IMMEDIATE REPORT

OF

VICTORIA UNIVERSITY OF WELLINGTON
ANTARCTIC EXPEDITION

1986 - 1987

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

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SUMMARY OF VUWAE 31

The 1986-87 Antarctic season saw the successful drilling of CIROS-1 in western McMurdo Sound. The hole reached a depth of 702 m, making it the deepest bedrock hole in Antarctica. The programme was co-sponsored by Victoria University of Wellington (science responsibility), Geophysics Division DSIR (drilling responsibility) and Antarctic Division DSIR (logistic responsibility), and was the culmination of 5 years of planning and preparation. The aim of the project is to obtain a record of Antarctic Cenozoic history in the southwest corner of the Ross Sea by coring sedimentary strata offshore. The core extends the Antarctic glacial record back to the early Oligocene, and has provided the first evidence of early Tertiary vegetation, a beech leaf. The core also yielded the first evidence of petroleum generation from the Antarctic continental shelf. Currently over 20 scientists in New Zealand, Australia, Japan, USA and UK are working on various aspects of the core.

A seismic survey related to the CIROS programme was also carried out in the vicinity of the CIROS-1 site and aims to link the geological structure as determined by drilling with other seismic surveys from the western Ross Sea. The survey was jointly sponsored by Victoria University and Geophysics Division, DSIR.

The Mt Erebus geophysics programme this season successfully installed a TV camera on the crater rim which transmitted real time pictures back to Scott Base. The aim of this programme was to discover how the lava lake eruptions are related to the different types of seismic activity recorded from Mt Erebus.

A biochemistry programme to test the detoxication enzyme glutathione-s-transferase in Antarctic fishes was carried out from Scott Base. The effects of freezing on enzyme levels was assessed and the data obtained this season compared to that from the 1983/84 season.

In addition to the New Zealand Antarctic Programmes summarised above, three people from Victoria University participated with investigators from Rice University of Texas in United States Antarctic Programmes. These programmes included sediment trapping in the McMurdo Sound area in spring and summer, and the Deep Freeze 87 icebreaker cruises on USCGC Glacier. Although the cruise was shortened from that originally planned, good seismic data and sea floor cores were obtained from the Cape Hallet area and within McMurdo Sound.

CIROS (K014) - P. J. Barrett

Abstract

CIROS-1, sited 12 km off Butter Point in western McMurdo Sound (Lat 77° 34'55"; Long 164° 29'55"), was successfully drilled to a depth of 702 m below the sea floor in marine glacial strata dating back to the early Oligocene (based on a preliminary study of foraminifera). The continuous nature of the core makes it an excellent record of glacial advances and retreats and will make it easier to date using microfossils and paleomagnetic stratigraphy.

The core also records changes in sand and pebble composition that reflect the progressive erosion of the Transantarctic Mountains. The abundance of coaly fragments and the dolerite boulders near the bottom of the hole suggest proximity to local bedrock of Permian coal measures intruded by Jurassic dolerite.

An asphaltic residue was found in sand 632 m down the hole. It indicates that petroleum has been generated in the Victoria Land Basin, and at this site was trapped but later released naturally.

Background

The aim of the CIROS project was to obtain a record of the Cenozoic history of the southwest corner of the Ross Sea by coring sedimentary strata offshore (Barrett 1982). Early Cenozoic strata are of particular interest because there are no strata of this age exposed on the Antarctic continent, and it is a period that is supposed to have seen the beginnings of Antarctic glaciation (Kennett 1977) and the rise of the Transantarctic Mountains (Fitzgerald et al. in press).

Previous drilling in the Ross Sea at DSDP-270 (Hayes, Frakes et al. 1975) and MSSTS-1 (Barrett 1986) had shown that Antarctic glaciation went back at least 25 and 30 million years respectively. The CIROS-1 drillhole was designed to core even older strata beneath the floor of McMurdo Sound (Fig. 1) to record the major glacial advances and retreats and to find out when they began. The core was also expected to show evidence of the uplift history of the Transantarctic Mountains.

Programme

The operation was staged from a camp at Butter Point camp 70 km west of Scott Base on the Victoria Land coast, and followed closely the schedule set out in the drilling operations plan (Antarctic Division 1986). A party of 10 flew to the ice in late August to open the camp and set up the rig, which is 12 km offshore, on the 2 m thick annual ice. Drilling began on October 14, after the arrival of the main group of drillers and scientists (Table 1).

Table 1. Field Personnel for CIROS 1986

SCIENCE	DRILLING	DRILLERS
Peter Barrett (Coordinator)	Jack Hoffman (Coordinator)	Colin Weaver
Alex Pyne (Manager)	Kevin Jenkins (Drilling Supervisor)	Stephen Pilcher
Kevin Hall (Geologist)	Pat (Rat) Cooper (Assistant Supervisor)	John Marcussen
Michael Hambrey (Geologist)		
Paul Robinson (Geologist)		
Hugh Rieck (Paleomagnetics)	CAMP SERVICES	OFF-SIDERS
Hideki Wada (Geochemist)		
Jeff Ashby (Core Processor)	Max Williams (Manager)	Stephen Brierly
Ted Hardy (Core Processor)	Jeff Westworth (Cook)	Geoff Brown
Carey Mills (Core Processor)	Neville Steedman (Carpenter)	Gary Brown
Bruce Morris (Core Processor)	E. J. Somerville (Mechanic)	Mervin McKinnon
Vince Belgrave (Surveyor)	Ron Topping (Operator)	Kim Stevenson
Paul White (Down hole logging)		Mike Wing
Brian Davey (Geophysicist)		
Graham Alder (Geophysicist)		

The team of 30 worked 12 hour shifts for the next 2 months commuting each day between Butter Point and the drill site. Coring proceeded without interruption or mishap to a depth of 702 m below the sea floor, which was reached on November 16. The hole was terminated partly because it was approaching the manufacturer's stated limit of the rig's capability but also because mud loss had become high as a result of fractures encountered at 700 m.

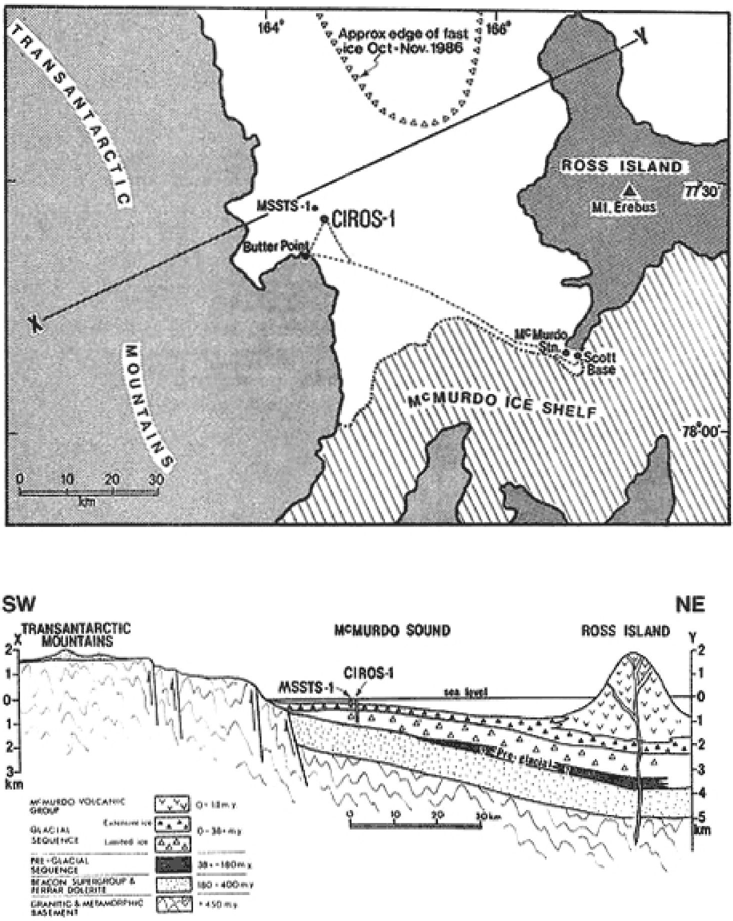

Figure 1. Map of McMurdo Sound and Geological cross section showing CIROS-1 and MSSTS-1 drill hole.

Results

The CIROS-1 drillhole is the 4th to be drilled offshore in western McMurdo Sound (see Fig. 2), but has been by far the most successful. The hole was continuously cored from a depth of 27 m below the sea floor to the bottom at 702 m, and over 98% of that interval was recovered. The quality of the core is excellent with some of the core being taken as single 3 m lengths.

