K040
1993/94

# LOGISTICS REPORT

## K040 : The Sedimentology and Trace Fossils of Devonian Strata at Table Mountain

New Zealand Antarctic Program 1993/1994

Event Personnel: M.C. Wizevich (Leader)
R.S.W. Thornley
K.J. Woolfe

December 1993 - January 1994

LOGISTICS REPORT TO THE NEW ZEALAND ANTARCTIC PROGRAM

# THE SEDIMENTOLOGY AND TRACE FOSSILS OF DEVONIAN STRATA AT TABLE MOUNTAIN (EVENT K040)

MICHAEL C. WIZEVICH

GEOLOGY DEPARTMENT
VICTORIA UNIVERSITY OF WELLINGTON

15 FEBRUARY 1994

## Aims

The origin of the 1000 m thick sequence of the Devonian quartzose sandstones of the lower Beacon Supergroup, South Victoria Land, Antarctica has generated considerable debate. The controversy centres on the presence of varied and abundant trace fossils, especially *Skolithos,* frequently used by some geologists to interpret marine paleoenvironments. However, the trace fossils are considered by others to be consistent with nonmarine deposition. Most previous studies have been conducted on a regional scale and insufficient data has been collected to establish sedimentary processes and the depositional environment with confidence.

This study was designed to examine the lowermost Beacon Super group (lower Taylor Group) in detail, collecting data from a relatively limited area and stratigraphic interval. Excellent 3-dimensional exposures at Table Mountain are ideal for lateral profiling techniques, which take into account lateral as well as vertical facies changes in order to provide a refined depositional model. Improved understanding of the depositional system will contribute not only to resolving the trace fossils problem, but also to southern Victoria Land paleogeographic and tectonic reconstructions.

**Objectives:**

1 To reconstruct the depositional environment of the lower Taylor Group
2 To determine the habitats in which the trace fossils were made.
3 Further investigate the enigmatic Pivot Member (Arena Sandstone).

## Planning

The only problem in the palnning aspect of the expedition was the failure for Event K040 to obtain, for what ever reason, the 1993/94 NZAP field event directive. This was discovered during the event briefing at Scott Base, but did not cause any any trouble.

There were a few situations during the expedition that could not have been anticipated (see Cargo and Field Transportation sections). Flexibility in the operations in Antarctica made our tasks easier and greatly assisted in the fulfilment of our objectives.

Wizevich and Thornley attended Tekapo and thoroughly enjoyed and benefited from the experience. Woolfe could not attend because of committments in Australia, but he could have benefited from receiving copies of the Antarctic Operations Manual, the Antarctic Field Manual, and the Antarctic First Aid Manual.

The overall approach used at Tekapo (i.e., teaching and building confidence by lecturing and then a 'hands on' session, and finally a simulated Antarctic experience during the overnight), was effective. Including the Antarctic veterans was extremely helpful in the learning process (as well as an opportunity to meet interesting people and learn about their studies), but at times (especially during the preliminary basic lectures) many appeared to be bored. Perhaps restructuring the Tekapo schedule such that the veterans can come after the basic lectures (over the weekend, which might mollify some complaints that the training interrupted work) may alleviate the boredom and still provide valuable resources for Antarctic neophytes.

## Cargo

Because of unforeseen circumstances, it was deemed necessary by the Event Leader that collected geologic specimen (rock samples) should be immediately returned to New Zealand so that analyses could begin without delay. A request was made to the SENZREP, who informed the Base Manager and 50 kg were allocated for the flight back to Christchurch. Luckily, Air New Zealand was just as accommodating and the samples made it to Wellington without a problem.

## Personnel

| | |
|---|---|
| Dr. Michael C. Wizevich:<br>Leader, Geologist | Geology Department,<br>Victoria University of Wellington |
| Dr. Kenneth J. Woolfe:<br>Geologist | Geology Department,<br>James Cook University,<br>Townsville, Australia |
| Mr. Stephen Thornley:<br>Geologist | Geology Department,<br>Victoria University of Wellington |

## Preparations for the Field

Very smooth transition. With a little bit of luck, a dose of experience, and heaps of help from the Base staff, we were able to put in at our field site about 68 hours after landing in Antarctica. This included overnight field training, and was a full day *ahead* of schedule.

