This report has been prepared for the benefit of the University 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 publication, and any scientific data contained herein may not be used or referred to in print without the express permission of the expedition leader and project leader concerned.

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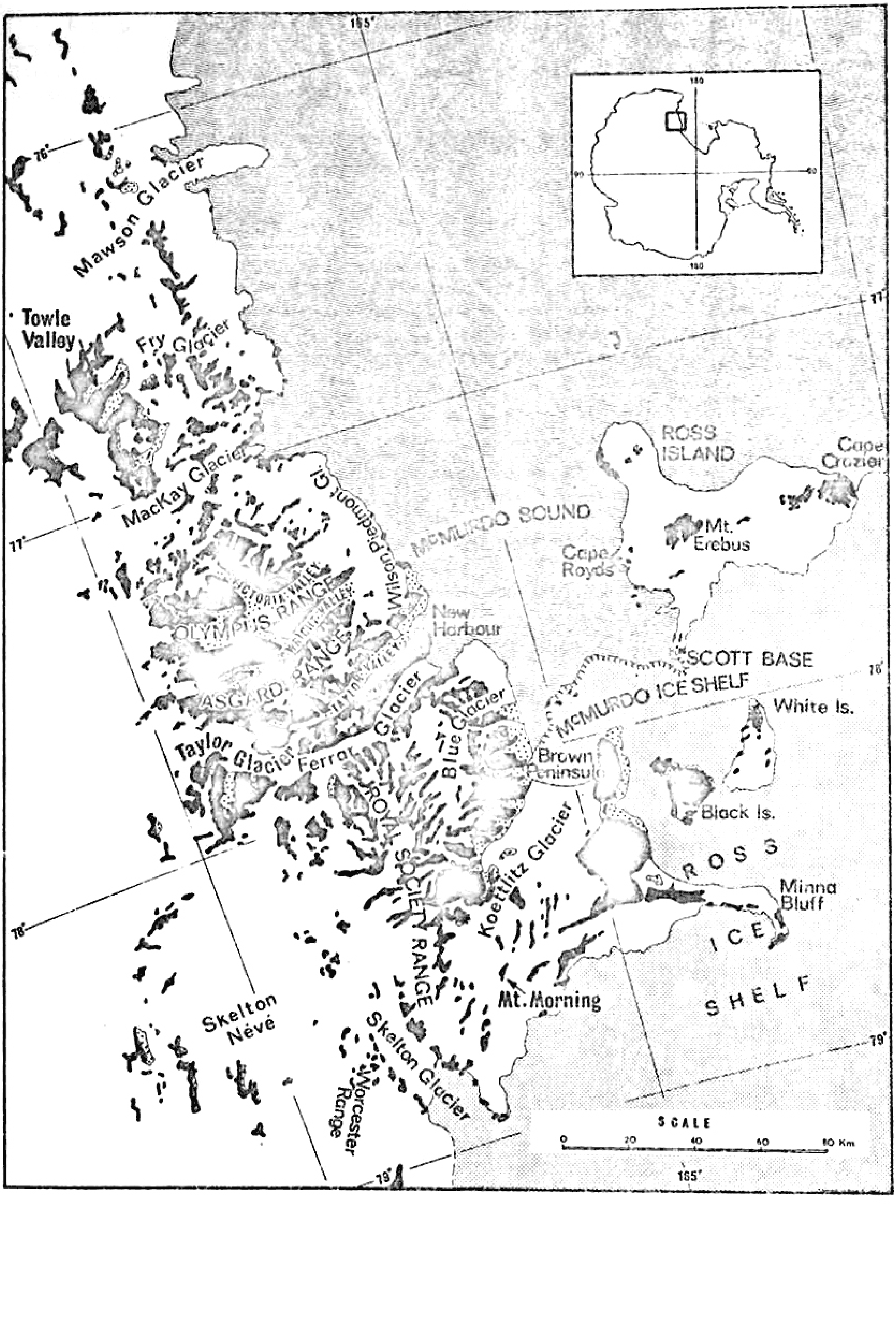
165°
76°
77°
78°
79°
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Mawson Glacier
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SCOTT BASE
McMURDO ICE SHELF
White Is.
Black Is.
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ROSS ICE SHELF
SCALE
0 20 40 60 80 Km

PREPARATIONS FOR VUWAE 21

A proposal outlining a programme involving four main scientific projects was submitted to the March meeting of RDRC. After some discussion, all four projects were approved, and the VUWAE programme passed on to Antarctic Division.

In summary it was proposed to send seven members to carry out the following projects and objectives:-

A. Glacial Studies

To investigate the processes of debris entrainment and the formation of debris layers within glacial ice.
To determine whether the change in mode of till deposition around glaciers such as the Taylor Glacier, results from a change in the dynamic and thermal conditions of a body of ice.

B. Salt Studies

To continue soil and surface measurements (temperature profiles, frozen ground level depths, surface colour etc.) on dark surfaces at chosen localities.
To examine and sample the Taylor mineral deposit at the snout and up glacier.
To investigate the structure of the large snow-ice features on Mts. Discovery and Morning.

C. Moss Ecology

To make a quantitative study of the ecology of mosses in the McMurdo Sound Region.

D. Geology of the Fry Glacier Region

To carry out geological reconnaissance in the previously unexplored Fry Glacier region 170 km north of Scott Base and to study in some detail the glacial geology of the dry valley areas and exposures of the Beacon Supergroup there.

Logistic Support and Further Planning

Major requirements requested from Antarctic Division were the usual items of field equipment, fuel and food. Helicopter time requested was 41 hours. Because of the nature of the expedition four toboggans and six sledges were requested.

One surveyor and two field assistants were also requested from Antarctic Division. Following discussion at Tekapo between the Superintendent and the Field Operations Officer (Antarctic Division), the Surveyors and VUWAE members, it was decided that both surveyors accompany VUWAE 21A on the first part of the Taylor Glacier expedition. This resulted in a considerable easing of workloads.

After the French volcanologists withdrew from the planned Erebus expedition, a small NZARP party was organised to continue the monitoring and surveying programme on the volcano. VUWAE members Stern and Keys were to participate and take seismic recordings and possibly a lava temperature measurement.

Minor changes in the VUWAE programme were implemented following discussion between VUWAE members, Kevin Tasker (Leader, Scott Base) and John Charles (Deputy Leader, Scott Base).

EXPEDITION MEMBERS

The main projects of VUWAE 21 were made up as follows:

A. Glacial Studies — VUWAE Members

Glaciogeologist	Paul Robinson	B.Sc. (Hons.), Ph.D. student (VUW)
Geophysicist	Tim Stern	B.Sc. (Hons.) (VUW)

B. Salt Studies

Geochemist	John (Harry) Keys	M.Sc., Ph.D. student (VUW)

C. Moss Ecology

Botanist	Andrew Frost	B.Sc. (Hons.) (VUW), M.Sc. student (VUW)

D. Geological Reconnaissance and Mapping in the Fry Glacier Region

Geologist	Chris Burgess	B.Sc. (Wales), M.Sc. (South Carolina), Ph.D. (Wales)
Geologist	Alan Palmer	B.Sc. (Hons), Ph.D. student (VUW)
Geologist	John Anderson	B.Sc. (Hons.), M.Sc. student (VUW)

Applications for two field assistants were called for in the Geology Department in mid 1976. The Antarctic Research Committee at VUW selected Stern and Anderson to fill these positions. Both will be involved in evaluation of Antarctic field data on their return to VUW in 1977.

FINANCE, EQUIPMENT AND GENERAL PROVISIONS

Finance

A grant from the University Grants Committee was used to pay for food, clothing, camping items, some specialised scientific equipment, freight, travel, and to cover insurance of personnel and equipment. The University Council provided financial support for Palmer, Anderson, Stern and Keys.

Equipment

Many items were already available in the VUWAE stores at both Wellington and Scott Base. They included down and windproof clothing, sleeping bags, mukluks, kitchen gear, ice axes, some crampons and crevasse rescue equipment, rock drums and scientific equipment. The Geology and Chemistry departments (VUW) provided other scientific equipment. The Otago University Department of Geology lent the expedition a Worden gravimeter and the Ministry of Works and Development, Water and Soil Division, Christchurch, lent a universal stage.

Antarctic Division provided expensive and specialist equipment including four motor toboggans, six sledges, four polar tents, four radio transceivers, four first aid kits and miscellaneous climbing equipment. The Division also clothed DSIR personnel working with VUWAE. A Briggs and Stratton drill was borrowed from McMurdo Station.