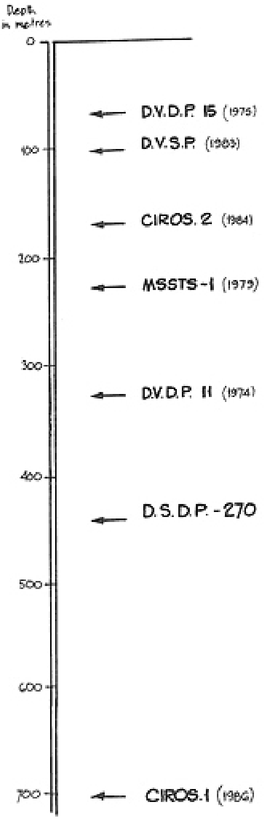

Figure 2. Antarctic bedrock holes.

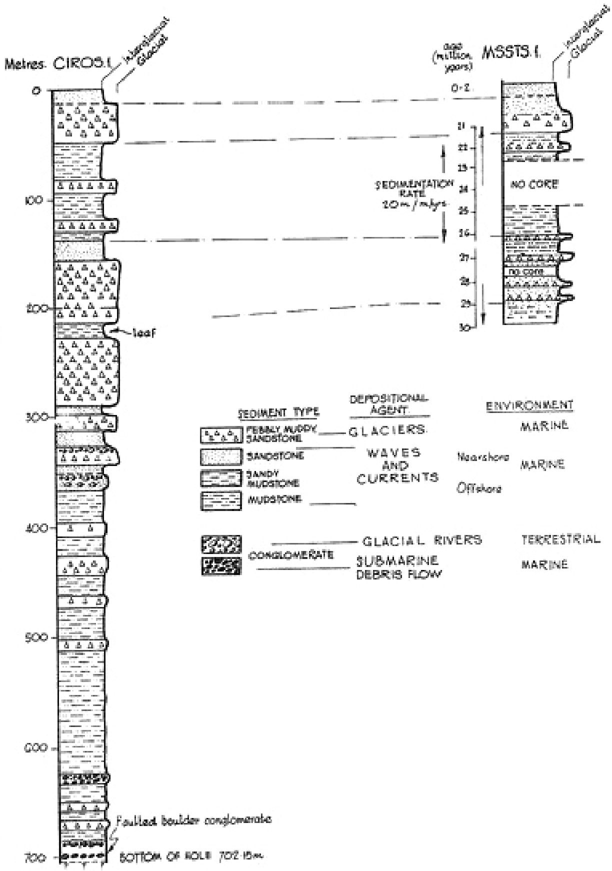

Figure 3. Sequence at MSSTS-1 and CIROS-1 showing correlation and age.

The core is all of Tertiary age, and a preliminary study of microfossils from the lower 20 m of the hole by Professor P. N. Webb indicates an Early Oligocene age (33 to 38 million years). The strata are mainly shallow marine sandstone and mudstone with scattered stones deposited by floating or grounded ice. The stones, many of which are striated, and other features in the core are a positive indication of the continued presence of ice throughout the time period represented by the core. This is the oldest physical record of Cenozoic ice in Antarctica.

The core is particularly valuable because of its length and continuity. Variation in stone content and sedimentary features record the advance and retreat of the ice, and indicate two distinct phases to the glacial history - an early one represented by core from the base of the hole to 366 m sub-bottom for which ice was quite limited in extent, and a later phase represented by core shallower than 366 m during which grounded and floating ice periodically covered the site and was much more extensive than today. Planned studies of the microfossils and magnetic reversal stratigraphy will allow these events to be accurately dated.

The hole terminated in a boulder conglomerate with clasts more than 47 cm across. All are dolerite, presumably the Ferrar Dolerite (Jurassic), which forms extensive sills through the flat-lying Devonian to Jurassic strata (Beacon Supergroup) in the nearby Transantarctic Mountains. The boulders are by far the largest clasts in the core and probably rolled off a nearby bedrock high. It seems most likely that the base of the Cenozoic sedimentary section is only a few metres below the base of the hole.

The rock types represented by the stones in the core vary widely but show a progressive change reflecting the depth of erosion as the Transantarctic Mountains grew. In the upper part of the core granitic basement rocks are common, but near the base most are dolerite. A significant proportion near the base are coal or black carbonaceous shale. The association with dolerite suggests they come from the Permian coal measures in the Beacon Supergroup high in the nearby mountains to the west, and that bedrock beneath the Cenozoic section at the CIROS-1 site is Permian coal meaures intruded by dolerite. This allows us to determine for the first time the net vertical displacement across the Transantarctic Mountain Front (over 2 km since the Early Oligocene).

Traces of methane were found in the upper part of the hole, but none was encountered lower down. A layer of dark-stained sand was encountered from 632.09 to 634.34 m. The stain is caused by hydrocarbons that appear to represent the residue of a deposit that has been naturally flushed. Nevertheless the material provides the first evidence from the Antarctic continental shelf of mature petroleum generation. Further tests are being carried out to determine in detail the composition of the substance.

Once coring had ended the hole was logged with several probes recording various properties such as density, natural radioactivity and temperature (which at the bottom was 25°C). The hole was then filled with a cement plug and abandoned. The surveyors who had been monitoring the site throughout the drilling found the ice had moved 9 metres northeast during the drilling and the weight of the rig and equipment on the site had depressed the ice by 13 cm (Belgrave, 1987). The drillhole itself has been located with an accuracy of better than 1 m.

A seismic survey between CIROS-1 and MSSTS-1 4 km to the northwest was carried out by Event K045 to trace the major reflectors and to determine depth to bedrock. The results of the survey will be reported separately.

Publication

This report will be submitted to the N.Z. Antarctic Record. The core logs (170 pages at 4 m/page and about 40 pages of core photographs will be published as another volume in the VUW Antarctic Data Series, and should appear about April 1987. An abstract has been submitted to the Fifth International Symposium on Antarctic Earth Sciences (August 1987). A comprehensive volume reporting a wide range of work on the core and similar in style to the recently published MSSTS-1 volume is also planned, and should be published in 1988. Also most of the 15 or so scientists proposing to work on core material are likely to publish papers on more specific aspects of the core in various international journals. When the chronology has been determined a joint paper will be submitted to Nature or a similar journal.

Future Work

Future work on the Cenozoic history of the southwestern corner of the Ross Sea is planned on three fronts.

1. Work on the CIROS drill core. The range of work planned for the CIROS-1 core is similar to but more extensive than that carried out for MSSTS-1 (Barrett 1986), and should be published in a similar format.

2. Seismic surveys. High resolution single channel seismic survey in McMurdo Sound is planned in association with Rice University using USCGS Glacier in February 1987. The results of this work will be presented along with a review of earlier seismic surveys in McMurdo Sound in a report to be prepared by the end of 1987.

3. Further drilling. The strata containing the early history of the Antarctic ice sheet and the Transantarctic Mountains have still not been cored, but may be found off Cape Roberts, where seismic surveys show the older strata of the Victoria Land Basin to be dragged up along the Transantarctic Mountain Front. Sites described as CIROS-3 and -4 (Barrett 1982) were proposed to core these strata, and have been included in a more comprehensive plan submitted to the Ocean Drilling Programme in July 1986. The proposal calls for a transect of holes from the centre to the margin of the Victoria Land Basin to sample various levels in the 12-km-thick sequence in order to date the break-up history of the Antarctic plate and the early history of the Antarctic ice sheet (Cooper et al. 1986). If the proposal were accepted drilling would not be carried out before 1989.

Acknowledgements

The CIROS project is a joint venture between Victoria University of Wellington, who are coordinating the science programme, Geophysics Division DSIR, who supervised the drilling, and Antarctic Division DSIR, who provided the logistic support. The provision by Antarctic Division of the camp at Butter Point for the project was a major undertaking in its own right and a key element in the success of the project. The drilling rig was provided by the US National Science Foundation, who will be receiving a split of the core for their Antarctic Core Facility at Florida State University.

The 10 man advance party, led by Kevin Jenkins, drilling supervisor for the project, deserve special mention for preparing the camp and the rig under difficult conditions. The team included Alex Pyne, Science Manager for the project, who not only ensured the processing and packaging of the 700 m of core but was also, because of his years of experience in sea ice operations, responsible for monitoring active cracks and thickness of the ice for vehicle movement and the drilling operation. The drilling itself went like clockwork despite equipment failures, vehicle breakdowns and a wide range of downhole problems. The drilling team were able to continue because they had on site the experience to analyse and fix the problems, and the planning and organisation to have the necessary materials and parts fast enough so that downhole progress was not threatened. For the latter the project depended heavily on the support of Stewart Guy and the staff of Scott Base. This was also where the years of planning by Jack Hoffman, drilling superintendent at Geophysics Division, paid off. The value of the hole may lie in the science, but the achievement to date is largely one for the drillers, planners and the support system.

