Royds, returning to camp three hours later.
25-28	Tent days. Southerly storm system; high winds and blizzard conditions with blowing snow and often zero visibility.
28 (evening) -29	"Broke camp" and returned to Scott Base; arrived early morning. Difficulties were only encountered between the Dellbridge Is. on bare ice in high winds.
29-Nov. 1	Repairs to toboggans and refitting of new sledges at Scott Base.
2	Sampling in front of McMurdo Station at the Desalination Effluent outlet.
3	Modifying corer at Scott Base to add extra 60 lbs weight.
4	Coring attempt at McMurdo resulted in a small core (in hard ground). Moved to old Fish Hut site; 5km from McMurdo, 476m water depth. Unsuccessful attempt, with repaired valve again broken.
5-6	New valve, flown from N.Z. fitted to corer and final preparations made to sledges and toboggans.
7	Departed Scott Base at 9.00 hours for Butter Point on a direct route to tip of "Dirty Ice" then to Butter Point. A strip of rough ice negotiated 2-6km off the Bowers extending from Strand Moraines to Butter Point. Arrived Butter Point 1800 hours, established camp at the MSSTS refuge hut.

Nov. 8 Moderate winds prevented work in the morning. Two holes attempted in late afternoon; corer malfunctioned on hole 2 about 5km east of Butter Point.

9 Corer repaired and another coring attempt later in the day. Trigger mechanism failure on the corer.

10 Corer repaired during the day. Neale (surveyor) arrived by helo from Vanda early evening. Ward, Pyne, Fitzgerald, Garrick and Neale to Strand Moraines to get erratic samples and visit K2. Excellent travel on the Bowers Piedmont Glacier. Fink and Iles arrived Butter Point from Scott Base, late evening in Snow Trac 35 to join K14.

11 Survey Beacons grid established off Butter Point by the whole party using toboggans.

12 The morning and early afternoon was spent on toboggan repairs after a helo drop of spare parts. One hole was attempted and a partial core recovered, 5km from Butter Point on a line to Hjorth Hill.

13 Surveyors (Fink, Neale) and Garrick to Trig Herb, re-establish the trig cairn. Ward, Pyne, Fitzgerald, Iles, Fink and Neale to Ferrar Glacier Snout, where coring attempt was unsuccessful. Travel was very slow on bare "rough pancake" sea ice. Return <u>via</u> snow-covered Bowers Piedmont for easier travel in early morning.

14 Broke Camp and departed Butter Point for Cape Chocolate (afternoon), arriving early evening near the Garwood Valley where camp was established on the sea ice.

15 Ward, Pyne, Fitzgerald and Iles depart for Scott Base on the Toboggans in marginal visibility conditions. Route to the Daily Islands - "Dirty Ice" - Scott Base was excellent travelling, on bare smooth sea ice until turning towards McMurdo at tip of the "Dirty Ice". The surveyors (Fink, Neale = K3) and Garrick remain for 24 hour tide levelling survey.

16 Rest day at Scott Base. K3 and Garrick return to Base.

17-18 Toboggans and corer repaired.

19 Successfully blasted the ice quarry, for the base emergency water supply, with the help of several Scott Base staff.

20 Remaining repairs and modification to the corer trigger carried out.

21 Departed Scott Base for Butter Point (Ward, Pyne, Iles and Garrick). Trip aborted when a toboggan broke down 20km from McMurdo Station, party returned to base overnight for new parts. Fitzgerald remaining at Scott Base for final exam.

22 Pyne and Iles on toboggans return to abandoned toboggan and sledges. Ward and Garrick by helo to sledges, but diverted to Winke Drill site in the lower Taylor Valley after failing to locate the sledges from the air. Return by helo to sledges early afternoon and the party proceeded to Butter Point, arriving early evening.

23 Tent day, bad weather.

24 Coring attempt unsuccessful. Pyne and Iles return to Scott Base

with the corer on an "opportunity" helo.