Miscellaneous small items were purchased to replace worn or broken VUWAE equipment and to obtain new supplies of various items. With the assistance of the Physics Department (VUW) Robinson built a set of temperature probes and adapted a wheatstone bridge for englacial temperature determinations.

Food

As for the last four years' expeditions, VUWAE 21 worked on a man day basis and were charged a flat rate ($20 per person per week), irrespective of whether the personnel were in the field or at Scott Base. (This flat rate also covers other consumables such as petrol, oil, and kerosene, and includes the use of Antarctic Division toboggans, tents, etc.). As in the past VUWAE purchased fresh meat and canned fruit to supplement the food boxes.

STRUCTURE OF THE EXPEDITION

The following indicates the field location, dates and composition of the various fractions of VUWAE 21. A more detailed summary of movements and activities is contained in Appendix 2, the expedition itineraries.

VUWAE 21A: Glacial, Salt and Moss Studies, Oct 21 - Jan 12.

Event 12/12A Oct 21 - Nov 12 Taylor Glacier Snout to Pandora camp

P. Robinson	
J. Keys	
J. Nankervis	DSIR Field Assistant
J. Palmer	Surveyor
W. Wicks	Surveyor (until Nov 10)
T. Stern	(from Nov 10)
A. Frost	(from Nov 10)

Event 12 Nov 12 - Dec 1 Pandora camp to Taylor Glacier Snout

P. Robinson	
T. Stern	
J. Palmer	(until Nov 21)

Dec 1 - Dec 9 Taylor Glacier Snout and Lake Bonney area

P. Robinson
T. Stern
A. Frost

Dec 10 - Dec 17 Hobbs, Blue and Salmon Glaciers and valleys

P. Robinson
A. Frost

Jan 2 - Jan 12 Taylor Glacier Snout to Pandora camp

P. Robinson
T. Stern
J. Palmer

Event 12A Nov 12 - Nov 21 Pandora camp to Taylor Glacier Snout

J. Keys
J. Nankervis
A. Frost

Nov 21 - Dec 1 Taylor Glacier Snout and Lake Bonney area

J. Keys
J. Nankervis
A. Frost

Dec 1 - Dec 14 Mts. Morning and Discovery

J. Keys
J. Nankervis

Event 5 Dec 18 - Dec 31 Mt. Erebus

C. Monteath	DSIR Field Operations Officer
J. Palmer	Surveyor
T. Stern	
J. Keys	(until Dec 27)

Two USARPS (S. Treves and assistant) were on the mountain until Dec 27 but as an independent unit.

VUWAE 21B; Geological Reconnaissance and Mapping in the Fry Glacier Region, Nov 20 - Jan 9.

Event 36 Nov 20 - Dec 21 Northwind Glacier Snout to Towle Glacier Snout

A Palmer	
C. Burgess	(until Dec 20)
J. Anderson	
K. Sullivan	DSIR Field Assistant
A. Frost	(after Dec 20)

Event 36A Dec 22 - Dec 31 Towle Glacier Snout to Chattahoochee Glacier and return

J. Anderson
K. Sullivan

Jan 1 - Jan 9 Elkhorn Ridge

J. Anderson
K. Sullivan

Event 36B Dec 22 - Jan 5 Towle and Northwind valleys and surrounds

A. Palmer
A. Frost

Jan 6 - Jan 9 Elkhorn Ridge

A. Palmer
A. Frost

SCIENTIFIC ACHIEVEMENTS

A. Glacial Studies

1. An ice velocity and ablation pole network was placed and surveyed in Taylor Glacier. The surveying was done twice, early and late in the expedition, and included the 18 pole network placed by Sillars (Barrett et al 1976) at the snout in 1975.

Approximate movement data (in metres) for some poles are given below (J. Palmer, Lands and Survey Department, Hokitika; pers. comm.). Figures in parentheses indicate the periods between surveys.

A4	4.4	(27-30.12.75 to 22-24.10.76)
B4	4.1	(" ")
C4	4.0	(" ")
A4	5.6	(27-30.12.75 to 3.1.77)
B4	5.2	(" ")
C4	5.0	(" ")
D6	0.8	(1-2.11.76 to 6.1.77)
E4	2.3	(" ")

2. The ranges in ablation measurements (in centimetres) in the 7 lines of the 56 pole network are given below. Figures in parentheses indicate the periods between measurements.

Line A	17.5 - 25.5	(22.12.75 - 24.10.76)
	13.0 - 22.0	(24.10.76 - 2.1.77)
	30.5 - 43.5	(377 days)
Line B	13.0 - 23.5	(22.12.75 - 24.10.76)
	15.0 - 21.0	(24.10.76 - 2.1.77)
	32.0 - 39.5	(377 days)
Line C	24.0 - 28.5	(22.12.75 - 24.10.76)
	16.0 - 21.0	(24.10.76 - 2.1.77)
	44.0 - 48.5	(377 days)

Line C is nearest to the snout.

Line D	(9 km from the snout)	
	5.0 - 12.0	(27.10.76 - 5.1.77; 70 days)
Line E	(13 km from the snout)	
	10.0 - 13.5	(25.10.76 - 6.1.77; 69 days)
Line F	(In the transection between Taylor and Ferrar Glaciers)	
	5.0 - 8.5	(6.11.76 - 9.1.77; 64 days)
Line G	(Between Arena Valley and Pandora Spire)	
	7.0 - 10.5	(13.11.76 - 10.1.77; 58 days)

3. Ice temperature measurements were undertaken in 2 holes in Taylor Glacier, to depths of 17.5 and 15.0 m respectively. The mean annual temperatures and heat flow gradients at the two sites were determined to be as follows:-

Hole 1 (660 m elevation); $-16.2 \pm 0.5^{\circ}C$; $0.22^{\circ}C.m^{-1}$.

Hole 2 (1266 m elevation); $-22.7 \pm 0.5^{\circ}C$; $0.25^{\circ}C.m^{-1}$.

4. Supraglacial pebble sampling was undertaken at 33 sites on the glacier in an attempt to determine whether various lithologies have differing rates of breakdown under the processes of 'fast-shattering' and 'freeze-thaw'. Englacial and proglacial pebble samples were collected to determine the degree of rounding and/or facetting on pebbles of different lithologies. Englacial pebble fabrics were also done to supplement those done in the 1975-76 season.

5. Ten days were spent at the Thiel Earth Sciences Laboratory sectioning and describing ice samples collected from Taylor Glacier. This work involved determining general trends in the petrography between various types of ice, which will be related to the origins of englacial debris and clean ice layers.

6. Initial observations on the Hobbs, Blue and Garwood Glaciers indicate that debris accumulations, in these high debris content alpine glaciers, is more likely to be supraglacial as opposed to a probable subglacial origin for Taylor Glacier debris.

7. Gravity profiles perpendicular to the flow of the Taylor glacier were carried out along lines A, D, E, F, G. An additional longitudinal profile was carried out from D line to Lake Bonney. In total ninety gravity stations were occupied.

Due to the large density contrast between ice and rock, the resulting bouguer anomalies may be interpreted in terms of ice thickness.

The initial reduction of data from G line gives a maximum anomaly of - 59 mgal, indicating a thickness of ice of the order of 1000 metres. However previous work with a radio echo sounder (Calkin, 1974) indicates an ice thickness of 800 metres.

Thus any plausible interpretation model must include a layer of lower density sediments between the ice and basement.

References:

Barrett, P., Collen J., Eggers, A., Palmer A., Robinson, P., Sillars, K., 1976. Immediate Report of Victoria University Antarctic Expedition 1975-76.

Calkin, P.E., 1974. Subglacial Geomorphology surrounding the Ice Free Valleys of Southern Victoria Land, Antarctica. J. Glaciology, v.13(69), p.415-29.

B. Salt Studies

1. Sampling in Kennar Valley and around Taylor Glacier completes a programme of sampling from the coast to the Lashly Mountains 90 km to the west, at the edge of the polar plateau.

2. Microscopic examinations of various salt samples were undertaken in the field and at Scott Base to help elucidate the patterns of salt crystal growth. The examinations indicate that wind erosion of surface salt deposits is extensive in some deposits.

3. Surface and soil temperatures and frozen level depths were measured on several basalt cones on the slopes of Mt. Discovery. These show that sunnier slopes tend to have shallower frozen levels indicating that more moisture is present in such soils for salt dissolution and distribution.