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INTERNATIONAL MOUNT EREBUS ERUPTION MECHANISM STUDY (K044) - R.R. Dibble

Abstract

Sixty eruptions of the Erebus lava lake were recorded on videotape from a TV camera on the crater rim, and on a 9 station seismic net and 2 infrasonic microphones, between 16 December 1986 and 7 January 1987. The best 29 recordings have been analysed. Times can be read from all recordings to 0.04s, but onsets are seldom that sharp. Plots of seismic arrival time versus distance from the explosion site show that the seismic intercept time is 0.91±46s later than the time of the visible explosion. This implies that the explosions were the source of the seismic waves, rather than that earthquakes triggered the explosions as previously published. The apparent seismic velocity was 2.61±58km/s. The large standard deviation could be due to emergent onsets, or to time variation in vesiculation and seismic velocity in the lava. Explosions usually occur in the incandescent centre of the lava lake, and are preceded by an updoming for c.0.2s. Some occur around the edges of the lake aureole of c.40 m diameter. All explosions which threw out bombs were accompanied by earthquakes, but the few ash jet eruptions were aseismic. The study was terminated by withdrawal of NSF from the cooperative NSF/NIPR/VUW progamme at Scott Base on 7 January 1987, but video surveillance continues.

An infrared temperature survey of 81 points was made of the crater walls and lava lake on 10 and 11 December 1986, using a Minolta IR-0510 infrared thermometer. The instrument provided by NIPR has a range of -50 to +1000°C. Rock temperatures ranged from -30 to +70°C, and the lava lake temperature ranged from 446 to 798°C, assuming an emissivity of 0.7. Stations were marked on polaroid photos to allow repeat observations.

Proposed programme

Erebus is a unique volcano in its high latitude location within a tectonic plate, and its persistently active lava lake of phonolitic composition. In an aseismic region, more than 100 volcanic earthquakes per day have been recorded. The larger (ML cl) accompany the 3.6 ±2.7 strombolian eruptions per day. The largest observed eruption, of airwave energy 1.6x10E9 J, and seismic magnitude ML 2.4, occurred on 17 September 1984 during enhanced activity.

The logistic support available from Scott and McMurdo bases at the foot of the volcano have made it one of the easier volcanoes to study. Winter temperatures down to c-60±C are the main problem. Geophysical studies during summer began in 1974, and year round studies began in 1980, when Dr. P.R Kyle set up the International Mount Erebus Seismic Study (IMESS) with Dr. J. Kienle of University of Alaska, Prof. K. Kaminuma of NIPR, Tokyo, and Dr. R.R. Dibble of VUW. Seismic, infrasonic, and magnetic induction data were telemetered and recorded continuously at Scott Base. The principal objective was location of earthquake foci, but statistics of occurrence, tidal effects, spectra, energy, and time and amplitude relationships between different types of data for both earthquakes and eruptions were also studied. Two types of eruption occurred: a high frequency type from the exploding vent, and a low frequency type, possibly from the lava lake. In the latter type, the infrasonic trace often showed a gradual pressure onset, one second before the seismic onset at very near stations, caused perhaps by the lava lake ballooning before it erupted. IMESS terminated in 1986. A list of publications is attached.

It was found that eruption earthquakes had an apparent range of depths to 4 km, but that the infrasonic signals were more consistent with a surface origin. Although a possible explanation was time error in picking emergent seismic onsets, and inaccurate modelling of velocity structure, a more attractive option was the triggering of eruptions in the vents by earthquakes at depth, as suggested by recent studies at Sakurajima Volcano, Japan.

The principal objective of IMEEMS in 1986/87 was to find if the earthquake origin times were earlier than or equal to the times of visible eruption, as required by the triggering hypothesis, using video recordings of eruptions with accurate time display.

Scientific Endeavours

The methodology was to add TV surveillance and an LPH geophone to the existing IMESS telemetry net, and read the onset times of signals from each eruption. After R.D.R.C. had approved the proposal, NSF declined to fund Prof. Kienle's proposal to continue operating the net, or to let him remove it. He agreed that I could operate and maintain 4 seismic stations. Antarctic Division cleared this with NSF.

Purchase and cold testing of equipment began on 1 June 1986. The prototype Philips CCD camera LDH 0600 with Cosmicar C1614EX-2 autofocus lens rated to -25°C, developed a fault at -10°C, but continued working to the end of the test at -40°C. A replacement was ordered from the French factory in August but had not arrived by the time I flew south on 18 November.

Also of concern was that NSF belatedly decided to remove the IMESS net. Prof. Kienle persuaded them to leave me the top 2 stations, and advised me by telex on 21 October 1986.

On 19 November, the helicopter scheduled to service the low level stations was requested to make a high level reconnaissance of the route to the TV site, and drop equipment at the lower hut on Erebus. Messrs Dibble, Wendon, and James Barker were briefly landed there, but it was discovered that the hut was above the new landing limit of 12,000 ft pressure altitude, and the pilot was disciplined to ensure no further landings were made. My programme could now be carried out only by flying toboggans to Fang acclimatisation site, and driving up with the equipment. The decision to support this was delayed until Phil Kyle arrived on 26 November, and until then, I installed the TV receiving/recording equipment, overhauled the IMESS receivers, and improved the real time detection ability of the Windless Bight Infrasonic array to Erebus eruptions.

Prof. Kyle said that NSF Washington was awaiting a request from me to borrow the top IMESS stations, El and Cones (sent via Ant. Div., 27 November), and had approval to operate 3 himself. He suggested that we go up Erebus together as independent parties, and he offered to take up the extra gear we needed for a base camp at Fang, so that we would not exceed our helo hours. The OIC then agreed to us taking the Grizzly toboggan I had always claimed was necessary, and with 4 U.S. Bombardiers as well, we flew to Fang on 3 December. All equipment, people, and most stores were carried up on Bombardiers by 6 December, using the route on the attached aerial photo. The Grizzly developed a slipping clutch due to missing bearing pads on the driven variator, and was left at Fang. The 2 Yamaha 300 which belong at the hut, could not climb steep hills or carry loads, and without Phil Kyle's unstinting help, we could not have gotten our equipment up. Without the Grizzly, Kyle would not have welcomed us on the mountain.

On 8 December, Bill McIntosh, Wendon and I blazed a toboggan route to within 100 m of the east rim of the crater, (Figure 4) and all 385 kg of TV equipment was installed there by 10 December (Figure 5). The new camera arrived, and was installed in a rugged insulated housing on a tripod, designed to withstand being hit by small bombs. The auto-iris oscillated until it was driven from video-out instead of iris-out.

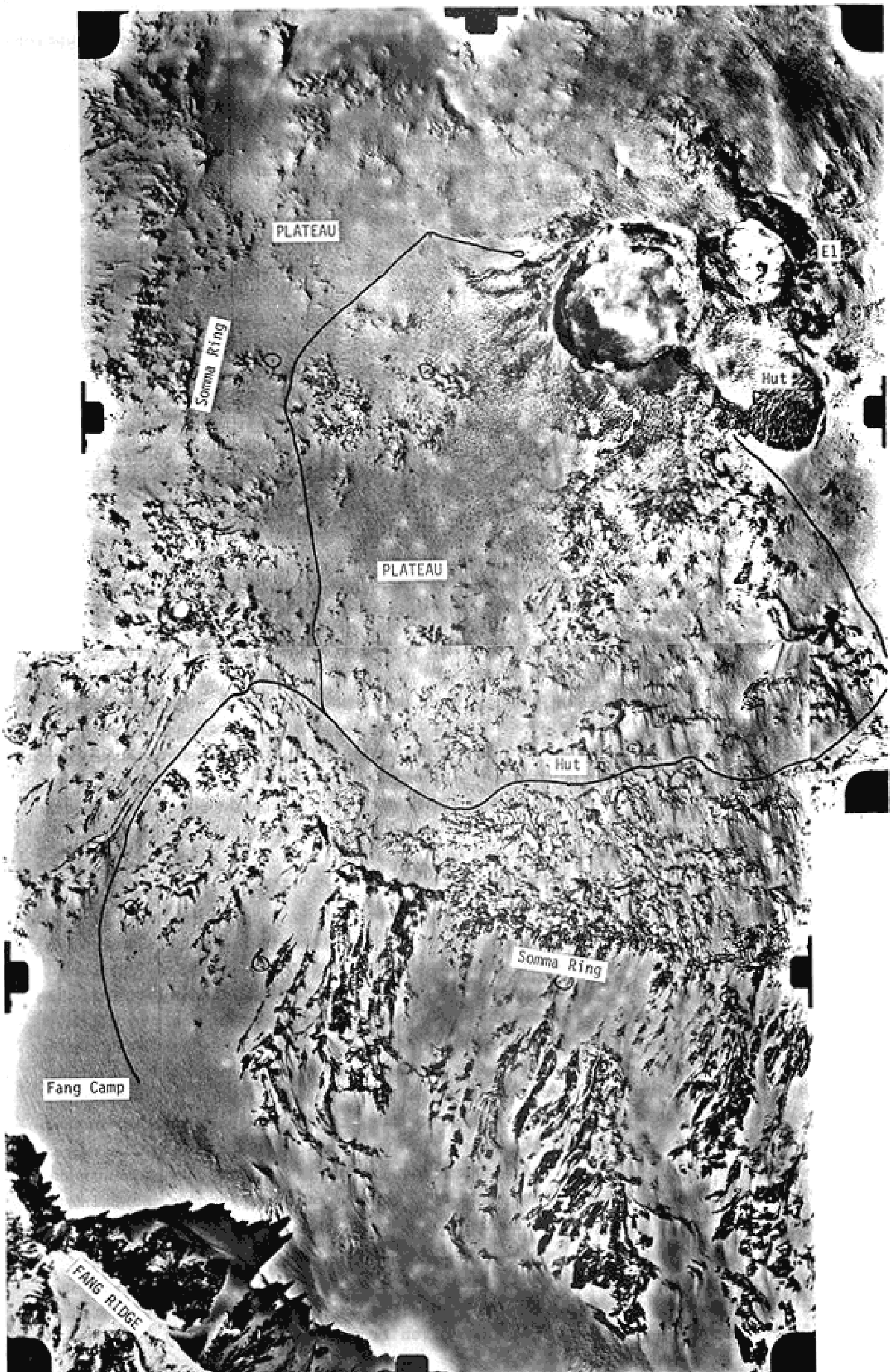
PLATEAU
E1
Somma Ring
Hut
PLATEAU
Hut
Somma Ring
Fang Camp
FANG RIDGE

Figure 4. Left. Aerial photographs of Mt. erebus summit area showing the toboggon route from Fang camp to the main crater.