## Field Transport

Helicopter support was the only field transport required for our expedition. Unfortunate circumstances led to additional support other than our basic allocation for put in and pull out. The party was transported to Table Mountain on one flight, although the helicopter was carrying a near full load. After a week in the field, Woolfe developed a medical complication and had to be evacuated from the field. Woolfe was eventually transported to New Zealand and was not be able to return. This left us without our most experienced Antarctic person, and seriously jeopardised our capacity to achieve the scientific objectives. A second medical evacuation (Thornley) nearly caused cancellation of the expedition. Fortunately, Thornley was returned the same day after being examined by the medical personnel at McMurdo Base. Dom McCarthy (Base Engineer) was sent up to assist Wizevich in Thornley's absence. The swiftness in which both evacuations (and one return) was achieved was impressive.

Because of the loss of Woolfe, we were not able to traverse glaciers and thus not capable to visit remote sites for geologic sampling. We requested the SENZREP for additional helicopter time in order to visit the locations. The additional time was granted and an experienced guide (Grant Avery, geophysics technician) was sent to accompany us. Unfortunately, our attempts were thwarted by bad weather (winds over 40 knots) and we could not complete our sampling. Furthermore, with the weather rapidly deteriorating, there was no time to load all of the camp into the helicopter. Left behind was approximately 700 lbs of equipment, including 70 lbs of rock samples that were intended to accompany the party back to New Zealand. Because the sampling was considered critical to accomplishing an event objective and because of the samples left at Table Mountain, the SENZREP and Operations Manager granted another attempt (i.e., additional helicopter time to revisit Table Mountain) before our scheduled departure to New Zealand. During the aborted attempt at sampling the Platform Spur site, it was determined that the only method to attain samples was to lower down on a rope over the edge of a near-vertical cliff face. Bruce Jenks (Field Supply Officer), experienced in rock climbing, was added to the party. On the return to Table Mountain, Thornley, Avery, and Jenks were dropped off at Platform Spur to sample on the face of the steep cliff. Wizevich was then transported up to Sickle Ridge. The helicopter pilot resolved that the locality to be sampled was ~10,000 ft (map read <9500 ft, see discussion in Event Map section) and dropped Wizevich and a crewman (the helicopter needed to refuel at Marble Point) at ~9,000. After sampling was completed, Wizevich was flown around Table Mountain in order to photograph the rock outcrops. Upon completion of the task, the remaining equipment at the camp was loaded. The party members at Platform Spur were picked up and we returned to Scott Base (via Marble Point for fuel).

**Event Diary**

4 Dec Wizevich and Woolfe flew to Christchurch and were met (~5 PM) at NZAP clothing shed by Thornley, who arrived the previous evening.

5 Dec Departed Christchurch ~12 PM arrived in Antarctica ~6 PM.

6 Dec Wizevich and Thornley attended survival school, overnight on ice. Woolfe drew and prepared field gear and provisions. Woolfe joined party at 10 pm for overnight stay, and to assist in next day's training.

7 Dec Field training, including 'shakedown' of field equipment, and practice as a team. Evening event briefing. Visited Discovery Hut - a very worthwhile experience.

8 Dec Helicopter arrived at Scott Base ~12:30 PM, arrived and put in at Table Mountain about 2 PM. Because of snow, wind and limited visibility, the proposed camp site could not be reached. Set up camp. Weather deteriorated in late afternoon.

9 Dec Reconnaissance of geology and local terrain. Walked to eastern peak (Navajo Butte) on Table Mountain, across saddle to 'Table Mountain' (western peak) and down northern slope of Table Mountain before returning to camp. In evening walked to edge of Bindshadler Glacier to look for best route for crossing of glacier next day.