4. The area of mineral discharge (Black et al, 1965) at the snout of Taylor Glacier was closely examined. Another saline discharge has occurred since the summer of 1975/76, mainly on the lateral stream delta. A cold (min. temp. - 7.8°C) saline spring was found flowing in late November, near the source of the lateral discharge. Such a spring does not appear to have been observed previously although Hamilton et al (1962) describe a saline "ice platform" at this location which was probably similar to the saline ice build-up from this most recent discharge. Estimated spring flow rates show some diurnal variation and possibly a relationship with spring temperature. No simple relationship exists between flow and air temperature and/or pressure.

The orange coloured layers in the glacier around the glacier discharge site were mapped. They do not outcrop more than 200 m from the site. Other englacial dirt layers on the surface further up Taylor Glacier appear to be mainly diffuse, low concentration rock debris layers, although one sharp high concentration layer containing mainly (basaltic?) tephra was found. These layers were previously believed to be extensions of the orange layers at the snout.

5. The volume percentage of tephra in englacial layers was measured for layers in the glacier between Mts. Morning and Discovery and in the Fang Glacier windscoop. Volume percentage is a useful parameter for distinguishing direct airfall deposits from wind deposited tephra and for describing englacial debris layers generally.

6. Snow free areas around the summits of Mts. Morning and Discovery were examined for traces of 'volcanic' salts such as are found on Mt. Erebus and the Fang. None were found.

7. The large (up to 20 m high) snow and ice features around the summits of Mt. Morning and Discovery were examined and ice sample densities measured. Their external and internal structures indicate that they are snow depositional features modified by strong mainly southerly winds. Direct condensation from clouds appears to be an important accumulation process. Although some of the "towers" on Mt. Discovery resemble the fumarole towers of Mt. Erebus, present day geothermal activity is not the cause of the Mt. Discovery and Mt. Morning structures. Structures similar to the latter are found on certain Marie Byrd Land volcanoes and were considered by Le Masurier and Wade (1968) to indicate fumarolic activity there. In the light of this season's work such a conclusion may be unsoundly based.

References:

Black, R.F., Jackson, M.L. and Berg, T.E. (1965). Saline Discharge from Taylor Glacier, Victoria Land, Antarctica. J. Geol. v.73(1), p. 175-81.

Hamilton, W., Frost, I.C., and Hayes, P.T. (1962). Saline Features of a Small Ice Platform in Taylor Valley, Antarctica. U.S. Geol. Survey Prof. Paper 450-B, p. 73-75.

Le Masurier, W.E. and Wade, F.A. (1968). Fumarolic activity in Marie Byrd Land, Antarctica. Science v.162, p. 352.

C. Moss Ecology

1. Areas where moss found:

Areas around streams below the Rhone, Hughes and Calkin Glaciers in the Taylor Valley, the moraines below the Hobbs Glacier and in the Salmon, Garwood and Towle Valleys, and in the Scott Base, McMurdo Station area.

2. Areas searched, sometimes briefly, where moss was not found:

Kennar and Beacon Valleys, area below La Croix Glacier and the side of the Taylor Valley around Lake Bonney not near melt streams below alpine glaciers. Although a week was spent searching in the Northwind Valley east of the Towle Valley, no moss was found.

3. Most patches of moss found below 330 m altitude were on sandy 'soil'. The few patches found in the Towle Valley above 1000 m were in cracks in dolerite blocks.

4. Algae and lichens were recorded from most of the areas visited. Most outcrops or rocks of Beacon sandstone had blue green algae growing just below the rock surface. Algae, such as Nestor sp. were frequently found in pools and other wet areas and lichens in rock cracks and on the surface of rocks.

5. Detailed quantitative surveys of moss were done below the Rhone, Calkin and Hughes Glaciers and on the delta below the snout of the Hobbs Glacier.

6. Sponophytes on Bryum antarcticum were collected from the Hobbs, Cape Chocolate area. Sponophytes (the sexual reproductive stage of a moss) have been recorded from Victoria Land only twice before.

7. Mosses were studied to 1300 m altitude in the Towle Valley, having previously only been recorded up to about 300 m altitude in Continental Antarctica.

8. The Garwood valley near the Garwood Glacier snout had the highest cover of moss of the areas studied.

9. Air spore samples were collected daily but these have not yet been studied.

10. Fresh algae was collected from Lake Fryxell and Lake Vanda for C_{14} dating standards for use by the Institute of Nuclear Sciences.

11. Soils were sampled for tests for microorganisms, pH, carbon and nitrogen content.

12. The ecological data recorded in the field will be analysed by computer for correlations between environmental factor and presence and absence, and cover of species.

13. Identification of specimens collected will be done by Botany Division, D.S.I.R., and Dr. S.W. Greene, Institute of Polar Studies, Great Britain.

14. A mummified seal was found beside the west side of the Northwind Glacier about 2 km from the snout. A mummified penguin was seen near the head of the Towle Valley.

D. Fry Glacier region

1. The previously geologically unmapped area of approximately 1500 sq.km was completely mapped. This area extends from the Convoy Range in the west to the Kirkwood Range and lower Fry Glacier in the east, and from Trinity Nunatak in the north to Benson Glacier and Mt. Razorback in the south.

2. Beacon Supergroup sediments were studied in detail at at least 14 sites. Most of the sediments which were exposed were mainly the Arena Sandstone and Beacon Heights Orthoquartzite of the Devonian Taylor Group.

3. The Aztec Siltstone, the topmost formation of the Taylor Group, was missing. It appears to have been eroded off by ice in the Permian - Carboniferous. The Metschel tillite was deposited on this surface, but as the climate improved much of the tillite was removed and a coal-bearing sequence, the Weller Coal Measures, was deposited.

4. The sandstone forms large rafts "floating" in Ferrar dolerite. This was emplaced as sheets in the Jurassic and now forms the most common rock type in the area.

E. Mt. Erebus

1. The temperature of the lava of Mt. Erebus was measured for the first time, using a Leeds-Northrup Co. Optical Pyrometer. A value, uncorrected for emissivity, of 980 ± 20°C was obtained.

2. The lava lake has slightly expanded in area since December 1975.

3. The activity of the volcano in December 1976 was less than it has ever been during monitoring periods since they commenced in December 1972. During the 10 day period spent at the summit, no eruptions were heard and no fresh bombs seen. However quite loud "whooshing" sounds from the Inner Crater were relatively common.

4. It is possible that major slumping may be commencing in the non lava half of the Inner Crater.

5. The geothermal cave system (Giggenbach, 1976) near the camp has changed significantly, due to partial collapse of the roof and floor in places, and inblown snow. Air and soil temperatures in and around the "seismological chamber" have increased in places and decreased in others, as have tunnel and chamber diameters. Access to the "seismo" chamber was more difficult than in previous years and may become even more difficult as blown snow accumulates inside the entry chamber. Easier access may be possible via the chamber below an enlarged tower forty metres up-slope from the usual one.

Stronger variable winds than in previous years inside the "seismo" chamber indicate that the new exit has altered the convection system and possibly the "delicate heat balance" (Giggenbach, 1976) inside the cave system. Certainly there is much more snow and ice inside the entry chamber than in previous years.

Reference:

Giggenbach, W.F., 1976. Geothermal ice caves on Mt. Erebus, Ross Island, Antarctica. N.Z.J. Geology Geophysics, v.19(2), p.365-72.

FIELD NOTES

A. Transport

(a) Toboggans. Event 12/12A

This event used two snowtric toboggans (NZARP Nos. 16 and 17), powered by Briggs and Stratton 16 h.p. 4 stroke motors. No. 17 had lost its engine cowling during the winter but a new, strong wooden one was made by the carpenter, Doc Livingstone. This cowling survived the trip's knocks well. A new petrol pump on the same toboggan had been incorrectly fitted but once this was established the problem was easily rectified. On the field trial it was impossible to start No. 16 after a night of - 40°C temperatures, although this toboggan usually started easily in temperatures of - 25° and warmer. A petrol burning preheater was subsequently fitted on to the air inlet manifold by the engineer, Jim Rankin, and worked well on the two or three occasions it was needed. Toboggan 17 was more difficult to start in - 25° temperatures and a gravity feed system bypassing the fuel pump was used on a few occasions to start it. Generally, however, the petrol pumps worked entirely satisfactorily in temperatures warmer than - 25° and few starting problems were experienced. The pullcord starting system adopted since 1975 is simple and effective once the operator learns the toboggan's starting characteristics.