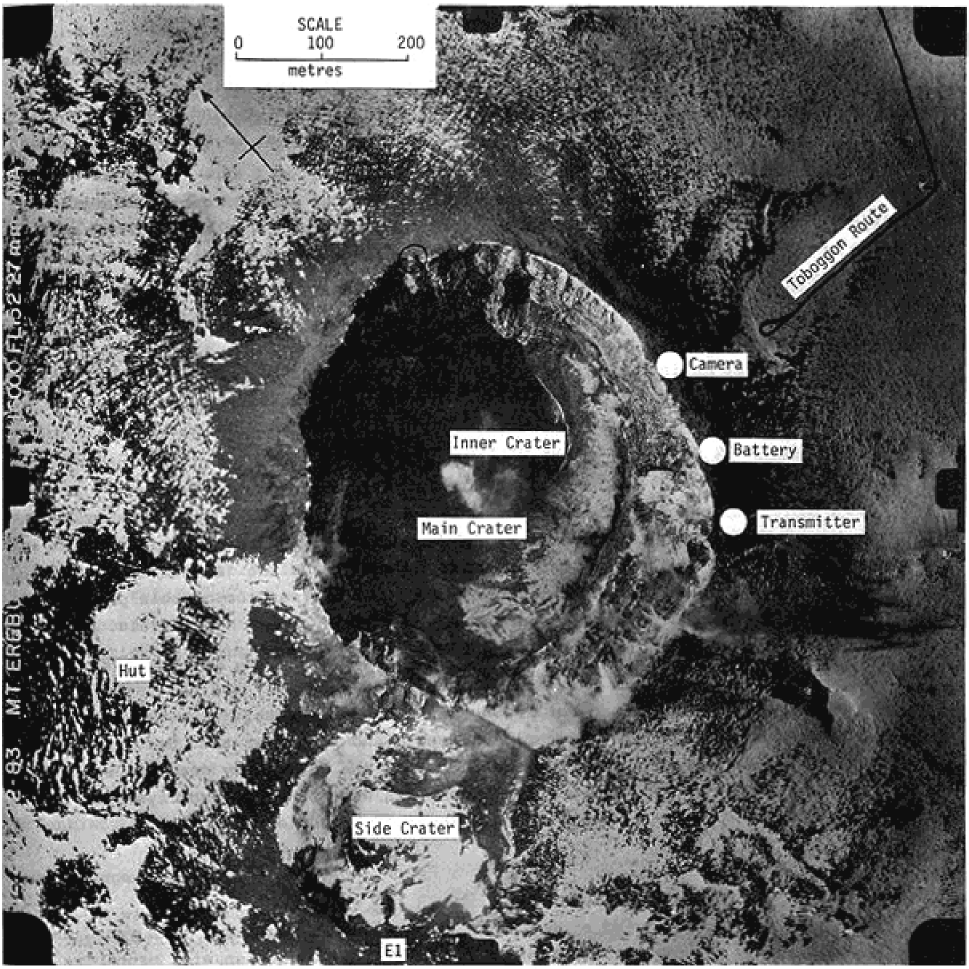

Figure 5. Above. Aerial photograph of Mt. Erebus summit showing the positions of the TV camera-transmitter equipment on the edge of the main crater.

The line scan would only start when the power plug was pushed into the camera body to get a fast turn-on. These problems, and difficulties in talking direct to the Science Lab by radio delayed TV operation until the last day the OIC would allow us on Erebus, and prevented me applying demisting techniques to the camera. My portable TV receiver and the NIPR portable oscilloscope proved essential.

A TRS power cable and polyethylene video cable were buried for 200 m around the rim to the BCNZ 400mW BCTTX transmitter on Ch 9. Dual Yagi 5 element antennae were used on a 2.4 m mast. The power supply placed midway, consists of 8 Donley 12V Gel/cell batteries of 60AH capacity in parallel, charged by a 42W Solarex panel. The total load is 4W. A switch disconnects the camera/transmitter when the battery is nearly flat, and reconnects as it recharges. Unfortunately, the camera may not restart.

While Dibble and Barrett were installing the TV, Miura and Wendon were measuring infrared temperatures in the crater from 4 points around the rim, using a Minolta IR-0510 thermometer with 1° beam, operating in the 8-14 micrometer band, and a digital recorder. They marked the measurement points on Polaroid photos, so measurements could be repeated. About 5 readings were made of each of 81 points.

On 13 December we serviced infrasonic microphones at El and Cones, and added 3 60AH gel/cells to the El battery. Mr. Miura installed a radial LPH geophone (T=4s) at El to find if there was a VLF seismic precursor corresponding to the infrasonic one. Then we received a reply from Washington declining to lend us El and Cones, but decided not to remove our equipment. We started down on the 17th and reached Scott Base on 18 December.

Meanwhile, Dr. Kaminuma was doing playback at Scott Base, and helping Mr. Denyer monitor the TV. He also recorded gravity tides on NIPR equipment. After our return, he instructed Barrett in the playback equipment, and in how the IMESS data had been analysed in Japan. He also made gravity surveys of the Dry Valleys, Dailey Is., and at Cape Bird as an NIPR project, taking Miura and Barrett with him.

Dr. Dibble's first priority on descending was to mitigate the threatened removal of NSF equipment from Scott Base, following NSF's decision not to lend it. Dr. Kyle had hoped the equipment could stay, but otherwise to put it in the "Little House" near Scott Base, and still connect it to the recorders at Scott Base. Dr. Dibble prepared cables for this before returning to NZ on 21 December, a day ahead of schedule.

Dr. Kaminuma and Mr. Miura returned to NZ on 7 January 1987, the day NSF shifted their equipment to McMurdo. Mr. Barrett continued with playback, and analysing the data, while in NZ, Dibble searched for replacement telemetry receivers. They were ordered on 9 January with promise of rapid delivery, and agreement that Barrett could stay to help install them, and resume IMEEMS, but by the 19 January deadline set by the OIC, the crystals had not arrived. The receivers were sent without crystals, and Barrett returned to NZ on 22 January, 14 days ahead of schedule.

Publications

The work will be presented at the IUGG conference in Vancouver this year, and will also comprise Mr. Barrett's BSc Hons project. The IUGG version will probably appear in Bulletin of Volcanology.

Future Research

The programme was designed to be a 2 year one, and can be continued without NSF cooperation. Time will tell whether the camera restarts when power returns after winter. If not, it must be visited to restart it, and the focus and TV signal strength should be improved, giving better picture quality. Continuation is needed to study changes in eruptive activity, mechanism, and infrared survey temperatures with time. After 1988, a small and completely new automated monitoring system is proposed to replace the NSF seismic telemetry net, hopefully with NSF collaboration.

Management of Science in the Ross Dependency

The future for international cooperative projects seems bleak if they can be terminated unilaterally by one of the funding agencies, in spite of the desire and ability of the cooperating scientists to continue them. For IMESS, NSF cancelled the NSF/NIPR agreement in favour of scientist/scientist arrangements, and then cancelled the NZ scientist/US scientist arrangement because it did not have DSIR/NSF agreement.

NZARP have good ability to cater for Erebus work using VXE-6 helicopters and Grizzly toboggans, but there was a reluctance to prove it this season. Both our field time and observation/analysis time were squeezed, and almost prevented pictures being transmitted at all. The attitude at Scott Base contrasted strangely with that at McMurdo in 1984/5 when I was with USARP, driving skidoos and firing large seismic explosions all over Erebus. At McMurdo, the base administrators and personnel have as much Antarctic experience as the scientists. Perhaps there should be a Science Rep at Scott Base similar to the NSF Rep.

Concerning 'special' areas, I observed that US scientists had freer access to these than NZ scientists.