25 Departed Scott Base early evening in Sno Trac 35, (Pyne, Fitzgerald, Dibble, Iles). Arrived Butter Point early morning (25th) with orange-peel grab borrowed from the Bio. Lab. at McMurdo.

26 Seismic programme began by Dibble and Iles and sampling was continued with orange-peel grab in New Harbour.

27 Completion of the sampling line to Hjorth hill. Seismic programme continued.

28 Repaired sledges and regular maintenance for toboggans. Seismic continued.

29 Tent day. Seismic continued.

30 Completed sampling in the Taylor Valley part of New Harbour and visited the Winkie drill site. Seismic continued.

Dec. 1 Tent day.

2 Completed Ferrar leg of sediment sampling (late evening and early morning of 3rd). Seismic continued. K3 arrived and pitched camp in the late evening.

3 K3 use two toboggans for ice movement survey. Seismic programme came to the end as Sno Trac 35 broke down and party awaiting helo with Bruce Scott (Base mechanic) and Sno Trac parts.

4 Early morning departure for Scott Base, (Ward, Pyne, Dibble, Fink and Neale) with three toboggans and sledges. Excellent ice conditions taking direct route and arrived at 0630. Quick 5.5 hour trip. Scott, Garrick, Fitzgerald and Iles arrive at Base with Sno Trac 35 at 1730 hours.

5 Processed sediment samples, and packed for shipment to N.Z. Unpacked and returned some field equipment.

6 Completed sampling at the McMurdo Desalination Effluent Discharge sites.

7 Rest day.

8-9 Cleaned equipment and packed cargons. Iles by helo to K13 at Knobhead (9th).

10 Prepared equipment for Lashly Mountains. Dibble with K5 to Erebus.

11 Pyne, Ward, Fitzgerald and Garrick to Lashly Mountains, Mt. Crean, established camp and began work on section L2.

12-14 Continued detailed work on the Weller Coal Measures (L2).

15 Tent day awaiting return to Scott Base. Helo attempt in early evening aborted because of snow storms.

16 Departed Lashly Mountains 1130 hours swapping tents with K13 who finally arrived on the incoming helo.

17 Packed remaining equipment for shipment to N.Z. and returned field equipment to storeman.

18-20 Awaiting C130 flight to Christchurch.

20 Late evening departure for Christchurch (Ward, Pyne, Fitzgerald and Garrick).

Days at Scott Base:

(a) Preparing and repairing equipment, sampling near Scott Base, blasting and survival course			...	30
(b) Waiting for Transport/Weather		...	...	4
Days in the field	...	...	...	35
Travel ...	...	...	...	13
Tent days (Weather and helo waits)		...	...	8
Days in Antarctica	...	...	...	68

Event 15 - Basement Studies.

Nov.16	Reid and Simmons to Scott Base.
17-20	Survival Training.
21	Reid, Mortimer and Simmons to Miers Valley.
22-Dec.7	Work in Miers Valley.
(Nov.28, 29 and Dec.5 - Tent days).	
Dec.8	Reid, Mortimer and Simmons to Colleen Lake.
9-16	Work in upper Garwood Valley.
(Dec.11, 14, 17, and 18 - Tent days).	
19	Reid, Mortimer and Simmons to Garwood Lake.
19-24	Work in lower Garwood Valley.
25	Christmas Day.
26	Reid, Mortimer and Simmons to Marshall Valley.
27-31	Work in Marshall Valley.
Jan.1	New Year's Day.
2	Mortimer and Simmons to Salmon Valley. Reid to Scott Base.
2-6	Work in Salmon Valley.
5	Reid to Christchurch.
7	Mortimer and Simmons to Taylor Glacier to join Event 2.
8	Work in Taylor Valley.
9	Mortimer and Simmons to Vanda Station.
10-12	Work in Wright Valley.
13	Mortimer and Simmons to Scott Base.
14-18	Return field gear to Scott Base store; awaiting transport to Christchurch.
19	Mortimer and Simmons to Christchurch.