10 Dec Traversed Bindshadler Glacier to Platform Spur. Route was flagged for future treks to Spur and to Sickle Ridge. Examined geology. Weather deteriorated; returned to camp across glacier at slightly higher elevation than flag route and encounter numerous 1-2 m wide crevasses on west side. Walked across lower Sphinx Valley and Navajo Butte to camp.

11 Dec More snow on ground from previous night. Further reconnaissance of Navajo Butte, Table Mount, Sphinx Valley and Centurion, a peak between The Handle (northern end of Sickle Ridge) and Sphinx Valley.

12 Dec Began measuring stratigraphic section on southern end of Table Mountain (west summit), on Columnar Valley side. Woolfe returned to camp with painful cheek area.

13 Dec Additional snow makes it difficult to examine gentle sloped outcrops. At same Table Mountain location, studied section higher up stratigraphically, where the rock faces are near vertical and thus not covered with snow. Woolfe remained in camp.

14 Dec Continued measuring stratigraphic section on upper part of Table Mountain (west summit). Woolfe remained in camp.

15 Dec Reviewed work to date with Woolfe, who returned to camp at noon. Continued measuring section on upper part of west summit. Weather deteriorated (~20 knot wind) in afternoon. Finished early.

16 Dec High winds (up to 30 knots); remained in tent for day. Much snow removed from outcrops.

17 Dec Woolfe returned to Scott Base for medical reasons. Returned to lower part of Table Mountain section.

18 Dec Snowed heavily during previous PM and continued lightly throughout day. Most of the outcrops are again covered in snow. Started section along vertical cliffs on northern side of Navajo Butte.

19 Dec Returned to northern side of Navajo Butte and finished measuring available (vertical) section. Began measuring new section on (upper) south side of Navajo Butte. Light snow fell all day.

20 Dec Returned to southern side of Navajo Butte and continued measuring section. Light snow fell throughout day.

21 Dec Returned to south side of Navajo Butte and finished measuring section. Light snow fell all day. Woolfe left Antarctica for Christchurch.

22 Dec Walked along SE Navajo Butte, noting areas for future work, through Sphinx Valley to Centurion. Measured short section. Snowed all day.

23 Dec Returned to Table Mountain (west summit) and continued measuring stratigraphic section on upper part of steep (subvertical) exposure .

24 Dec Visited by Santa; requested wind to blow snow from outcrops. Began measuring lower part of section on north side of Navajo Butte. In late PM, winds increase to 20-25 knots. We believe in Father Christmas!

25 Dec Inspected lower Table Mountain section; still had considerable snow. Returned to northern side of Navajo Butte and continued measuring section. Strong winds (probably >30 knots) during PM.

26 Dec Winds continued in AM, but diminished in early PM. Returned to northern Navajo Butte; work went slow in moderate wind and cold.

27 Dec Returned to lower Table Mountain section. Outcrop visibility vastly improved. Continued measuring stratigraphic section.

28 Dec Returned to lower Table Mountain and continued measuring section.

29 Dec Returned to north side of Navajo Butte and in PM returned to south side of Table Mountain section. Continued measuring sections.

30 Dec Thornley evacuated to Scott Base for medical exam, returned same day. D. McCarthy joined party while Thornley was away. Strong wind (20 knots) in AM, got stronger (~40 knots) in PM. Remained in tent for day.

31 Dec Continued to measure section on north side of Navajo Butte.

1 Jan Same as previous day.

2 Jan Spent AM finishing section on north side of Navajo Butte. In PM returned to Table Mountain (west summit) to also finish section.

3 Jan Started to measure section on (lower) south side of Navajo Butte.

4 Jan Detailed reconnaissance of SE side of Navajo Butte. Examined New Mountain Sandstone in Sphinx Valley area, recorded paleocurrents and observations of trace fossils and sedimentary structures. Determined outcrop in Sphinx Valley was not sufficient for detailed study.

5 Jan Finished measuring stratigraphic section on south side of Navajo Butte. Started measuring series of smaller sections on SE side of Navajo Butte.