The inclusion of Prof. Kaminuma and Mr. Miura in my event was successful, and I think essential. They provided the LPH geophone and Infrared thermometer for IMEEMS, operated them, and produced the data. They continued to provide the clock and recorders, and the recording materials as for IMESS. The NIPR budget for research in the McMurdo regions is about NZ$50,000 per year, excluding salaries, and greatly assists IMEEMS. However international cooperation has its problems! The boundary between scientist/scientist arrangements and institution/institution ones is murky, and scientist/foreign administration contact is not even-handed. NZ administrators and OIC'S like foreign scientists to communicate directly with them, but discourage NZ scientists from communicating directly with foreign administrators. I still wonder why Dr. Wilkness ordered the NSF equipment out of Scott Base and so dismantled IMEEMS. Perhaps scientists should write directly, but send the letters via the Director of Antarctic Division. Replies should come back the same way.

There needs to be a distinction between a guest foreign scientist who brings expertise and existing equipment, but no money, and one who brings foreign funds. It was NIPR who agreed to support IMEEMS, and Prof. Kaminuma rightly had an independent role. It was unworkable for me to assume full responsibility for him as guest foreign scientist.

Acknowledgements

I wish to thank RDRC for approving, and UGC/VUW for funding my program, and NIPR for cooperating in it. I thank the Director of Antarctic Division, the OIC Scott Base and the NSF Rep at McMurdo for trying to avert the international calamity which overtook us, and VXE-6 for minimising the effect of the new altitude restriction on the Erebus programme. Most of all, I thank Dr. P.R. Kyle and Bill McIntosh for their help and positive attitude to getting the work done in spite of the new problems, and I sympathise with Bill that he was finally ordered to dismantle what we had all worked so hard to achieve.

McMURDO SOUND SEISMIC STUDIES - Bryan Davy

Abstract

There were two parts to the K045 scientific programme. The first involved the downhole velocity logging of the CIROS-1 drillhole at the completion of drilling. This work encountered severe noise problems which may make the signal irrecoverable. The second part of the event involved the determination, using seismic reflection techniques, of the dip, faults and strong reflectors in the geologic structure in the immediate vicinity of the CIROS-1 drillhole as well as the testing of various seismic reflection techniques for any future reflection projects on the sea-ice. Despite transport and manning problems 2 seismic lines were shot running at right angles from the CIROS-1 drillhole and records appear to have primary reflected energy down at least to 800 metres sub-seafloor. Tests proved explosives a more useful sound source than marine airguns.

Background

While velocity measurements are made on the recovered core the effects of pressure, temperature, pore fluid etc., mean that the velocity of the core samples can differ markedly from the *in situ* velocities which the downhole technique will measure. The reliability of the tie between the recovered core and seismic reflection and refraction lines in the CIROS-1 hole vicinity is dependent on how well the *in situ* sediment velocities are known. Most of the available literature on vertical seismic profiling refers to the use of three component seismometers deployed down the drillhole. There is little published regarding the use of a hydrophone in a sea-ice situation. From land operations one of the main requirements is to separate the desired first arrival signal from tube waves, strong resonant wave modes set up in the water column. Other than a well-cemented hole the next most preferred configuration for seismic energy transmission is an open hole. Consequently the shot hole was placed 50 metres from the drill rig and the downhole logging was performed in an uncased hole (until the collapsed hole was encountered).

It is important to link the geological structure determined by drilling with the horizons detected in other seismic surveys in the western Ross Sea, particularly the multichannel seismic survey conducted by the S.P. LEE, in order to date these horizons and their deformation. The reflection survey will also hopefully reveal some of the deformation history in the vicinity of the drillhole as well as the possible presence of reflecting strata at depths greater than reached by the drilling project.

Two sound source types, explosive and marine airgun, are available. Explosives are the traditional sound source used in 'land' seismic work in the Antarctic. Marine airguns, lowered through a hole in the sea-ice, have been used in the northern Arctic regions and are potentially a less expensive sound source than explosives. K045 was to test the feasibility of this sound source versus explosive.

Personnel

Event leader — Bryan Davy, Geophysics Division, DSIR
Graham Alder, Victoria University of Wellington
Hernan Moreano Andrade, Instituto Oceanografico de la Armada, Equador.

Results

(a) Downhole velocity survey

A Mark Products P27 deep hydrophone was lowered down the CIROS-1 drillhole in steps varying from 10 to 20 metres with the seismic travel time from a surface explosive event being recorded at each level on an ES-1200 Nimbus seismic recorder. The difference in travel time to each level should provide the velocity of the intervening layers. The hydrophone was connected beneath the MWD Water and Soils Division logging cable. Unfortunately the outer earth-return nature of this cable meant that it acted like an aerial picking up background electromagnetic noise of a similar level to the voltages produced by the hydrophone. Much of this background noise appeared of a regular sinusoidal nature and it is hoped that selective filtering of the digitally recorded signal can yet yield the first arrival information required. Examination of the raw seismic record indicates seismic arrivals from the surface explosion but the nature of these seismic modes was indeterminate as was the presence of first arrival information. Halfway down the hole, at a depth of 317.8 m the hydrophone encountered a hole cave-in. Due to the uncertain value of the data being recorded as well as the difficulties anticipated in clearing the blockage it was decided to abandon the downhole survey at this stage.

(b) Seismic reflection profiling

Two 24 channel 6-fold seismic reflection lines designed both to determine the geological structure in the CIROS-1 immediate vicinity and to evaluate marine airgun sound sources as an alternative to explosive operations were surveyed running at right angles away from the drill hole. In order to speed up surveying operations two 12 channel ES-1200 Nimbus seismic recorders, belonging to Geophysics Division DSIR and Victoria University respectively, were linked for the first time to form a 24-channel system. The sound source was lowered through a 12 inch diameter hole drilled through the sea ice using an ice auger system developed by Alex Pyne, Victoria University. These holes were originally spaced every 70 metres with the reflected sound being detected by a line of geophones set in the ice with an individual spacing of 35 metres, overall spread length of 815 metres and a near-geophone to shot offset varying between 70 and 420 metres. After 6 drill holes 12 of the geophones were 'rolled along'. This configuration yields 6-fold common midpoint coverage. The first line shot was orientated at 314 degrees E, towards the MSSTS-1 hole, and although it did not reach this hole as hoped for at first, with a 2.5 km length it did cross the S.P.Lee multi-channel seismic line. A second 2 km line with orientation 224 degrees E was surveyed with twice the shot spacing i.e. 140 metres in order to cover a greater distance, although halved resolution, within the time and explosive resources available.

Generally airgun operations proved slow and complicated with shuttle sealing and airgun firing and recovery difficulties. Where airgun records were obtained they appear on the unprocessed records to be significantly inferior in resolution and penetration to those obtained by explosives despite the stacking of airgun records. In order to achieve some significant ground coverage and also due to undermanning on the project the survey concentrated on the use of an explosive sound source. Reflecting horizons appear on the raw records to be detectable to depths of 700-800 metres at least, although such identification is made difficult by the presence of strong horizon multiples over the same time window.

Recommendations

Preliminary examination of the seismic record suggests primary reflected energy is present to at least 800 metres sub-seafloor. Multi-channel seismics enables the removal of much of the sea-floor multiple reflector energy as well as the provision of velocity information. Thus where it is unlikely a multichannel marine seismic ship can venture the above system provides a viable alternative. Explosive sound sources despite their greater expense are the much preferred option due to their simplicity of operation and superior sound source characteristics. The joining of the two twelve channel Nimbus recorders successfully provided a 24-channel system halving the number of shots required for a single 12-channel recorder. A tracked heated cab/room environment is required for the Nimbus recorders. With an explosive sound source the rear transport could be toboggan based. The seismic line, if possible, should be bulldozed and surveyed.

Any future downhole velocity logging using a hydrophone transducer needs to be linked to the surface by a shielded logging cable.

Acknowledgements

Thanks to Alex Pyne for his assistance in planning and organisation as well as the use of the ice auger, derrick and associated sledges.

Thanks to Geophysics Division technical staff for the work configuring the Nimbuses for dual operation, constructing a portable airgun firing unit and various triggering adapters as well as general seismic equipment support.

Thanks to Eric Broughton of the Victoria University technical workshop for the work on development of the compressed air supply system.

DETOXICATION SYSTEMS IN ANTARCTIC FISH (K047) - K. C. Falkner

Abstract

During the 1986/87 summer season the level of detoxication enzyme glutathione-s-transferase was tested in antarctic fish species Pagothenia borchgrevinki and Dissostichus mawsoni. The enzymes were tested using a variety of substrates including the lipid peroxide cumene hydroperoxide. These measurements will be used to calculate base levels of enzyme activity. The enzymes of antarctic fish have appreciable activity with 1-chloro-2, 4-dinitrobenzene and cumene hydroperoxide but very low activity with 2,4-dichloro-1-nitrobenzene and O-nitrobenzly chloride. Frozen samples of antarctic fish liver were taken for further purification and study at Victoria University. This will be compared and combined with research from the 1983/84 season and with other temperate comparative species to help ellucidate the role of these enzymes.