Days in Antarctica		...	...	...	63
Days at Scott Base		...	...	...	9
Days in field		...	...	...	53
Travel	...	...	...	...	8
Tent days and helo waits			...	...	10
Work	...	...	...	...	44

APPENDIX V - VEHICLE ITINERARY

NZARP Event K14

Date:	Destination, Route and Areas Covered:	Vehicles/Sledge Loading/ Personnel: (*mechanical failure)		Running hours:	Distance (km):
Oct.17-18	Scott Base...Ski Chalet	SM 016 /	/1	1.0	14
	...Castle Rock (survival	SM 039 /	/1	2.0	20
	course testing toboggans)	SM 038 /sledge	/2	2.0	20
22	Scott Base; McMurdo Stn.	016 /sledge(B5)400lb	/1		6
	area	* 039 /sledge(T1)900lb	/2		
		038 /sledge(B7)600lb	/2		
		(039 towed to Scott Base)			
24	Scott Base...Cape Evans	016 /(B5)600lb	/1	4.5	33
		039 /(T1)900lb	/1		
		* 038 /(B7)800lb	/2		
(evening)	Evans...Royds...Evans	016 /	/1	2	25
	(ice edge reconnaissance)	039 /	/1		
		* 038 /	/2		
		(038 refuelled @ 5.25 hrs. 016 nearly empty @ 5.25 hrs. 039 refuelled @ 6.0 hrs.)			
28-29 (evening)	Evans...Scott Base	016 /(B5)650lb	/2	3	30
		* 039 /(T1)900lb	/1		
		038 /(B1)650lb	/1		
Nov.2-5	Scott Base; McMurdo Stn.	016 /(B4)100lb	/	1	15
	area	039 /(T1)	/		
		038 /(T3)	/		
7	Scott Base...Butter Point	016 /(B4)700lb	/1	8	75
	(direct route, patchy rough	039 /(T1)900lb	/1		
	ice, Strand Morains - Butter	038 /(T3)900lb	/2		
	Point, generally very good ice conditions)	(all machines refuel @ 4.5 hrs. 039 est. 0.5 gal. remain)		(average 9.4 km/h)	
8	Butter Point area	016 /(B4)	/1	1.5	15
		039 /(T1)700lb	/1		
		038 /(T3)700lb	/2		

9	Butter Point area		016 /(B4)	/1	1.0	10
			039 /(T1)700lb	/1		
			038 /	/2		
10	Butter Point...Strand Morains		016 /	/1	2.5	35
	...Butter Point (excellent		039 /	/1		
	travel on Bowers Piedmont		038 /(B4)400lb	/3		
	Glacier)					
11	Butter Point area (sea ice	*	016 /	/2	4	35
	survey beacons established)		039 /	/1		
			038 /(B4)600lb	/4		
12	Butter Point area		016 /	/1	1.0	20
			039 /(T1)700lb	/1		
			038 /(T3)700lb	/2		
13	Butter Point...Trig Herb		016 /	/1	2	20
			039 /	/1		
			038 /	/1		
	Butter Point...Ferrar Snout		039 /(T1)700lb	/1	5	30
	.. Butter Point		038 /(T3)700lb	/1	(average	
	(bare rough pancake ice		Snow Trac 35 /	/4	6 km/h)	
	Bowers P. n. via)					
14	Butter Point...Garwood Valley	*	016 /(B4)600lb	/1	5	55
	(excellent travel, smooth		039 /(T1)800lb	/1	(average	
	ice after Strand Morains)		038 /(T3)800lb	/1	11 km/h)	
			Snow Trac			
			35 /(T2)500lb	/4		
			(Sno Trics refuel @			
			4.5 hrs.; 0.5-1.0			
			gal. in all tanks)			
15	Garwood Valley...Scott Base		016 /(B4)600lb	/2	5.5	65
	(via Daily Islands and dirty	*	039 /(T1)800lb	/1	(average	
	ice edge, smooth ice until		038 /(T3)750lb	/1	12 km/h)	
	5km from McMurdo Station)		(refuel @ Scott Base)			
16	Garwood Valley...Scott Base		Sno Trac			
			35 /(T2)500lb	/3		
21	Scott Base...Butter Point	*	016 /(B4)700lb	/1	2	23
	(aborted 20km from McMurdo		039 /(T1)900lb	/1		
	Station).		038 /(T3)900lb	/2		
	Return...Scott Base		039 /	/2	1.5	23
			038 /	/2		