The engines on the toboggan generally ran well and carburettor and manifold problems with No. 16 gave the only engine trouble. However mechanical breakdowns occurred on several occasions. These were due to fatigue and the rough terrain, accentuated by the occasional pulling of heavy loads necessitated by time restrictions due to bad weather and a full programme. Incomplete checking and replacement of worn parts by the party prior to leaving Scott Base had its repercussions in the field although the snowtric is fairly easy to work on. Adequate time should be allowed to thoroughly check toboggans, especially swinging arms and brackets, drive sprockets, tracks, and suspension and ski springs and assemblies. Assurances from base staff that "the toboggans (etc.) are in A1 condition" should not be taken for granted, nor allowed to lessen the priority of thoroughly checking them. Complete sets of tools and spares should be taken for each toboggan. To the spare parts list for snowtrics in the toboggan manual issued by Antarctic Division, should be added the following: leaf spring for front ski and at least four oil seals and bearings. A good supply of nuts, bolts and washers (compatible with the toboggan, especially the ski assembly), small amounts of metal sheeting, lengths of wire, and rubber tubing, all of various sizes, should be taken.

The new engine mounting system, installed since 1975, is excellent and no problems were experienced with it. Both machines had previously been fitted with ice cleats which were essential since most of the surface of Taylor Glacier is bare ice. The steering of snowtrics is greatly improved, especially on hard ice, when the worn guide rib on the underside of the ski is replaced. Windscreens for both toboggans were made before leaving Scott Base. Simple braces greatly strengthened these, and they survived the field season virtually intact.

It was decided early in the expedition to use sledges as much as possible and not ride two up on the toboggans. The latter practice has been shown (Curphey, 1975) to overload the toboggan causing undue wear and subsequent breakage of the suspension springs. We broke no suspension springs.

Toboggan covers were used on both toboggans. However they could not be tied down adequately to prevent snow getting into the engine compartment during blizzards. Nevertheless on the one occasion when this was a real problem, snow blown and compacted under the track and around the idler wheels was more of a problem since the cover probably kept some snow out of the engine compartment.

The towing power of these snowtric toboggans seems to have been underestimated, especially on bare ice. In this situation the reduction in friction between sledge runner and ice more than compensates for the reduced traction of the toboggan. Sledge loads of up to 1000 lbs were easily towed by each toboggan on the glacier even up gentle inclines, without flogging. Heavier loads up to 1500 lbs were occasionally pulled when the situation demanded but this was seldom. Relaying was necessary for loads greater than 800 to 1000 lbs on the steeper sections of the glacier routes. Toboggan 17 performed well at altitude (up to 2720 m on Mt. Morning) and pulled 800 lbs comfortably up gentle tacks on snow and sastrugi. Such weights can be pulled without fear of axle (etc.) failure if the machines are kept in good condition.

Toboggan manuals were kept up to date, listing breakdowns and repairs. This has not always been done in the past. The following lists contain breakdowns etc. on the two toboggans used by Event 12/12A.

<u>NZARP 16, Snowtric</u>

Up to 21.10 Replaced plastic connection to air filter with metal one. Fitted preheater on intake manifold. Fitted several new drive protection lugs and retensioned tracks. Made new windscreen.

28.10 Throttle sticking so return spring fitted.

29.10 Bolt in swinging arm and bracket sheared. Replaced for trip back to camp. Leaking petrol lead replaced. Bracket holding front end of leaf spring on ski snapped so that leaf spring prone to jump out of position.

2.11 Left hand end of left hand rear axle pulled out through hole worn in outer swinging arm due to fatigue of the axle.

3-4.11 Made up new axle with new sprockets and flanges. Fitted new bearing and oil seal to new swinging arm. Oil seal, bearing and right outer swinging arm broken or badly worn on right hand rear axle. Replaced with new set. Checked and greased all idler wheels. Fitted new guide rib on ski and made bracket to hold end of leaf spring in place. Retensioned tracks. Topped up oil.

10.11 Main bolt holding ski on sheared. Replaced.

11.11 Front bolt holding front of leaf spring sheared. Replaced.

21.11 Replaced carburettor and manifold gaskets.

2.1 Replaced engine end of Salisbury clutch. Cleaned main jet.

<u>NZARP 17, Snowtric</u>

Up to 21.10 Made new engine cowling and windscreen. Connected petrol pump correctly. Fitted several new drive protection lugs and retensioned tracks.

29.10 Remaining leaf on ski spring snapped. Temporary repairs made since no spares at Scott Base.

3.11 Replaced ski and leaf spring with OMC ski and spring.

4.11 Removed and checked both rear axles. Replaced worn sprocket on left hand axle. Oil seal faulty butno spares left. Refitted and retensioned tracks. Topped up oil and greased machine.

10.11 Left hand drive shaft failure by inner sprocket. Replaced with new shaft, sprockets, housing, bearing and oil seal.

17.11 Replaced OMC ski with snowtric ski.

30.11 Checked tracks. Fitted four new drive protection lugs on left hand track. Replaced bolt on inner left tensioner to give more slack on left hand track which was badly worn. Retension tracks. Oil and grease.

8.12 Further slackened left hand track in effort to reduce wear. Replaced burred bolts on inner left tensioner, shearing one off in process so that track was only held by one bolt there.

10.12 Problems with tracks sliding off rear axle sprockets at drive slots (mainly left hand track) due to steep sidling necessary. Tightened both tracks.

The following fuel consumption and mileage figures are only approximate since most distances had to be estimated due to an inaccurate odometer.

NZARP 16	21.10 - 28.11	286 miles using 36 gallons:	7.9 mpg
	2.1 - 12.1	90 miles using 9 gallons:	10 mpg
	Overall distance covered:	752 km	
	Overall petrol consumption:	3 $km.litre^{-1}$.	(8.4 mpg)
NZARP 17	21.10 - 14.12	409 km using 141 litres i.e. 2.9 $km.litre^{-1}$.	(8.2 mpg)

Reference:

Curphey, I., 1975. Journey Report on the Bowers Mountains Geological Expedition 1974-75. Unpublished report held at Antarctic Division, D.S.I.R.

Event 36.

The event used 2 OMC 2 stroke toboggans for over 200 km of sledging. They ran very well and were kept in excellent condition by Sullivan and Anderson. There was never any trouble starting the machines in the morning and because of excellent maintenance breakages were minimised. By repairing broken springs as soon as possible, wear on the tracks was lessened. Bare ice and steep grades meant inevitable breakages though replacements were available on the expedition. Petrol consumption was surprisingly economical, considering the weight pulled. Most travel was done by train (i.e. toboggan, sledge, toboggan, sledge all connected), which, by equalising work done by the toboggans, usually meant equal fuel consumption. A detailed report on mileage, fuel consumption, breakages and repairs should accompany Sullivan's report to Antarctic Division.

(b) Sledges

The two events required the use of three sledges each. Due to some minor accidents in the spring, dog sledges were at a premium early in the season. However with the assistance of various people, the sledges were prepared. Foot brakes were made, some tufnol replaced and some lashings repaired.

Event 12/12A used one dog sledge with keels, one combination sledge with keels and brakes and one manhauler with neither keels nor brake. The bare ice was too hard early in the season for the keels and they were seldom used at all on the glacier, even on the descents. However the descents off Mts. Morning and Discovery would have been extremely difficult without them. Foot brakes are a very useful addition. The sledges handled the hard ice conditions admirably, and little damage occurred. For details of these see Loss and Damage to Field Equipment, FIELD NOTES, Section E. The orange whistles used were excellent for sledge to toboggan communications.

(c) As in recent seasons air transport in the field was provided by the US Navy using twin turbine UHI-N helicopters. No problems were experienced. The windscreens on the snowtric toboggans had to be removed prior to loading and the removal of skis gave more room inside the cabin. Care must be taken when loading sledges on to the helo skids. They must be lashed so that when the aircraft lands and the skids flex, projections on the body of the helo do not push down on to the wedged sledge. Firm but not over-tight lashings will allow some movement of the sledge. On at least three occasions the Americans made unexpected and much appreciated mail deliveries. For details of helo use see Appendix 1.

B. Main Areas covered and Routes

(a) Event 12/12A

Most of the first half of the season was spent on the Taylor Glacier. This glacier is fed by the polar plateau and stretches about 80 km to Lake Bonney. From the Lower Finger Mountain icefall down there is virtually no permanent snow covering the ice. Virtually continuous snow cover exists between the two icefalls near Finger Mountain but above the upper icefall snow cover is intermittent. Bare ice continues to west of Depot Nunatak. US Navy aerial photos indicate that these conditions are much the same every summer.