6 Jan Finished measuring series of sections on SE side of Navajo Butte.

7 Jan Measured section on SW side of Navajo Butte. At 10 AM, 12 and 2 PM hiked to top of outcrop (Mt Newell repeater is N of Table Mountain) to communicate with Scott Base regarding visit by Distinguished Visitors (DVs). Visit delayed (until following day) by bad weather at Base.

8 Jan Visit from DVs (scientists in influential positions) enjoyed by all. Requested from SENZREP additional helicopter time at pull out, in order to sample rocks at Platform Spur and Sickle Ridge. Started and finished measuring a section between Navajo Butte and west summit.

9 Jan Traversed SE side of Navajo Butte and traced beds between series of sections measured earlier. Recorded additional paleocurrents and observations of trace fossils and sedimentary structures in Sphinx Valley. Climbed up Centurion, sampling sandstones for petrographic analyses, and then up The Handle for samples of Ferrar Dolerite. Hiked along ridge towards NE terminus, dropped down to Columnar Valley. Crossed Valley to base of Table Mountain, sampled lower stratigraphic units and inspected lower New Mountain Sandstone for future study.

10 Jan Finished up loose ends on several sections in the Navajo Butte area.

11 Jan Climbed down to Columnar Valley to finish remainder (lower 30 m) of stratigraphic section at Table Mountain.

12 Jan Traversed NE side of Table Mountain to examine lower units of the Taylor Group. Recorded paleocurrents and observations of trace fossils and sedimentary structures; collected samples for petrographic study.

13 Jan Spent day re-examining the stratigraphic sections that we have studied. Collected samples of concretions for Woolfe to study.

14 Jan Winds in AM about 15-20 knots. G. Avery put in to help collect flags (placed 10-12-93) on Bindshadler Glacier, and sample rocks on Platform Spur and Sickle Ridge. Party traversed glacier as weather deteriorated

(wind >40 knots). Helicopter picked up party on Spur. Studied Spur from air, decided sample site could not be reached without ropes. Sickle Ridge covered in clouds, no attempt to reach. Weather deteriorated further, pilot decides to retrieve some of camp gear and head back to Scott Base. Met with SENZREP and Operations Officer and decided to retry sampling and to retrieve equipment on Monday. Showered.

15 Jan Formally requested additional helicopter time.

16 Jan Played American football and beat the Yanks at their own game!

17 Jan Helicopter moved Thornley, Avery and B. Jenks (rock climbing expert) to Platform Spur to sample. Wizevich flown to Sickle Ridge to sample. Wizevich returned to Table Mountain; photographed outcrops and retrieved camp. Picked up party at Spur and returned to Scott Base.

18 Jan Wizevich and Thornley returned to Christchurch.

Event Map

Figure 1 is a detailed sketch map of the Table Mountain area, showing the camp site and the locations visited by helicopter (Platform Spur and Sickle Ridge). Other areas mentioned in the diary are also indicated.

During our expedition, we noted in two instances that the measured altitude was approximately 500 feet (150 m) higher than what was printed on our maps. Upon landing at Table Mountain, we measured the altitude using an altimeter set at Scott Base. Our reading of 2338 m was significantly different than the 2183 m on the 1:50,000 USGS-DOSLI topographic map (1993, Cathedral Rocks sheet) and radically different from the 1800-1900 m on the topographic base of the geologic map (Geology of the Knobhead Area, Woolfe et al., 1989). In addition, during helicopter transport to a sampling locality to Sickle Ridge the helicopter altimeter read ~10,000 ft, whereas the map (Woolfe et al., 1989) indicated 2800-3000 m (~9000-9500 ft). This particular error was costly in terms of helicopter time because the pilot refused to land on top of the ridge and the field party was dropped at the next lowest site (~9,000 ft) and it was necessary to climb (this took time) up the 1,000 ft to the sampling site while the helicopter waited. The pilot was following regulations that require oxygen for the crew at altitudes above 10,000 ft. Oxygen was not brought on the mission, because it was believed the site was ~9,000 ft.

A labelling error was spotted on the 1:50,000 USGS -DOSLI topographic map (1993, Cathedral Rocks sheet). 'Navajo Butte' was placed at a feature marked 2183 m elevation (actually, the location of our camp!), approximately 1 km northeast of its correct location (feature marked 2263 m).