Programme

The research in the Antarctic this season represents the third phase in a three phase programme to study the detoxication systems of antarctic fish. The first two phases involve the thermodynamic characterization of a reaction with the general substrate 1-chloro-2, 4-dinitrobenzene.

The first phase involves the thermodynamic characterization of the spontaneous reaction, so reaction velocity can be calculated at any given pH or temperature. This allows extrapolation to the physiological conditions of antarctic fish. Results show that the spontaneous reaction will proceed 30 times slower under antarctic conditions.

Relevant thermodynamic parameters calculated for the reaction are activation enthalpy 49 KJ mol^{-1} and enthalpy of glutathione sulphydryl proton 31.6 KJ mol^{-1}.

The second phase involves the thermodynamic characterization of enzymes from Dissostichus mawsoni being compared with those of other organisms with different temperature regimes. Results gained to date give activation energies for the catalysed reaction between 1-chloro-2, 4-dinitrobenzene of 56.8±7.8 KJ mol^{-1} for D.mawsoni, 47.0±3.8 KJ mol^{-1} for the moth Galleria mellonella and 34.8±2.6 KJ mol^{-1} for rat glutathione-s-transferase 1,2.

The third phase involves the characterization of enzyme levels with different substrates. In particular endogenous xenobiotic substrates will be examined. These include the lipid peroxide cumene hydroperoxide, a substrate used in the Antarctic this season.

To summarize, the first phase examines the need for a detoxication system. The second examines any structural evolutionary change unique to the Antarctic and the third examines specialization of enzyme type that may have occurred to facilitate life in the antarctic waters.

Personnel

K. C. Falkner, Biochemistry Department, Victoria University of Wellington.

Scientific Endeavours

This project attempted to test the glutathione-s-transferases of antarctic fish species with a variety of xenobiotic substrates. The substrates chosen were 1-chloro-2, 4-dinitrobenzene, 2,4-dichloro-1-nitrobenzene, p-nitrobenzly chloride and cumene hydroperoxide. To test for these enzymes fish had to be caught, their livers excised and homogenised, then lightly centrifuged and assayed spectrophotometrically. All work was based at Scott Base and fish were caught in the Cape Armitage area.

Attempts were made to separate the two enzyme systems that break down cumen hydroperoxide; glutathione-s-transferase and selenium dependent glutathione peroxidase. These were unsuccessful as the yield of enzyme from initial purification procedures was too low.

It was possible to repeat the work attempted in the 1983/84 programme where results gained were affected by instrument errors. This gave significantly higher enzyme activity in accordance with that found in frozen samples in New Zealand. The effect of freezing on the glutathione-s-transferases and cumen peroxidase activity were examined as well as the thermal stability of the enzyme in crude homogenates.

Frozen liver samples of antarctic fish species were brought back to New Zealand for further research.

Publication

This research will be incorporated in a PhD thesis titled "Detoxication systems of antarctic fish". The anticipated completion date for the thesis is 25 February 1988. From this thesis it is expected that one paper specifically on the purification and properties of the glutathione-s-transferases will be published. Other papers on the effects of temperature and pH on glutathione-s-transferases will also feature material from antarctic fish.

Future Research

As this project is based on laboratory work in New Zealand the future research for this project is outlined below:

In this project frozen samples brought back this season will be used to repeat the purification procedures developed after the 1983/84 season. It is hoped that the experiments giving the enthalpy of activation for the glutathione-s-transferase will be repeated and attempts will be made to characterize this and the other glutathione-s-transferases present in D.mawsoni.

The glutathione-s-transferases of the fish Geniagnus monopterygius will be purified and characterized as a comparative species. It is hoped sufficient enzyme will be obtained to gain an enthalpy of activation with as least one of the isoenzymes.

Rat glutathione-s-transferases will be used to look at variation within one animal as opposed to variation between species. The glutathione-s-transferases of rat are highly characterized making it a suitable candidate for study.

Management of Science

At present the scope of studies that can be undertaken at Scott Base is limited unless commitment to an antarctic programme spans several years in which equipment can be tested and specialist wannagins built. However there seems quite a lot of scope for studies such as these in which the antarctic is seen primarily as a sample collection area and only limited scientific work is attempted. Scott Base is well sited to study antarctic flora and fauna so it is unfortunate that the Base has no real biological science laboratory. It would be a great asset to the programme to have a biological laboratory complete with running water and refrigerated areas.

DEEP FREEZE 87. USCGC GLACIER CRUISE - ROSS SEA. - Graham Alder, Alex Pyne

Summary

The USCGC Glacier was used for a science cruise in the Ross Sea during February 1987. The cruise was provided for two groups from Rice University (Houston, Texas) led by Dr. J.B. Anderson and included three people from Victoria University.

In the first part of the cruise (5-15 February) a seismic and sedimentological programme was undertaken in the Cape Hallett region. The aim of this study was to investigate sediment transport in several large submarine channels that cross the region with subsequent deposition in the basins to the north. Two parallel single channel seismic reflection and bathymetry profiles 150 nautical miles long and 30 nautical miles apart were run ESE from Cape Hallett using a 8.6 kJ sparker system. Piston cores approximately 15 nautical miles apart were taken along the profiles using a corer with 3 m long barrel.

In the second part of the cruise (15-20 February) the programme concentrated on the McMurdo Sound area with S-216 joining the USCGC Glacier.

Seismic, bathymetry and piston coring transects were undertaken in the Cape Royds area to determine how sediment was moving over the sea floor of this area to the 900 m deep Erebus basin offshore. Bathymetric surveys of the inshore area were carried out using the Arctic Survey Boat and VUWARC echosounder and revealed several small canyon-like features running offshore.

A seismic line was run across McMurdo Sound to intersect the CIROS-1 site and lines were also run in the New Harbour-Marble Point area to study sediment accumulation in sea floor depressions of this area.

A major part of the S-216 programme was to recover a large sediment trap (collecting area = $1M^2$) deployed from the fast ice edge in 520 m water depth in early December 1986. The position of the trap was determined by Brian Andersen (NZ Lands and Survey) soon after deployment. The surveying and geographical back sights in combination with accurate bathymetry were crucial to the later successful recovery of the trap. The Navsat position determined on the USCGC Glacier proved to be at least 2.5 km west (shallower) than the trap recovery position.

The trap mooring consisted of subsurface floats, trap and an acoustic release that was ranged and released from a portable deck unit installed in the small boat independent of the icebreaker . Once the mooring was released a helicopter was used to locate the floats and the small boat then secured the trap mooring for pickup by the icebreaker's main crane.

A seismic line was also attempted in Granite Harbour to determine the nature of sediments "ponded" in the inner and outer basins of the harbour. Dense pack ice was encountered while running the lines which resulted in poor quality records.

Acknowledgements

We would like to thank Dr. J.B. Anderson and Dr. R. Dunbar for the invitations to participate in their programmes this season.

Part II LOGISTICS NOTES

McMURDO SOUND SEISMIC STUDY - Event K045

Narrative

Event K045 was delayed in Christchurch by bad weather for five days before flying to the Antarctic on Wednesday 12th November. Following the arrival of the flight from New Zealand the next day the party proceeded to Butter Point where the CIROS-1 drill-hole, well ahead of schedule, was almost complete. There was time to unpack and check equipment before attempting the downhole velocity shoot. The well shoot was of doubtful success due primarily to unanticipated electromagnetic induction in the unshielded logging cable used. Unfortunately while there had been time prior to shipment to check transmission of signal from the hydrophone up the logging cable, work on the Nimbus recorders configuring them for twin reflection operation meant that the Nimbuses were not available for a full system test prior to shipping south. Well logging was continued in the hope that later digital filtering would render the data usable. Logging was discontinued when a hole collapse was encountered at 318 metres sub-seafloor.

For the seismic reflection work K045 planned to draw manpower support from the CIROS-1 scientific party and the leading vehicle for housing the seismic recorders was to be the Haaglund. Unfortunately due to the early completion of the CIROS-1 hole none of the scientific party were available for K045 and replacement personnel from Scott Base, due to arrive on the Haaglund, arrived only near completion of the Event due to the non-appearance of the broken-down Haaglund.

Consequently the majority of the seismic reflection work was performed by B. Davey and G. Alder rather than the four people budgeted for. The leading vehicle with heated 'cab' was the Ford pick-up truck with only two-wheel drive and broken front suspension. The extent and geometry of the lines was thus limited by the broken ice and snow-drifts beyond the fortunately large section of good sea-ice adjacent to the CIROS-1 drill site. With only two people airgun work could not be attempted and it was not until the final 1.5 days, with the arrival of 2 extra personnel from Scott Base that the airgun comparison could be atttempted. Airgun operations turned out to be full of difficulties and the first day was spent just getting the one gun, the VUW free running airgun, operating in a temporary fashion. It appeared the freezing action on air-seals and air-ducts could only be overcome by heating the airguns in heated cabs between shot operations. The Bolt airgun would only fire subsequent to being stripped in a heated laboratory.