Sledge travel is easy on the ablation dimpled bare ice and also on the virtually sastrugi free snow. Some slight crevassing near Cavendish Rocks and other places near the glacier sides provides rough going, but most routes up and down glacier completely avoid these. Crevasses become more of a problem above the upper Finger Mountain icefall. These were very obvious and generally well bridged in mid November 1976.

Route finding on the glacier is fairly obvious. Scott, in "The Voyage of the Discovery" states the importance of taking wide sweeps around corners and this was found to be true. Routes can generally avoid steepish slopes. Getting on and off the glacier was almost always easy although aerial photos were used a lot to find the easy places. The glacier margin is very steep in many places, and ropes were used occasionally.

Event 12A sledged between Mt. Morning and Mt. Discovery and the Koettlitz Glacier. Aerial photos were used to help choose the route, which was fairly obvious on them. Several areas of crevasses were negotiated with no problems. Most of the route is snow-covered, and much sastrugi, up to 1 metre high, though generally less than 0.3 metres high was encountered. Some small areas of soft snow were met on the way up Mt. Discovery. The descent off Mt. Discovery was very steep in three places where the toboggan and sledge had to be belayed. Travel beside the Koettlitz Glacier gave a few problems with meltwater. However the toboggan was easily able to negotiate a 1.5 m wide by 0.4 m deep meltstream.

(b) Event 36

The following is a brief outline of camp sites used, sledging conditions and routes around the Fry Glacier region.

From the snout of Northwind Glacier (put in site), steep and almost bare ice made conditions hazardous and camp was shifted to 76°42'S, 161°05'E (altitude 800 m) with some difficulty up glacier. The route lay towards the northern side where the grade was less and a little snow cover was present.

Travel between camp 1 and camp 2 (76°42'S, 161°08'E; 1000 m) was fairly easy. At the time (24 November) a thin snow cover existed in places which aided traction. Crevasses were no problem as they were narrow and easy to see. By January the snow cover had totally disappeared and travel with loaded sledges would have been difficult.

Camp 3 (76°43'S, 161°28'E; 1400 m) was about 0.5 km west of the summit of Flagship Mountain. The gradient between Dotson Ridge and Flagship Mountain, behind Flagship Mountain, is very steep and frequently bare ice. It was often necessary to use ice screws and a rope and pulley system to get loads up. The more obvious routes are heavily crevassed and not recommended. Closer to Flagship Mountain is soft neve snow and sastrugi.

Camp 4 (76°47', 161°17'; 1250 m) was approximately 2 miles north of Mt. Razorback. Travel from Flagship Mountain to Camp 4 was easy, on neve snow with some sastrugi. As Mt. Razorback is approached, more and more ice appears, and the grade steepens. The blue ice is cut by meltwater channels, some of which were very deep and bridged by snow in December. Between Dotson ridge and Larson Crags is steep bare blue ice, and similarly near Mt. Razorback down on to the Benson Glacier.

Camp 5 (76°38'S, 161°39'E; 850 m) was on the southern side of a prominent nunatak 10 km north of Flagship Mountain where the Atka Glacier meets the Fry Glacier. Access to the Atka Glacier from the neve south of Flagship Mountain is difficult because of ice and steep slopes. It is possible to select a snow-covered area and drive straight down, especially approximately 2 km east of Flagship Mountain. Once down on to the Atka Glacier, travel by toboggan presents few problems. No crevasses were apparent in December, and there was good snow cover with little sastrugi.

Fry Glacier, east of Camp 5, is heavily crevassed with large steep patches of blue ice. However access to the lower Fry Glacier is provided by a snow "chute" between the nunatak and hills to the south, which has good snow cover. From here on, access, at least down to the Albrecht Penckt Glacier, should be possible. In December 1976 the glacier was snow-covered with sastrugi.

Camp 6 (76°36'S, 161°04'E; 1000 m) was 9.5 km NNE of Flagship Mountain. Although very level, there are large patches of bare blue ice crossing the Fry Glacier from Camp 5 to Mt. Naab. Melt-out pools were developing in the glacier surface and quite a bit of water was present in December. In January the condition of this part of glacier had worsened and the surface became very rough with large melt-out pools. Closer to Mt. Naab, on the Towle Glacier, there was good snow cover in December and good sledging conditions.

Camp 7 (76°32'S, 161°11'E; 1300 m) was approximately 4 km southwest of Mt. Douglas. Between Mt. Naab and Mt. Douglas are some steep slopes, some of which were becoming icy by mid December. Flatter areas, especially below Fry Saddle, are heavily crevassed though there was no trouble crossing them. Closer to Mt. Douglas the snow became very soft and powdery in places but travel conditions were generally good.

Fry saddle appears to be very steep blue ice. However on December 22 a route was found up the eastern side, close to Mt. Douglas ridge which presented few problems.

Camp 8 (76°38'S, 161°04'E; 1050 m) was on the southern side of Towle Glacier approximately 3 km from the end of Elkhorn Ridge. In mid December sledging conditions were very good between Mt. Naab and Camp 8. However by mid January much of the snow cover had been removed and only snow patches were left making sledging rougher.

Camp 9 (76°40'S, 160°48'E; 950 m) was at snout of Towle Glacier on a small patch of moraine. The snout of Towle Glacier, though not as steep as the Northwind, also has large areas of blue ice. We picked a route down the northern side of the glacier and then straight down the snout, which is quite steep. However a better route may be along the southern side of the glacier and down on to the apron which is a string of lakes. The glacier sides are rounded rather than cliffed. The lakes, however, thawed a few days later and became covered in water, leaving only a snow apron between them and the glacier. This area is swept by strong katabatic winds funnelling down Towle Valley from the polar plateau (over 70 knots were recorded) which strips the snow from the snout of Towle Glacier and for some considerable distance back. By mid January there is mainly bare blue ice back almost to Mt. Naab.

Camp 10 (Sullivan and Anderson: 76°26'S, 160°42'E; 1400 m) was 2 km southeast of the summit of Trinity Nunatak. Once up Fry Saddle snow conditions were good all the way to Trinity Nunatak with large patches of level bare blue ice and some snow sastrugi. Good snow cover existed (late December) between Trinity Nunatak and Chattahoochee Glacier which made travel to Camp 11 easy (76°35'S, 160°36'E, 1700 m).

Camp 12 was in approximately the same position as Camp 8. However in the space of 2 weeks the snow cover had been substantially removed. Sledging conditions from the Chattahoochee Glacier to Fry Saddle were good.

Camp 13 (Palmer and Frost: 76°43'S, 161°04'E; 560 m) was set up at the snout of Northwind Glacier, mainly by foot. A toboggan was taken from the snout, 4 km along the southern side. By this time there was a lake between the glacier apron and the moraine of Elkhorn Ridge. However the snow apron was wide enough to allow access. It is possible to cross Elkhorn ridge on foot, beside a prominent stack of dolerite.

6th January, 1977.

The shift to Camp 14 (Palmer and Frost: same location as Camp 12) entailed tobogganing around from the Northwind Glacier to the Towle Glacier. The Northwind Glacier was inaccessible for approximately 3 km back from the snout because of steep gradients and bare blue ice. By January the whole of the Northwind Glacier was bare ice, far out into the Fry Glacier. At the end of Elkhorn ridge is an area of melt-out pools and sastrugi that could be difficult to cross in January.

:. Weather

Detailed meteorological observations were taken up to five times per day by various members of VUWAE 21. These were recorded in the standard NZMS Field Books, which will be returned to the NZMS. Members of the expedition will retain copies. Meteorological records from the Fry Glacier region are reproduced in Appendix 3. These latter records were transmitted daily to Scott Base who relayed them to Helo Operations at McMurdo Station.

Weather conditions in the Taylor Glacier, Cape Chocolate and Mts. Morning, Discovery and Erebus regions, were much as in previous years, although it was relatively cold early in the season. Katabatic winds blowing much of the time on Taylor Glacier made work difficult at times and caused the loss of a few days. A southerly storm on the 5th and 6th November was severe with winds gusting over 80 knots. Judging by sastrugi, strong southerly winds are a feature of Mts. Morning and Discovery although only one storm was experienced in the two weeks spent there. What seems to be almost typical Christmas weather on Mt. Erebus, southerly to easterly wind and snow, meant the loss of four days over Christmas.