Weather

A detailed weather log using the instruments supplied by Scott Base was kept in a "Met book" and relayed at each sked (9 AM and 9 PM daily) to Scott Base.

Generally, the weather at Table Mountain was good. Recorded temperatures ranged from a high of -11°C to a low of -23°C. Winds were recorded in an excess of 40 knots on a few occasions, but only 4 of the 38 field days were deemed severe enough to remain in the tent (perhaps two more should also have been designated as such). During the first half of the field season, significant snow (up to 10 cm) of recent snow covered the rock outcrops and hindered work greatly. Fortunately, on Christmas and Boxing days (Dec. 25-26) high winds blew, and were sufficient to remove most of the snow. Most fortunately, a stable high pressure system settled over the Table Mountain area for about 10 days. The resultant brilliant weather allowed the party the opportunity to collect data, unencumbered by the weather.

On the day of the pull out, high winds (in excess of 40 knots) and impending deteriorating weather forced a cancellation (later rescheduled) of helicopter movements to sampling sites and necessitated leaving about half of our camp equipment (and rock samples) at Table Mountain.

### Accident, Incidents or Hazards

Two medical evacuations were necessary during the expedition at Table Mountain. The first, Woolfe returned to Scott Base, then returned to New Zealand was caused by an infection in the upper jaw area. Although dentally related, a potential problem was not recognised in the mandatory dental examination. The second evacuation was required when Thornley reported to the Scott Base medical technician a green discolouration of a friction blister on his foot, and gangrene was suspected. After inspection of the foot by medical staff at McMurdo, Thornley returned to Table Mountain on the same day he was evacuated. The blister was caused by improper fitting Sorell boots, however, they were the largest size available.

### Field Equipment

In general, the clothing and equipment issued by NZAP was of sufficient quality and performed admirably. We had problems finding the right boots for work. Neither plastic (too cold when standing still and too rigid for climbing rocks), Sorells (too flexible for climbing and crampons, and do not breathe well-sweat inside), and mukluk (poor support of ankles, and not durable) boots are ideal for our type of work. Our work requires climbing of rocks and ice, standing in one place (examining rocks) for extended periods of time. Unfortunately we can not suggest an alternative. Perhaps either a warmer plastic boot or a more supportive and durable mukluk type boot would be better. We did experience some troubles with the Primus stoves, which often do not burn cleanly and kerosene spillage is a sad fact of life. Are gas (e.g., propane) cartridge stoves a possible alternative? Waste Management Officer Thornley reports that plastic bags supplied for buckets are at least twice as large as bucket. Either smaller bags or larger buckets would be more efficient.

The food box contained plenty of food, however, many of the items were not utilised, primarily because of personal preferences of the party members. Perhaps it would be best if some input could be made by party members for their own food boxes. Simple substitutions such as pasta for mashed potatoes or peanut butter for salami would have made a difference.

## Radio Communications

K040 was issued with both VHF and compak HF radios. The HF radio was emplaced, tested, and remained in standby for duration of stay at Table Mountain, but was not utilised because of the ease of use of the VHF radio. Communications via the Mt. Newall repeater were always adequate and the high gain antenna was not required. On several instances, the battery appeared to become flat prematurely and our signal would weaken such that Scott Base could not receive our broadcasts, necessitating a changing of batteries. It became apparent that one of the batteries failed to hold a full-capacity charge. However, we were able to get enough use from the faulty battery to allow sufficient recharge time for the good battery. Nevertheless, an extended period of cloudy, sun-less weather may have required use of the VHF radio as a backup. Solar panels worked well, but were often difficult to keep in an efficient orientation in the ice and snow. Perhaps a wire frame or backrest with small spikes in the base (to keep the panel from slipping, especially in moderate winds) would be a worthwhile, low-cost, and lightweight component that can be easily added to the panels.