22	Scott Base...(stranded 016 + sledges)...Butter Point (good travel), smooth ice on bladed fuel-train road)	* 016 /(B4)700lb 039 /(T1)900lb 038 /(T3)900lb (refuel after 6.5 hrs.)	/1 /1 /2	7 (average 10 km/h)	70
24	Butter Point area	016 / 039 /(T1)700lb 038 /(T3)700lb	/1 /1 /1	1	15
25	Scott Base...Butter Point	* Sno Trac 35 /(T2)800lb (2 bogey tyres broken)	/4	5.5 (average 12.7 km/h)	70
26	Butter Point area	039 /(T1)700lb 038 /(T3)700lb N.B. 016 + Sno Trac 35 used by Dibble + Iles for seismic study (26 Nov. - 3 Dec.)	/2 /2	2.0	25
27	Butter Point...Hjorth... ...Butter Point (rough ice, Taylor Valley side of New Harbour)	039 /(T1)700lb 038 /(T2)700lb	/2 /2	5	40
30	Butter Point...Taylor Valley ...Butter Point	" "		5	45
Dec.2-3	Butter Point...Ferrar Snout... ...Butter Point	039 /(T1)700lb 038 /(T2)700lb	/2 /1	6	50
3	Butter Point...survey beacon	039 / 038 /	/1 /1	5	35
4	Butter Point...Scott Base (direct route, large smooth ice areas east of Butter Point - Strand)	016 /(B)600lb 039 /(T1)800lb 038 /(T3)900lb	/1 /3 /1	5.5 (average 12.7 km/h)	70
		Sno Trac 35 /(T2)600lb (2 bogey tyres broken)	/4	5.5	
6	Scott Base...McMurdo Station area	039 /(T1)500lb 038 /(T3)500lb	/2 /3	1.0	6
		Toboggan total :		95.25 hrs.	995km.

APPENDIX VI - WEATHER OBSERVATIONS

Event 5 - IMESS: Mt. Erebus

Date	Time (NZST)	Location	Altitude (m)	Temp. (°C)	Pressure (mb)	Wind Speed and Direction	Visibility	Sky	Remarks
Dec.									
20		Erebus		-28		11 knts.		Fine	
21		Summit		-27		12 knts.		Fine	
22				-28		0		Fine	
23				-25		1 knt.		BKN	Fog & snow.
24				-26		6 knts.		BKN	
25						"Windy"		OVC	"Good inside".
26				-30		20 knts.		SCT	Blowing snow.
27				-27		9 knts.		BKN	Fine, calm midnight.
28				-28		22 knts.		Fine	
29				-28		21 knts.		Fog	Blowing snow.
30				-25		24 knts.		"	" "
31				-23		22 knts.		"	" "
Jan.									
1				-27		24 knts.		"	" "
2				-22		9 knts.		"	" "
3				-28		17 knts.		"	" "
4				-27		6 knts.		Fine	Deteriorated evening.
5				-27		21 knts.		Fog	Blowing snow.
6				-25		20 knts.		"	" "
7				-24		21 knts.		BKN	Slight blowing snow.
8				-27		26 knts.		Fog	Blowing snow.
9				-26		9 knts.		SCT	Fine, nearly calm.