Approximately 2.6 km of 6-fold seismic reflection line was shot on the line between CIROS-1 and MSSTS-1 with a CDP spacing of 17.5 metres. On a line running at right angles towards Butter Point approximately 2 km of 6-fold line with 35 metre CDP spacing was shot.

Explosives

70 Electric detonators were drawn from the Scott Base explosive magazine. The remaining twenty detonators, AN60 gelignite - two 50 lb boxes and 1.5 reels of detonating cord were drawn from the explosive store at Butter Point.

Communications

Two hand held Tait VHF radios with a chit-chat channel were required when shot-point and the mid geophone spread logging point were over 1 km apart. These were available most of the time.

Weather

As K045 was based at Butter Point when in the field, the weather was logged either by the drill site party or the Event dismantling Butter Point camp. Weather was good enough however that no work days were directly lost to bad weather.

Itinerary

Thursday 6th November to Wednesday 12th - waiting at Christchurch for weather to clear.
Wednesday 12th - Arrived at Scott Base.
Thursday 13th - Following the arrival of Jack Hoffman proceeded in Haaglund to Butter Point.
Friday 14th - Unpacking and testing gear at CIROS-1 drill site.
Saturday 15th - Preparation for velocity logging of hole. Started well-shoot at midnight manually lowering the cable the first 200 metres.
Sunday 16th - After shooting several levels the cable was retrieved to check the cause of noise. After deciding the noise was unavoidable lowered cable and started logging again. Logging was abandoned mid-afternoon after encountering a cave-in of the hole 318 metres sub-seafloor.
Monday 17th - was spent resting.
Tuesday 18th - Testing the Bolt 1900 airgun. Some problems with seals necessitated stripping and reassembly of the Bolt airgun in a heated laboratory before it would fire.
Wednesday 19th - Geophone spread laid out and ice auger set up at first shot point in preparation for overnight survey. Abandoned when Haaglund does not arrive.
Thursday 20th - Haaglund only available for four hours during which one hole was shot with explosive and airgun on a line towards MSSTS-1 drill hole.
Friday 21st - The Haaglund, scheduled for 10 a.m. arrival and survey, postponed to Saturday morning. A third string of geophones was laid out to facilitate surveying on Saturday.
Saturday 22nd - Haaglund being repaired, arrival postponed.
Surveying started using the Toyota HiLux and Ford pickup truck. 12 holes shot.
Sunday 23rd - Haaglund being repaired, arrival postponed.
Drilled 4 holes and laid out next geophone spreads. Toyota HiLux and Tait radios required in the afternoon for Butter Point relocation survey.
Monday 24th - Haaglund being repaired, arrival postponed.
18 holes shot.
Tuesday 25th - Haaglund being repaired, arrival postponed.
Informed it was unlikely to turn up at all. Request manpower assistance for airgun work to arrive on the next cargo train. Three holes were shot before the VUW Nimbus fails. All subsequent holes now needed to be double-shot. As the line was now amongst rough ice it was decided to move to the second line at right angles, heading landward towards Butter Point from the CIROS-1 drill site.
Wednesday 26th - 10.5 more holes are drilled and shot exhausting the detonator supply.
Thursday 27th - Arrival of two assistants from Scott Base means airguns can be tested as sound source. The whole day is spent unsuccessfully trying to get either airgun operating. Only subsequent to heating up at Butter Point was the VUW free-running

airgun fired in the evening. Even then it was not operating as expected.
Friday 28th - Surveying resumed using VUW airgun and a jury-rigged air supply arrangement. Air consumption per shot deteriorated during the morning such that eventually about one hour was spent charging air tanks prior to shooting each hole. Four holes were shot twice with 6 or 12 fold stacked firings of the airgun. Surveying was discontinued at 1.30 p.m. Equipment was loaded on sledges and towed to Scott Base by the D4 bulldozer overnight.
Tuesday 2nd December - The party returned to New Zealand.

Cargo

Unaccompanied baggage

1 carton containing air compressor, airhoses, airbottles and VUW free-running airgun	350 kgs
2 boxes containing geophones, geophone-takeout cables, shot cable, batteries and chargers for recorders, triggering control units and miscellaneous equipment	200 kgs

Accompanied baggage

1 box containing Bolt 1900 airgun and associated airhoses	260 kgs
1 box containing Geophysics Division Nimbus and spares	50 kgs
1 box containing manuals, spares, cables, tapes and paper for both Nimbuses	40 kgs
VUW Nimbus	20 kgs
Nimbus tapedeck	12 kgs
	-------
	930 kgs

DETOXICATION SYSTEMS IN ANTARCTIC FISH

Planning

The planning for this event was relatively straight forward. However problems can arise in between the time of when proposals are first initiated and when approval is obtained. For example some of the critical hazardous chemicals were sent to the Antarctic by ship cargo in early 1986 before finding out if the project had been included in the research programme.

The major problems that this event encountered in the Antarctic related to the lack of co-ordination between this event and K012. It was assumed that where co-ordination was required, i.e. access to the New Zealand fish hole and the sharing of transport, that K012 would have been officially notified. The event briefing sessions at Tekapo are recognized as an important place for meeting the leaders of other events and discussing event co-ordination. Thus briefing K047 and K012 at the same time was a very good idea. It was unfortunate that the leader of K012 was not present at Tekapo and this may have avoided the confrontation that lead to denial of access to the fish hole and to ground transport that was assigned to be shared between events.

Cargo

The cargo for the event was transported to Scott Base in three loads. The first was of hazardous cargo for ship transport. This comprised of one box containing the chemicals,

Ethanol	500 mls
Hydrochloric, Phosphoric, Perchloric acids concentrated 250 ml each	
Sodium hydroxide	2 x 25g
Sodium Azide	5g

Substrates for enzyme assay: Epoxy (p-nitrophenoxy)propane, 1-chloro-2,4-dinitrobenzene, 2,4-dichloro-1-nitrobenzene, p-nitrobenzly chloride, cumene hydroperoxide, hydrogen peroxide. Less than 5g or 6ml of each.

The second group was those that were packed in a cargon for flight to Scott Base. The cargon's approximate cube was 12 ft and weight 155 lbs. It contained assorted laboratory equipment, glassware and non hazardous chemicals.

The third load was red flighted chemicals 5,5-dithiobis(2-nitrobenzoic acid) and glacial acetic acid 200 ml. All cargo reached Scott Base before I arrived and was not damaged during transport.

Return cargo: this comprised of 2 boxes of equipment approximately 120 lbs which arrived in mid December and one small box of frozen samples. The frozen samples were brought back to New Zealand as excess baggage and as it was Saturday they were left in the freezer at Harewood store on 24 November with instructions to send them via refrigerated freight lines to Wellington. When the samples had not arrived by 9 December I phoned Harewood store to enquire about the delay. The samples had not been dispatched. I rang again on 19 December and twice on the 23 December to ensure the samples had been dispatched. The samples were finally dispatched on the 7 January and I received the samples 10 January. This is an unacceptably long delay as samples deteriorate and are only stable for prolonged periods if stored at -70°C.

Event Diary

K047 arrived at Scott base on 3 November. The next 3 days were spent locating and unpacking cargo and making up stock solutions for testing enzyme activity. The 7th was spent attending a sea ice survival course. Between the 8th and 17th fish species were checked for glutathione concentration in livers and enzyme activity. Attempts were made to separate the different types of detoxification enzyme for cumene hydroperoxide but these were unsuccessful. On the 12th, caught first D mawsoni with enzyme assays showing more activity than in previous season. Between the 14th and 17th the weather was poor and time was spent evaluating early results and checking the thermostability of the D mawsoni enzymes. On the 18th I assisted Dave Lambert K121 with penguin sampling from Cape Crozier and Cape Royds. The 19th and 20th were spent fishing with a D mawsoni being caught on the 20th. Tissue from this fish was tested for enzyme activity that night which effectively completed the research programme. The 20th was spent cleaning and packing up. Departure time was approximately 0030hrs on the 22nd arriving in Christchurch mid morning.

Use of Scott Base Facilities

Extensive use was made of the bio-lab area in Q hut and the wet Lab in the pump house. The area in the bio-lab was particularly useful although a little cramped. The wet lab is useful in that it is one of the few areas in Scott Base where the ambient temperature can be reduced. This facility is therefore invaluable for the running of cold temperature experiments such as protein separation. Most of the equipment taken to the Antarctic by this event was of a specialist nature, such as protein purification equipment. Items that would be of general use that were taken were a magnetic stirrer and a pH meter. The pH meter currently located in the bio-lab area doesn't work and is probably not accurate enough for general use. The centrifuge in the bio-lab could also be upgraded with the purchase of a fixed angle rotor and the purchase of new plastic inserts for the swing arm rotor. Red plastic inserts would initially be most useful. This would increase the ability to use this facility for more than haemocrit type work. It would be of great assistance to prospective researchers to have a list of equipment available in the bio-lab and wet lab facilities.