The Comms operators provided excellent service and an efficient link to Scott Base. Their friendly and helpful manner made the radio skeds much looked forward to occasions. News about other events, Scott Base happenings, electronic mail from New Zealand, and a casual chat were much appreciated by all event members. Weather forecasts were not supplied and would have generally have been of little help as frequently the weather was localised.

Details of field movements (i.e., helicopters) were given in advance, but updates on the arrival time were often not available. This was certainly not a fault of the Scott Base Comms operators, but due to the lack of communication from the helicopters. In several instances we were surprised by the sudden arrival of a helicopter. In other instances we had difficulty communicating directly with the helicopters and had to use Scott Base as an intermediary. On the return to Table Mountain on 17 Jan, one member of the party was in the helicopter when communications were attempted, and it was clear that the field party could not hear the helicopter broadcasts for whatever reason, but were well received by the air crew. Both the lack of warning and the difficult direct communication wasted valuable helicopter time.

## Environmental Impact

See attached sheets.

We saw no trace of earlier camps on Table Mountain, but did find (and return to Scott Base) a smoke grenade on the NE corner of the mountain.

## Management of Science in the Ross Dependency

Our type of expedition probably requires less amount of forward planning and logistical support than most Antarctic projects and thus NZAP was able to easily cater to all our needs. In the unfortunate circumstances of our two medical evacuations, Scott Base personnel were able to coordinate and execute the pull outs in an efficient and impressive manner. Furthermore, the flexibility of the program, which allowed us to return to Table Mountain to collect samples and photograph the outcrops, allowed us to achieve important scientific objectives.