Date	Time (NZST)	Location	Altitude (m)	Temp. (^oC)	Pressure (mb)	Wind Speed and Direction	Visibility	Sky	Remarks
Event 13 - Beacon Studies.									
Nov.									
22	0820	Portal Mt.	1700	-17	798	3 knts. SW	50	Clear	
23	0800	"	"	-19.5	801	Slight NE	50	"	
24	0745	"	"	-20	800	8 knts. SW	50	"	
25	0915	"	"	-18.5	796	4 knts. SW	50	"	
26	0730	Alligator Pk.	1450	-17.5	815	-	50	"	
	1740	"	"	-15.5	815	4 knts. E	50	"	
27	0750	"	"	-17.5	817	5 knts. SW	50	"	
28	0750	"	"	-17.5	814	5 knts. Variable	50	"	
	1700	"	"	-15.5	814	4 knts. NE	50	"	
29	0755	"	"	-17.5	817	Slight SW	50	"	
30	0810	"	"	-17.0	820	Slight variable	50	"	
Dec.									
1	0810	"	"	-18.0	820	9-15 knts. SW	50	"	
1	1800	Mt. Kempe	2500	-18.0	815	3 knts. variable	150	"	
2	0800	"	"	-18.0	816	5 knts. SW	180	"	
3	0800	"	"	-19.0	815	Calm	180	"	
4	0800	"	"	-22.0	809	15-20 knts. SW	200	"	
5	0815	Table Mt.	1700	-13	763	2-5 knts. W	60	Overcast	
6	0800	"	"	-12	767	10-30 knts. S	20	Snowing	
7	0800	"	"	-11	766	4 knts. N	50	Broken Cloud	
	1900	"	"	-9.5	767	4 knts. NE	50	Overcast	
8	0800	"	"	-12	769	Calm	20		
	2100	"	"	-14	773	Calm	50	Snowing	
9	0800	"	"	-14	774	2 knts. E	50	Scattered 5/8 CS	
10	0805	Knobhead	1500	-11	819	6 knts. SW	50	Clear	
	2030	"	"	-10	818	5-7 knts. NE	5	Snowing & overcast	

Date	Time (NZST)	Location	Altitude (m)	Temp. (^{o}C)	Pressure (mb)	Wind Speed and Direction	Visibility	Sky	Remarks
Dec.									
11	0800	Knobhead	1500	-12	819	7-8 knts. SW	50	Snowing & overcast	
12	0800	"	"	-11	820	7 knts. NE	50	Broken	
13	0800	"	"	-12	820	3 knts. NE	15	Overcast	
14	0830	"	"	-10	818	3 knts. NE	20	Broken	
	1800	"	"	-12	818	4 knts. NE	10	Overcast, snowing	
15	0800	"	"	-12	816	4 knts. SW	50	Scattered	
16	1300	Mt. Crean	2200	-19	732	3 knts. W	50	"	
	2030	"	"	-19	733	8 knts. W	50	"	
17	0830	"	"	-19	732	9 knts. W	50	Scattered cloud	
	2400	"	"	-19	731	8 knts. N	50	" "	
18	0800	"	"	-19	733	4 knts. NE	20	Broken	
	1800	"	"	-19	735	3 knts. W	20	Snow, overcast	
19	0800	"	"	-21	731	10 knts. W	50	Scattered	
	1800	"		-	-	25 knts. W	50	Blowing snow	
20	0200	"		-	-	40-50 knts. W est.	-	" "	
	1800	"		-22	730	20-50 knts. W	50	" "	
21	0200	"	"	-	-	40 knts. W est.	-	Overcast & blowing snow	
	1800	"	"	-18	735	10 knts. W	50	Scattered cloud	
22	0800	"	"	-20	734	10 knts. W	50	Clear	
	1500	Scott Base							

Event 14 - Sea floor sediment sampling: McMurdo Sound.