D Communications

There were few problems with radio communications. Both Compak 8 and Labgear sets were used. Some Compak batteries lasted less than eight days and two of Event 36's gave only three days transmission each. Reception was exceptionally good in the first half of the season when 2773 was the frequency used. Later in the season communications were not as good when 5400 had to be used because of interference on 2773. Vanda often had to relay for Event 36, and occasionally for Events 12 and 12A.

Some transmission problems were experienced with one Labgear and one Compak sets and these were returned to Scott Base and replaced. Three of the Compaks used had tone call alarm buttons. When tested, two of these tripped the alarm system at Scott Base, but the third, that used by the Fry Glacier party, did not.

John Charles, the deputy leader at Scott Base, was cheerful and efficient in his handling of field party radio communications. He ensured good support from Scott Base whenever this was required. George Money and Mac Caves and the rest of the Post Office staff also helped give the field parties excellent communications.

E. Loss and Damage to Field Equipment

(a) Event 12/12A

In the course of the expedition on the Taylor Glacier one Polar tent and one Italian tent were badly ripped, one manhauling sledge badly damaged, and one combination sledge slightly damaged. One toboggan cover was lost. Several breakdowns occurred with the toboggans as were detailed in Section A, FIELD NOTES.

Most of this damage occurred in a severe southerly storm on November 5 and 6, when the camp was located near the Kukri Hills, on smooth flat ice of the transection between the Taylor and Ferrar Glaciers. Prior to the storm the usual precautions of tying down equipment, boxes etc. around the tents had been taken. The katabatic winds common on these glaciers made this essential. The three sledges were tied to (tent) pegs or tubular ice screws in the ice. The toboggans were pointed towards the southwest, the direction from which the katabatic had been blowing. The toboggan covers were fastened or tied down at three points: the ski and the bar on the outside of each footrest platform. The tents were securely pitched with ice screws anchoring the south and west facing guys. The tents were pitched on a north-south line, 1 metre apart.

The toboggans were not turned to face the south after the southerly struck. Eventually they were both blown over (probably by the same gust) and sent sliding across the smooth ice. The toboggan covers must have partly inflated to assist in the blowing over. One cover came free of its toboggan, probably due to poor knot tying, and was blown away. The other remained tied to its toboggan and acted as a sail so that that toboggan travelled further on its side. Contents in the space under the seat were spilled and some blown away when the seat fastenings on one toboggan broke open. One of the sliding toboggans knocked an anchoring sledge peg out so that the sledge was also able to slide away. It was chased for about 100 metres before it was last seen sliding across the ice and then lost in blowing snow. The toboggans were righted and turned to face the south. They were undamaged. Thereafter they were tied via the front bumper bar to pegs in the ice. The strength of the wind and the smoothness of the ice made it difficult to move around outside the tents. It was decided that it would be foolish to search for the lost sledge and other lost items at that time.

At this stage a 2 - 3 cm long tear was noticed against the northeast facing pole in the outer wall of the southern tent. Owing to the severe weather conditions it was decided to leave the repairs until the wind abated. About 3 hours later the same tent was found to be badly ripped for about 3 metres along the same pole and along the bottom of the east side. The inner wall was ripped along the bottom of the east and west sides and up the northwest facing side near the northwest pole. The contents of this tent were put into the other tent. The two tents were then tied and braced with a climbing rope and more ice screws were put in to secure it. All the party slept in the unripped tent that night.

After the storm a search was made for the lost equipment. Everything was found except the toboggan cover although some items were almost three kilometres away from camp. The sledge was found about two kilometres away with all the bridges broken at the corner along one side.

More strong winds a few days later further ripped the badly ripped tent which was considered too badly torn to repair in the field. It was able to be slept in, however. A small tear by one door guy developed in the other tent which was patched immediately it was noticed and no further ripping occurred.

Ten days later some of the party returned to the put in site where the Italian tent had been left pitched covering some loose equipment. It had been badly ripped at its lee end and most of the poles and some equipment were missing. However all the poles and missing equipment were found and the tent tied down to prevent further damage. It is assumed that this damage occurred in the November 5 storm.

The two Polar tents and the Italian tent were all in excellent condition before the storm. It is possible that the badly ripped Polar tent had spent time on Erebus where the strength of the fabric could have been impaired by volcanic gases. However it is also possible that this tent ripped because it bore the brunt of the wind's force, being to the windward of the other. The incidents with the Polar tents illustrate the desirability of immediate patching of small tears.

The failure of the party to turn the toboggans directly into the wind caused an unfortunate chain of circumstances which ended in the wrecking of the manhauling sledge.

The combination sledge had one of its side longitudinals broken in one place on landing at the put in site. This may have been due to poor loading on the helo skid, but it is possible that a small bump in the ice pressed up against the longitudinal as the helo landed. The break was splinted before the sledge was used. Another break on the same longitudinal, but on the other side of an adjacent bridge, occurred some time later when the sledge was loaded and running. This was also splinted soon after. These splints required only a little attention during the rest of the expedition.

The only damage to sledge runners occurred on the manhauling sledge. One runner began splitting at the sides due to the rough ice. It was roughly repaired before the sledge was wrecked (as described above).

(b) Event 36

One polar tent was torn by strong katabatic winds on December 30. The wind was estimated to be at least 80 knots as it exceeded the anemometer which records only up to 60 knots (at 2 metres). The tent tore in two places; a one metre long tear under the doorway and a 0.2 metre tear on the lee side of the tent on the inner wall.

Most of the guy ropes on the windward end of an Italian tent were snapped during strong turbulent winds in the Northwind valley. One of the longitudinals on one sledge was broken on landing on a helicopter. This was due to the flexing of the skid on landing and the tightness of the lashings.

Two items were lost on this expedition. One snow stake was dropped from a loaded sledge while travelling. The groundsheet for one polar tent was lost while camp was being broken, due to a very gusty wind, on the Chattahoochee Glacier on December 24.

F. Recommendations

(a) It is suggested that tests be made on the strength of fabrics currently being used on Polar tents. On this expedition two such tents were badly torn by winds gusting above only 60 - 70 knots at 2 metres. This seems to be an unacceptably low wind speed and obviously could lead to dangerous situations. Both tents were well pitched.

It is possible (although it would be a coincidence) that these two tents have been on Erebus and have had their fabric weakened by the acid volcanic gases. Flags placed on the main crater floor in 1974 were visibly corroded after 3 or 4 weeks. Easterly and southeasterly conditions which are common at the summit almost invariably envelop the camp in vapours from the Inner Crater. There have been a total of at least 2 weeks of such conditions, in which tents have been pitched at the summit camp, since 1972. It may be advisable to keep a log of the particular tents used on Erebus.

(b) The guy ropes on the Italian tents should possibly be replaced with stronger cord, although this will not reduce the possibility of abrasion.

(c) Toboggan windscreens should be braced to prolong their life.

(d) Parties who will be lashing sledges to helicopters should be familiarised previously, possibly at Tekapo, with the loading, especially of combination Nans

(e) To add one more possibility to the continuing debate on "carbon monoxide" poisoning, it may be that red lined tents present a greater risk for such poisoning because red and orange flames from a faulty primus are not so apparent. Event 36 experienced a minor case of poisoning from a new primus that appeared to be in good order.

(f) Several of the VUWAE primuses are getting old and should be replaced before the 1977/78 season.

(g) As has been recommended in the past, sledge keels and foot brakes should be considered essential parts of a sledge.

G. <u>Personnel</u>

All members of the expedition had a successful and happy season. A large part of the expedition's success was due to the overall competence of our DSIR companions, Palmer, Nankervis and Sullivan. Their inventiveness and mechanical and alpine experience proved extremely worthwhile. Sullivan's sledging experience was invaluable to Event 36. Both Robinson and Anderson proved very capable toboggan mechanics also.

It is a boon to one's work programme and general wellbeing if a field worker can climb up a steep slope to an outcrop, cross a crevasse field, or do some difficult sledging between localities, all the time remaining confident in his companions' abilities. This would have been the case generally with VUWAE 21.

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We also thank John Nankervis, Ken Sullivan, John Palmer, Bill Wicks, Colin Monteath, Howard Dengate, and Jude Faircloth for all their assistance to the Expedition and its members.