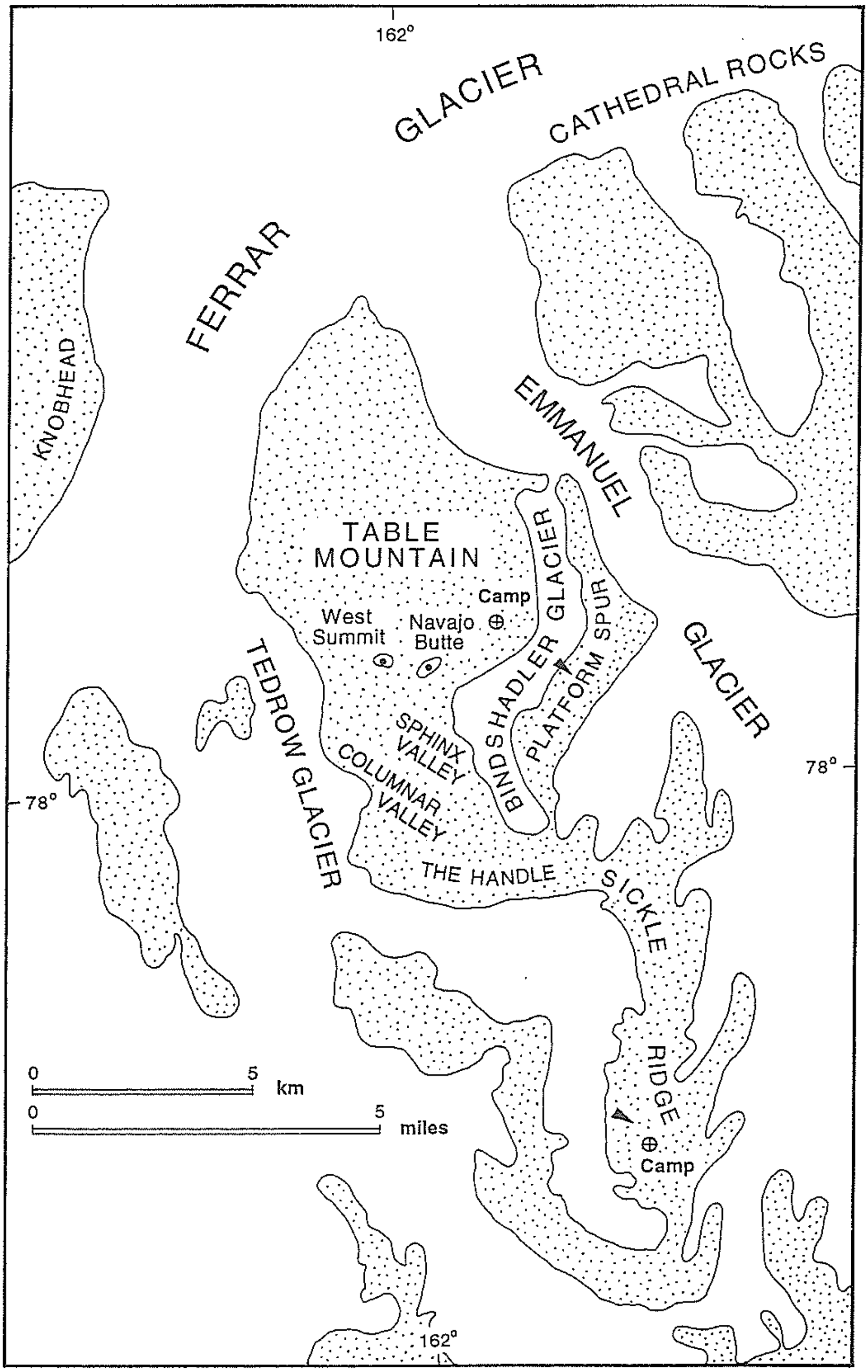


Figure 1. Location map for event K040. Camp marked with 'x' and areas sampled on 17 January 1994, at Sickle Ridge and Platform Spur marked with arrows.

# NZAP ENVIRONMENTAL RETURN 1993-94 SEASON

Office use only

Complete all relevant sections and include in both Immediate Science And Logistics Reports

## *Use of chemicals including radionucleides in Antarctica.*

Complete the following for each chemical and Radionucleide taken to Antarctica

| Chemical form | Locations used | Quantity (u Curies where applicable) |
| --- | --- | --- |

Were all chemicals returned to New Zealand........................................................................ ☐ Yes ☐ No

If NO detail why, location, quantities of material released or stored

## *Use of explosives.*

Detail any use of explosives.

| Date | Location (inlc reference) | Explosive type | Size of charge kg | Number exploded |
| --- | --- | --- | --- | --- |

## *Importation of animal, plant (includes seeds), microorganism or soil.*

Detail each species and quantities taken to Antarctica

| Species | Quantity | Location |
|---|---|---|

Were all these returned to New Zealand........ ☐ Yes ☐ No

If NO detail why, locations and quantities released.

## *Collections of biological or geological material made*

For each major location eg Scott Base, Cape Evans etc detail each species handled in any way

| | | Numbers or amounts in each category | | | | |
|---|---|---|---|---|---|---|
| Species or geological specimen type | Location | Caught or collected | Tagged or banded | Killed | Restrained | Other eg surgery |
| eg Adelie Penguin | Cape Bird | 25 | 25 | 0 | 25 | 0 |
| eg Ventifacts | SE Bull Pass | 2 | | | | |
| Rock Samples | Table Mountain | 60 | | | | |
| Rock Samples | Platform Sput | 3 | | | | |
| Rock Samples | Sickle Ridge | 7 | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Rock Samples were fist-size specimen and returned to N.Z. for laboratory analyses.

## *Details of entry to Protected Areas.*

List any protected area, Specially Protected Area (SPA) or Site of Special Scientific Interest (SSSI) or Specially Reserved Area (SRA), you entered.

| Permit No. | Name of SSSI, SPA or SRA | Date Visited | Party size | Total person-days in Area |
| --- | --- | --- | --- | --- |

## *Other impacts*

Detail any

A green-flag area was established near camp for grey water disposal.
All soiled wastes were returned to Scott Base.
Smoke grenades were found (one from aborted landing by visiting D.V's and another one [origin unknown] about 2 km NW of camp) and returned to Scott Base for disposal.