Date	Time (NZST)	Location	Altitude (m)	Temp. (°C)	Pressure (mb)	Wind Speed and Direction	Visibility	Sky	Remarks
Oct.									
25		Cape Evans	0			25-40 knts.@	max.10km	OVC	Snow squals, & blowing snow.
26		166°24.5'E				180°T.	min. 0		Some finer periods lasting
27		77°37.5'S				gusts >50 knts.			a few hours with
28									very strong winds.
29									
Nov.									
8	0830	Butter Pt.	5m	-13	1003	9 knts.@ 180°T.	50km	SCT	Wind increase, mod. blow.
9	0830	164°13'E	"	-13.5	996	5 knts.@ 180°T.	50km	SCT	snow.
10	0830	77°39.2'S	"	-16	992	0	50km	SKC	
11	0830	"	"	-9	994	6 knts.@ 225°T.	20km	OVC	
12	0845	"	"	-8	997	7 knts.@ 180°T.	50km	SKC	
13	1320	"	"	-9		9 knts.@ 180°T.	50km	SCT	
14	0830	"	"	-10	1000	7 knts.@ 180°T.	50km	SCT	
15	0845	164°30'E	0	-7	998	0	5km	OVC	Light falling snow.
		78°00'S							
24	0830	Butter Pt.	5m	-9	1005	0	50km	SKC	
25	0815	164°13'E	"	-8	999	4 knts.@ 180°T.	30km	OVC	
27	0830	77°39.2'S	"	-7	997	0	50km	SKC	
28	0830	Butter Pt.	5m	-9	994	5 knts.@ 180°T.	20km	BKN	
29	0830	"	"	-10	998	15 knts.@ 180°T.	10km	OVC	Mod.Blow.snow. Snowed NE last nite.
30	0825	"	"	-10	1001	2 knts.@ 180°T.	50km	SKC	Snowed last nite then wind from South.
Dec.									
1	0820	"	"	-8	998	5 knts.@ 180°T.	50km	SKC	
3	0825	"	"	-6	998	3 knts.@ 180°T.	50km	SKC	
4	0830	"	"	-10		20 knts.@ 180°T.	50km	SKC	

Date	Time (NZST)	Location	Altitude (m)	Temp. (°C)	Pressure (mb)	Wind Speed and Direction	Visibility	Sky	Remarks
Dec.									
12	0830	Lashly Mts.	2250	-16		2 knts.@ 180°T.	50km	SCT	Cloud build up in the
13	0830	159°32.5'E	"	-18		10 knts.@ 000	30km	SCT	north & east, moving south
14	0830	77°54'S	"	-17		5 knts.@ 000	50km	SCT	during the day, giving light
15	0830	"	"	-21		15 knts.@ 270°T.	50km	SCT	snow and variable winds.

Event 15 - Basement Studies.

Date	Time (NZST)	Location	Altitude (m)	Temp. (°C)	Pressure (mb)	Wind Speed and Direction	Visibility	Sky	Remarks
Nov.									
22	0730	West end of	200	-3.0	861.5	1.2 knts.@ E.	Good	Clear	
23	0800	Lake Miers	"	-5.0	982	2.0 Knts.@ E.	Good to E. 50km t W.	OVC	
24	0800	"	"	-4.0	985	4.0 knts.@ SE.	Horizon	Clear	
25	0800	"	"	-5.0	978	Calm	"	BKN	
26	0830	"	"	-2.0	972	7.0 knts. @ E.	"	SCT	
27	0830	"	"	-4.0	975	Calm	50km	BKN	
28	0800	"	"	-7.5	973	9.0 knts.@ E.	5km to W. 20km to E.	OVC	
29	0800	"	"	-8.0	977	4.0 knts.@ E.	5km	OVC	
30	0800	"	"	-8.0	981	1.0 knts.@ SW.	Horizon	Clear	
Dec.									
1	0820	"	"	-4.0	978	Calm	"	"	
2	0820	"	"	-4.0	977	5-10 knts.@ SE.	"	"	
3	0810	"	"	-7.0	976	4.0 knts.@ E.	"	"	
4	0820	"	"	-5.0	970.5	3.0 knts.@ E.	"	"	
5	0820	"	"	0	958.5	10-15 knts.@ N.	50km	OVC	
6	0800	"	"	+ 2.0	962.0	8-15 knts.@ S.	50km	"	Gusty wind up to 25 knts.
7	0830	"	"	+ 2.5	960.5	8 knts.@ E.	50km	BKN	Temperature reached +7°C @ 1500 hrs.
8	0820	"	"	0	965	6 knts.@ E.	10km to W. 20km to E.	OVC	Light snow.