APPENDIX 1 - FLIGHT REQUIREMENTS, VUWAE 21

Date		Project	Purpose	Origin	Destination	Aircraft
Before Oct	15	A - D	Air cargo (389 kg)	Christchurch	Scott Base	C141
Oct	15	A, B	Transport 2	Chch	SB	C141
	21	A, B	Put in 6	SB	Taylor Gl	3 Helos
	22	A, B	Put in Cavendish Depot	Taylor Gl	Cavendish Rocks and return	Helo
Nov	8	A, C	Transport 2	Chch	SB	C141
	10	A, C	Put in 2, pick up 1	SB	Taylor Gl	Helo
	10	D	Transport 3	Chch	SB	C141
	20	D	Put in 2	SB	Northwind Gl	2 Helos
	21	D	Put in 2	SB	Northwind Gl	Helo
	21	B, C	Transfer 3	Taylor Gl	Lake Bonney	Helo
	21	A	Pick up 1	Taylor Gl	SB	Helo
Dec	1	A	Transfer 2	Taylor Gl	Lake Bonney	Helo
		B	Transfer 2	Lake Bonney	Mt. Morning	Helo
	10	A, C	Transfer 2, pick up 1	Lake Bonney	Hobbs Gl and SB	Helo
	14	B	Pick up 2	Koettlitz Gl	SB	Helo
	17	A, C	Pick up 2	Hobbs Gl	SB	Helo
	20	C, D	Put in 1	SB	Towle Gl and ret.	Helo
	22	D	Transport 1	SB	Chch	C130
	29	B	Transport 1	SB	Chch	Helo
Jan	2	A	Put in 3	SB	Taylor Gl	Helo
	10	D	Pick up 4	Towle Gl	SB	2 Helos
	12	A	Pick up 3	Taylor Gl	SB	Helo
	13	C, D	Transport 3	SB	Chch	C130
	17	A	Transport 2	SB	Chch	C130

Total helo hours used were approximately that requested, 42 hours. The flights to and from the Fang and Erebus were not part of VUWAE hours.

APPENDIX 2 - ITINERARIES

Event 12/12A Taylor Glacier

Oct	15	Robinson, Keys, Nankervis, Palmer, Wicks, Sullivan to Scott Base.
	16-20	Preparing field gear, scientific and surveying equipment, working on toboggan etc. One night out to test equipment.
	21	Robinson, Keys, Nankervis, Palmer, Wicks to snout of Taylor Glacier. Testing equipment.
	22	Robinson, Keys place depot near Cavendish Rocks, using helo.
	22-24	Work snout area. Survey trig control (trigs A, B, C) and velocity ablation poles (lines A, B, C) and examine saline discharge.
	25	Tent day due to strong katabatic wind.
	26	Half tent day. Move camp 6 km up glacier.
	27	Establish trig D (Glacier) and measure back to trig C. Place poles in line D and examine saline discharge.
	28	Establish trigs E (Peninsular) and F (Cliffs). Work on glacier.
	29	Establish trig G (Terrace). Start survey of trig control. Place poles in line E.
	30-31	Drilling 17.5 m hole and englacial temperature measurements.
Nov	1	Toboggan maintenance, temperature measurements, survey lines D, E; work at saline depressions below trig E.
	2	Complete survey of lines D, E, temperature measurements. Move camp 16 km up glacier. Relaying due to broken-down toboggan.
	3	Half tent day, work on toboggans.
	4	Toboggan and sledge repair and maintenance.
	5	Tent day due to southerly storm.
	6	Search for lost equipment. Establish trig K(Ferrar) and put in line F.
	7	Establish trig H (Falklands). Trip to depot to check that it is intact.
	8-9	Tent days due to strong katabatics. Got ready for drilling but too windy.
	10	Stern and Frost arrive and Wicks departs. Move camp 18 km up glacier. Relaying due to broken down toboggan. Toboggan repairs.
	11	Drilling 15 m hole, temperature measurements.

Days in Antarctica	27½	Oct 15 - Nov 11
Days at Scott Base	5½	
Days in field	22	
Travel	2½	
Tent	5	
Work	12½	
Toboggan etc. repairs	2	

Event 12

Nov	12-20	Establish trigs L (Bandy), M (Arena), and N (1433), place poles in line G, start gravity survey and complete surveying.
	21	Palmer returns to Scott Base via Vanda.
	22-23	Robinson and Stern work down glacier doing gravity survey and sampling programme.
Dec	1	Robinson and Stern placed on shore of Lake Bonney to join Frost.

Dec 2-9 Work around snout of Taylor Glacier; pebble fabrics and sampling, placing of ice deformation grid and ice sampling, completion of gravity survey and moss plot study in this area.
10 Robinson and Frost to Hobbs Glacier, via short sampling stopover at Lake Fryxell, and overfly of Herbertson Glacier survey point as requested by Palmer. Stern to Scott Base for Erebus expedition.
11-16 Robinson working on Hobbs, Blue and Salmon Glaciers. Frost studying mosses in these areas and out to adjacent coast.
17 Robinson and Frost to Scott Base via snout of Garwood Glacier; on ground for 1 hour reconnaissance and sampling debris layers and mosses.
18-19 Cleaning and repairing field equipment at Scott Base. Frost discusses Antarctic ecology with USARPs Parker and Friedman. Robinson prepares laboratory equipment and recalibrates temperature probes.
20 Frost transfers to Event 36.
20-30 Robinson studies ice samples at McMurdo.
Dec 31 - Jan 1 Preparing and testing field equipment.
Jan 2 Robinson, Stern, Palmer return to snout of Taylor Glacier, laying depots en route.
3-11 Resurvey ice velocity and ablation poles on Taylor Glacier.
12 Return to Scott Base.
13-16 Returning field equipment and packing cargo for return to New Zealand.
17 Robinson and Stern to Christchurch.

Days in Antarctica	66 (Nov 12 - Jan 16)
Days at Scott Base	19½ (includes time spent at McMurdo)
Days in the field	46½
Travel	5½
Tent	6
Work	34
Toboggan repairs etc.	1

Event 12A

Nov 12 Keys, Nankervis, Frost move to Kennar valley.
13-14 Work Kennar valley and Taylor Glacier - ½ tent day.
15-16 Descend Taylor Glacier sampling at Beacon valley, and on glacier en route.
17 Tent day, awaiting helo. Toboggan and sledge maintenance.
18 Awaiting helo. Work side of Taylor valley.
19 Tent day (snow).
20 Awaiting helo. Work side of Taylor valley.
21 Work on Taylor Glacier, shift to Lake Bonney.
22-30 Work on and beside Taylor Glacier (saline discharge) and around Lake Bonney, studying moss plots. Toboggan and sledge maintenance.
Dec 1 Keys, Nankervis to Mt. Morning, laying depot en route.
2 Work on snow mushrooms and snow-free areas.
3 Travel over Mt. Morning to depot in saddle between Mts. Morning and Discovery.
4-7 Work around depot. ½ tent day.
8 Toboggan maintenance. Travel up to 1900 m on Mt. Discovery.
9 Work around summit area of Mt. Discovery.
10 Work parasite cone at 1900 m, then travel down to another cone 850 m lower on Mt. Discovery.
11-12 Tent days (blizzard).
13 Work at cone then travel down to Koettlitz Glacier, working at another cone en route. Work at cone near Koettlitz Glacier.

Dec 14	Return to Scott Base.	
15	Sorting out event gear. Nankervis transfers to Event 33.	
16-17	Work on samples, mending gear, packing samples.	

Days in Antarctica	36	Nov 12 - Dec 17
Days at Scott Base	3½	
Days in field	31½	
Travel	6½	
Tent	4½	
Work	20	
Toboggan etc. repairs	1½	

Event 5, Mt. Erebus

Dec 18	Awaiting helo, cleaning gear. Monteath, Keys, Stern, Palmer + 2 USARPs to Fang Glacier.
19	Traversed Mt. Fang, sampling tephra layers en route.
20	Climbed up to Erebus Crater via fumarole towers (sampled). Checked lava lake and measured lava temperature.
21	Shifted to Mt. Erebus summit camp, after acclimatising satisfactorily in 3 days.
22	Set up seismometer and seismograph inside cave. Placed leg of lamb in hot ground in Side Crater.
23-26	Tent days due to wind and snow. Set up inoperative seismo gear in main tent. Retrieved successful hangi on 25th.
27	Keys plus 2 USARPs return to Scott Base. Keys works on samples. Monteath, Stern, Palmer begin surveying programme.
28-30	Surveying continuing, with holdups due to poor visibility.
29	Keys returns to Christchurch.
31	Monteath, Stern, Palmer return to Scott Base.