A good supply of distilled water should be available. This will require fixing the still and obtaining ideally a 25 litre glass container to collect the water once distilled. Washing up soiled glassware is currently a problem but was overcome with the use of the mess facilities.

ACKNOWLEDGEMENTS

In addition to those people and groups acknowledged in previous sections of this report VUW Antarctic Research Centre wishes to acknowledge the following for assistance to the expedition.

University Grants Committee for funding VUWAE 31 and VUW Internal Research Committee for grants to non-staff members of the expedition.

Ernie Millington and his team in the VUW mechanical Workshop who built the specialised core processing equipment for the CIROS programme. John Casey (VUW Photographic Facility) for developing and testing the core photography system used at the CIROS drillsite. Eric Broughton (VUW Geophysics Institute) assisted with CIROS electronic equipment.

Antarctic Division DSIR, Stores Section assisted with the purchase of Antarctic clothing for the expedition and efficiently transported our expedition cargo to and from Antarctica.

Winifred Begg typed this report.

APPENDIX I **VUWAE CARGO SUMMARY**

CARGO TO ANTARCTICA

Winfly cargo

1.03 m^3	Science equipment		373 kg	
0.1 m^3	Petrol motors		36 kg	
0.15 m^3	Core photography, accompanied cargo		38 kg	
	Surveying equipment, accompanied cargo	est.	160 kg	
	(Dept. Lands & Survey responsibility)			

Mainbody cargo

0.67 m^3	Science equipment	est.	200 kg	
0.46 m^3	Core processing equipment	est.	100 kg	
	Computer, accompanied cargo		30 kg	
	Microscope, accompanied cargo		25 kg	
	Downhole logging (MOWD responsibility)			
0.18 m^3	Control unit		70 kg	
0.1 m^3	Winch box		50 kg	
0.1 m^3	Probe box		66 kg	
0.06 m^3	Tool box		30 kg	
0.03 m^3	Tool kit		12 kg	
0.14 m^3	Neutron radioactive source		46 kg	
0.03 m^3	μ radioactive source		57 kg	
	sub total			1293 kg

K044 MT EREBUS ERUPTION STUDY

1.04 m^3	Scientific equipment	est.	400 kg	
	Gellcell batteries	est.	250 kg	
	sub total			650 kg

K045 MCMURDO SOUND SEISMIC STUDY

1.23 m^3	Air compressor and equipment		350 kg	
	2 boxes equipment		200 kg	
Accompanied cargo				
	Bolt 1900 airgun		260 kg	
	Nimbus (DSIR) and parts		50 kg	
	Nimbus (VUW)		20 kg	
	Nimbus tapedeck		12 kg	
	Manuals and parts		40 kg	
	sub total			930 kg

K047 DETOXICATION ENZYMES STUDY

0.34 m^3	Laboratory equipment		70 kg	
	Chemicals (red flight)	est.	20 kg	
	sub total			80 kg
	TOTAL			2953 kg

CARGO FROM ANTARCTICA

K041 CIROS

0.12 m^3	Science equipment		36 kg	
0.09 m^3	" "		29 kg	
0.12 m^3	" "		52 kg	
0.51 m^3	" "		100 kg	
0.12 m^3	" "		59 kg	
0.72 m^3	Core processing equipment		263 kg	
1.08 m^3	" "		354 kg	
0.65 m^3	Core saw (NZGS DSIR)	est.	250 kg	
0.64 m^3	Downhole logging equipment (MOWD)		331 kg	
4.70 m^3	7 boxes Core (NZGS DSIR)		2368 kg	
	sub total			3842 kg

K042 SEAFLOOR SEDIMENTS (No separate programme this season)

0.3 m^3	Ice drilling equipment		106 kg	
0.65 m^3	Winch		241 kg	
0.21 m^3	Hydrographic wire		143 kg	
0.8 m^3	Trailer skis		44 kg	
	sub total			534 kg

K044 MT EREBUS

1.04 m^3	Science equipment		325 kg	
	sub total			325 kg

K045 MCMURDO SOUND SEISMIC STUDY

	Science equipment as previously	sub total		930 kg

K047 DETOXICATION ENZYME STUDY

	Science equipment (2 boxes)	sub total	est.	60 kg
		TOTAL		5690 kg

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Triassic Paleoecology of the Lashly Formation, Transantarctic Mountains, Antarctica.
Helen Isobel Gabites (MSc thesis)

Abstract

The Lashly Formation, an alluvial plain sequence of Triassic age in South Victoria Land, contains a variety of fossil plant material and other features such as trace fossils and paleosols. This study examines the paleoecological record, and uses it to provide a scenario of geography and climate of the period.

Twenty varieties of megaflora are described. A further two specimens are identified to genus level, and seven are recorded as unidentified foliage, seeds, sporophytes or cones. Samples of silicified wood provided growth ring data for 'sensitivity' and 'complacency' statistical analysis. Five fresh water and terrestrial trace fossils are also described. They include *Cylindricum*, *Skolithos*, *Scoyenia* and *Heimdallia*. Root casts and impressions are found associated with paleosols and mudstone horizons. They are described in four categories: horizontal, taproot, adventitious and rhizomatous root systems. Seven types of developed paleosols were recognised. They are classified according to their morphological and sedimentological similarities with modern soil types. Paleoflora, paleosol and sedimentological records at specific sites are used to provide models for floral succession, and the effect of flood events on the floodplain vegetation.

Interpretation of paleoenvironment and paleofloral characteristics provides the basis for a model of paleolatitude of the field area through the Triassic. There is a close correlation between the apparent polar wander curve of Irving & Irving (1981) and the field evidence of this study. The model developed shows the field area at approximately 75°S in early Triassic, moving to beyond the Antarctic Circle to approximately 61°S by late Triassic.

Sedimentology of the Weller Coal Measures at Mt. Fleming Antarctica.
Alex R. Pyne (MSc Thesis)

Abstract

The Weller Coal Measures are an alluvial plain sequence of early Permian age, and are particularly well exposed at Mt Fleming, where they are 186 m thick. In this study they are mapped, described and interpreted in terms of three facies associations. FA1 forms the basal and upper units and is a cyclic association of sandstone, shale and coal deposited by meandering channels. FA2, which overlies the basal occurrence of FA1, contains in the lower part interbedded sandstone and shale with channelling and sand lenses indicating depostion on a levee. This grades into shale with thin sandstone stringers and limestones deposited in a lacustrine setting on the floodplain. FA3, which overlies FA2, is dominantly sandstone with minor shale and coal lenses and was deposited in braided channels.

The sandstone beds of FA1 and FA3 include intervals of small and large planar and trough cross-stratification. The large scale trough cross-stratification is considered to form from migrating in-channel linguoid dunes and hence provides paleocurrent directions that are close to the channel direction. A study of FA1 based on 187 measurements shows a symmetrical bimodal distribution indicating high variability in channel deposited sandstone from within meander loops. The symmetrical bimodal paleocurrent pattern can be simply explained by the downstream migration of a circular meander loop. The 88 measurements from FA3 are also bimodal but have a lower angular range, giving a sinuosity of 1.6, close to the low sinuosity channel pattern inferred from facies analysis.

Regional paleoslope has been determined for the Weller Coal Measures by considering patterns of point bar migration and preservation as well as channel direction measured from large trough cross-stratification. Paleoslope is taken as the direction with least readings and one that bisects the two main modes. These data indicate an east-sloping floodplain throughout most of the deposition of the Weller Coal Measures, consistent with few flow directions for the Carboniferous-early Permian ice sheet, but covered the region immediately prior to Weller deposition. The study indicates that simple averaging is not a reliable way of estimating paleoslope for high sinuosity current systems.

Deposition of the Weller Coal Measures followed a climatic warming and the final retreat of the early Permian ice sheet. However, vertical facies changes in the coal measures are thought to have resulted from regional tectonic events influencing slope and sediment supply rather than further climatic change.

Modern Sedimentation in Ferrar Fjord, Antarctica. David N. Kelley (BSc Hons. thesis)

Abstract

The origin of sediment forming the floor of Ferrar Fjord, on the coast of South Victoria Land, Antarctica, has been studied using grain size distribution, composition and shape. The sediment has subequal proportions of mud and sand and a few stones.

Comparison with accessible sources indicates about 25% of the sediment is supraglacial sand and 25% is eolian sand, the remainder being mud whose properties are consistent with those of the fine fraction of basal debris from a wet-based glacier. A process model is proposed whereby sedimentation of mud takes place from turbidity currents, generated by slumping at the grounding line, and density currents, formed by the sinking of hypersaline, supercooled water produced during sea-ice formation. The sedimentation rate is estimated to be about 0.4 mm yr^{-1}.

A facies model, based on the processes considered to be important and which identifies five depositional zones in the present-day fjord, is also presented. This model is considered in conjunction with the recent glacial history of McMurdo Sound and used to infer an origin for the well-sorted sand and sand-mud couplets of CIROS-2 drill core.