Date	Time (NZST)	Location	Altitude (m)	Temp. (°C)	Pressure (mb)	Wind Speed and Direction	Visibility	Sky	Remarks
Dec.		West end of							
9	0820	Lake Colleen	310	0	959.5	1 knt.@ E.	50km	SCT	
10	0820	"	"	+1.0	962	1 knt.@ E.	Horizon	SCT	
11	0810	"	"	-5.0	962	6 knts.@ E.	500m	OVC	2" snow overnight.
12	0830	"	"	-1.0	965.5	1 knt.@ W.	Horizon	BKN	
13	0830	"	"	-2.0	964.0	5 knts.@ E.	Horizon	OVC	
14	0800	"	"	-4.0	962.0	3 knts.@ E.	10km	OVC	
15	0800	"	"	-8.0	959.4	Calm	50km	BKN	4" snow.
16	0810	"	"	-3.0	962	3 knts.@ E.	50km	SCT	
17	0800	"	"	-7.0	962.5	5 knts.@ E.	20km	OVC	light snow.
18	0820	"	"	-9.0	965	6 knts.@ E.	5km	OVC	" "
19	0800	"	"	-9.0	962	1 knt.@ E.	0	BKN	" "
20	0810	1km west of Garwood Lake	10	-3.0	1001	6 knts.@ E.	50km	SKC	
21	0820	"	"	0	1003.5	7 knts.@ E.	50km	SKC	
22	0810	"	"	+4.0	1003	Calm	50km	SKC	
23	0820	"	"	+3.0	1003	2 knts.@ SE.	50km	SCT	
24	0810	"	"	-3.0	1002.5	12 knts.@ E.	1km	OVC	
25	0820	"	"	+2.0	1003	6 knts.@ E.	50km	SKC	
26	0815	"	"	+1.0	1005	1 knt.@ E.	50km	SCT	
27	0810	Upper Marshall Valley 2km E. of Rivard Gl.	350	+1.0	961	2 knts.@ E.	50km	SKC	
28	0800	"	"	+1.0	964.5	2 knts.@ E.	50km	SKC	
29	0820	"	"	0	967.5	10-20 knts.@ W.	50km to E. 10km to W.	OVC	
30	0820	"	"	+1.0	964.0	15-25 knts.@ W.	50km	SCT	
31	0830	"	"	+6.0	956.0	Calm	50km	SCT	
Jan.									
2	0815	"	"	0	959	Calm	50km to E. 20km to W.	OVC	

Date	Time (NZST)	Location	Altitude (m)	Temp. (^{o}C)	Pressure (mb)	Wind Speed and Direction	Visibility	Sky	Remarks
Jan.									
3	0815	Salmon Vly.	950	-4.0	922	2 knts.@ N.	Horizon	SCT	Camp in high basin with restricted visibility, light snow.
4	0815	"	"	-7.0	925	6 knts.@ N.	Zero	OVC	Light snow.
5	0820	"	"	-5.0	925	7 knts.@ S.	Horizon	OVC	
6	0820	"	"	-2.0	924	2 knts.@ S.	Horizon	BKN	
7	0820	"	"	-2.0	924	Gusts up to 30 knts. from S.	50km	BKN	