Days on Mt. Erebus	12
Tent	4
Work	6½
Travel	1½

Event 36 Fry Glacier region

Nov 10	Burgess, Anderson and Palmer arrive at Scott Base.
20	Sullivan and Palmer to Northwind Glacier after a delay of up to a week due to bad weather. Burgess and Anderson delayed by bad weather.
21	Burgess and Anderson to Northwind Glacier.
22-23	Work on Elkhorn Ridge.
24	Camp shifted to 5.6 km northwest of Flagship Mountain.
25-26	Mapping Flagship Mountain area.
27-30	Tent days, lost because of southerly blizzard.
Dec 1	Camp shifted to 1 km west of Flagship Mountain.
2	Mapping Flagship Mountain.
3	Camp shifted to 3 km north of Mt. Razorback.
4-6	Mapping Waterhouse Neve*, Barrett's Bluff* and Mt. Razorback area.
7	Camp shifted to 9.5 km north-northeast of Flagship Mountain (Matchless Mountain*).

Dec	8	Mapping Lower Fry Glacier south to Mt. Davidson.
	9	Camp shifted to 3 km east of Mt. Naab.
	10	Mapping Mt. Naab.
	11	Camp shifted to 3 km southwest of Mt. Douglas.
	12	Tent day, lost due to bad weather.
	13	Mapping Mt. Douglas area.
	14	Camp shifted to 5.6 km southeast of Mt. Naab.
	15-16	Mapping Elkhorn ridge.
	17	Camp shifted to snout of Towle Glacier.
	18	Further mapping of Elkhorn ridge.
	19	Preparation for resupply on 20th.
	20	Resupply. Frost to Towle Glacier, Burgess to Scott Base.
	21	Further mapping of Elkhorn ridge.
	22	Anderson and Sullivan to Trinity Nunatak via Fry Saddle. Katabatic winds force Palmer and Frost to take a tent day. Burgess returns to New Zealand.
	23-28	Palmer and Frost map Towle Valley and work on mosses.
	23	Anderson and Sullivan map Trinity Nunatak.
	24	Anderson and Sullivan shift camp to Chattahoochee Glacier 19 km south of Trinity Nunatak.
	25-28	Anderson and Sullivan map Chattahoochee Glacier area.
	29	Palmer and Frost tentbound by katabatic winds. Anderson and Sullivan shift camp to 5.6 km southeast of Mt. Naab on Towle Glacier.
	30-31	Palmer and Frost and Sullivan and Anderson tentbound by strong katabatic winds.
Jan	1	Anderson and Sullivan help Palmer and Frost move to snout of Northwind Glacier across Elkhorn Ridge.
	2	Palmer and Frost work in Northwind Valley. Anderson and Sullivan work in Towle Valley.
	6	Anderson and Sullivan help Palmer and Frost shift back to Towle Glacier 5.6 km southeast of Mt. Naab.
	7-8	Tentbound by snow.
	9	Preparing to move out.
	10	Return to Scott Base.
	11-12	Packing cargo, returning event equipment.
	13	Palmer, Anderson, Frost return to Christchurch.

* Names to be submitted for approval.

Days in Antarctica	63
Days at Scott Base	11
Days in field	52
Travel	14
Tent	11
Work	25
Preparation for resupply and move out day	2

APPENDIX 3 - WEATHER AT 0800 HOURS, VUWAE 21B

Date	Location	Altitude (m)	Temp. (°F)	Pressure (mb)	Wind speed and direction	Visi-bility (miles)	State of the Sky	Remarks
Nov 22	76°42'S, 161°05'E	800	+ 5	901	6 knts @ 045°T	7^+	Clear	
23	"							
24	"		+ 8	898.5	10 knts @ 110°T	7^+	Clear	
25	76°42'S, 161°08'E	1000	4	896.5	Calm	7^+	4/10 cloud @ 12000 ft	
26	"		2	893	4 knts @ 0°T	7^+	Clear	
27	"		7	892	Calm	7^+	OVC @ 8000 ft	
28	"		10	893	Calm	7^+	OVC @ 8000 ft	
29	"		18	896	14 knts @ 150°	7^+	OVC @ 6000 ft	Gusting 40 knts
30	"							
Dec 1	"		18	904	Calm	7^+	OVC @ 8000 ft	
2	76°43'S, 161°28'E	1400						
3	"		8	847.5	Calm	7^+	Clear	
4	(76°47')	1250	7	854	5 knts @ 100°T	7^+	OVC @ 10,000 ft	
5	(161°17')		6	855	5 knts @ 100°T	7^+	Clear	
6	"		14	857	Calm	7^+	OVC @ 12,000 ft	
7	"		8	846.5	6 knts @ 100°T	7^+	Clear	
8	(76°38')	850	16	889	Calm	7^+	2/10 cloud @ 7000 ft	
9	(161°39')		0	886	4 knts @ 270°T	7^+	Clear	
10	(76°36')	1000	19	887.5	Calm	7^+	9/10 cloud @ 10,000 ft	Broken cloud
11	(161°04')		22	885	Calm	7^+	4/10 cloud @ 12,000 ft	Scattered cloud

Date	Location	Altitude (m)	Temp. (^{o}F)	Pressure (mb)	Wind speed and direction	Visi-bility	State of the Sky	Remarks
Dec 12	($76^{o}32'S$)	1300	8	853	8 knts @ $340^{o}T$	7	OVC @ 5000 ft	Light snow
13	($161^{o}11'E$)		25	860	Calm	7	OVC @ 6000 ft	Light snow
14	"		26	865	Calm	7^{+}	4/10 @ 8000ft	Scattered cloud
15	($76^{o}38'$)	1050	20	899	Calm	7^{+}	OVC @ 10,000 ft	Haze
16	($161^{o}04'$)		20	902,5	Calm	7^{+}	9/10 @ 9000 ft	Broken cloud
17	"		15	897	3knts @ $0^{o}T$	7^{+}	Clear	
18	($76^{o}40'S$)	950	22	902	Calm	1 mile	Fog	
19	($160^{o}48'E$)		20	900	Calm	7^{+}	Clear	
20	"		26	893.5	1 knt @ $020^{o}T$	7^{+}	Clear	
21	"							
22	"		20	902	20 knts @ $180^{o}T$	7^{+}	Clear	Wind gusting 30 knts
23	"		21	910.5	4 knts @ $060^{o}T$	7^{+}	4/10 @ 9000 ft	
24	"		23	902	2 knts @ $060^{o}T$	7^{+}	1/10 @ 9000 ft	2/10 high
25	"		27	900	3 knts @ $060^{o}T$	7^{+}	OVC @ 9000 ft	
26	"		19	898.7	2 knts @ $060^{o}T$	7^{+}	OVC @ 9000 ft	
27	"		27	903.9	Calm	7^{+}	1/10 cloud @ 6000 ft	
28	"		28	909.2	Calm	7^{+}	1/10 high cloud	Wind from west later
29	"		23	904	20 knts @ $240^{o}T$	7^{+}	Clear	Gusting 50 - 60 knots
30	"		23	904	20 knts @ $240^{o}T$	7^{+}	Clear	Gusting 50 - 8- knots
31	"							
Jan 1	"		25	905	4 knts @ $060^{o}T$	7^{+}	Clear	Became cloudy
2	($76^{o}43'S$)	560	28	947	2 knts @ $030^{o}T$	7^{+}	1/8 cloud @ 9000 ft	
3	($161^{o}04'E$)		28	945	10 knts @ $210^{o}T$	7^{+}	Clear	Gusting 15 - 20 knots

Date	Location	Altitude (m)	Temp. (°F)		Wind speed and direction	Visibility	State of the Sky	Remarks
Jan 4	(76°43'S)	560	27	945	15 knts @ 210°T	7^{+}	Clear	Gusting 25 knts
5	(161°04'E)		28	947	10 knts @ 210°T	7^{+}	7/10 broken cloud @ 10,000 ft	
6	"		28	940	3 knts @ 030°T	7^{+}	1/10 scattered high cloud	
7	(76°38'S)	950	18	879.5	10 knts @ 030°T	7^{+}	OVC 3/10 @ 5000 ft 7/10 @ 9000 ft	
8	(160°48'E)		18	880	Calm	7^{+}	Broken 5/10 @ 5000 ft 4/10 @ 9000 ft	
9	"		20	885	Calm	1	OVC @ 3500 ft	
10	"		22	880	Calm	7^{+}	9/10 broken cloud @ 10,000 ft	

APPENDIX 4

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