## *Summary of locations occupied*

Complete the following for each site occupied by your event

| | Sites Occupied or visited | Field Camp Location<br>For field camps give longitude and latitude or map reference. | | | Dates Occupied | | Total Days | Number of people | Total man-days at location | Previously used camp site |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Latitude | Longitude | Map and Ref | From | To | | | | |
| 1. | Scott Base | 77°51.0S | 166°46E | | | | | | | |
| 2. | Vanda | 77°31.4S | 161°40.4E | | | | | | | |
| 3. | Cape Bird | 77°14.0S | 166°28.0E | | | | | | | |
| 4. | Table Mountain | 77°58.2S | 162°02.5E | | 8 Dec | | 9<br>38 | 1<br>2 | 85 | ☐ Yes ☒ No |
| 5. | Platform Spur | | | | | | | | | ☐ Yes ☐ No |
| 6. | Sickle Ridge | | | | | | | | | ☐ Yes ☐ No |
| 7. | | | | | | | | | | ☐ Yes ☐ No |
| 8. | | | | | | | | | | ☐ Yes ☐ No |
| 9. | | | | | | | | | | ☐ Yes ☐ No |
| 10 | | | | | | | | | | ☐ Yes ☐ No |
| 11. | | | | | | | | | | ☐ Yes ☐ No |
| 12. | | | | | | | | | | ☐ Yes ☐ No |
| | | | | | | | | | | |

Notes:

K040
1993/94

# IMMEDIATE SCIENCE REPORT

## K040 : The Sedimentology and Trace Fossils of Devonian Strata at Table Mountain

New Zealand Antarctic Program 1993/1994

Event Personnel: M.C. Wizevich (Leader)
R.S.W. Thornley
K.J. Woolfe

December 1993 - January 1994

IMMEDIATE SCIENTIFIC REPORT TO THE
ROSS DEPENDENCY RESEARCH COMMITTEE

# THE SEDIMENTOLOGY AND TRACE FOSSILS OF DEVONIAN STRATA AT TABLE MOUNTAIN (EVENT K040)

MICHAEL C. WIZEVICH

GEOLOGY DEPARTMENT
VICTORIA UNIVERSITY OF WELLINGTON

15 FEBRUARY, 1994

## Popular Summary of Scientific Work Achieved

The origin of quartzose sandstones in the lower part (Devonian) of the Beacon Supergroup, southern Victoria Land, Antarctica has generated considerable debate. The controversy centres on the presence of varied and abundant trace fossils, frequently used by some geologists as indicators of marine paleoenvironments. However, these same trace fossils have been found by others in nonmarine paleoenvironments. Most previous studies of these sandstones have been conducted on a regional scale and insufficient data has been collected to establish sedimentary processes and depositional environment with confidence.

This study was designed to examine the lowermost Beacon Supergroup in detail. The New Mountain Sandstone at Table Mountain has excellent 3-dimensional exposures, and contains a variety of trace fossils and sedimentary structures. The exposures are ideal for lateral profiling techniques, which take into account lateral as well as vertical facies changes in order to provide a refined depositional model. Improved understanding of the depositional system will contribute not only to resolving the trace fossil problem, but also to southern Victoria Land paleogeographic and tectonic reconstructions.

Detailed examination of the New Mountain Sandstone revealed no evidence of marine deposition. Most of the sandstone was found to be eolian (wind blown), with evidence of water-lain deposition in the upper part. Features which support an eolian environment include climbing translatent strata, pinstripe laminations, adhesion ripples and ripple forms with coarse-grained tops. Thin intervals of trough cross-bedded sandstone represent periodic flooding by braided rivers. Paleowind directions are primarily from the northwest and the rivers flowed towards the northwest. Deposition in the uppermost New Mountain Sandstone was likely in a complex intermixture of eolian and fluvial environments. Features indicative of a water-lain environment include massive sandstones, slumped cross beds, mudcracks, and a change in paleocurrent direction to the northwest.

## Proposed Programme



The origin of the 1000 m thick sequence of mostly quartzose sandstones of the lower Beacon Supergroup (Devonian), southern Victoria Land, Antarctica has generated considerable debate. The controversy centres on the presence of varied and abundant trace fossil assemblages, especially sediments containing *Skolithos,* frequently used by geologists to interpret marine paleoenvironments. However, the trace fossils, in the lower Beacon Supergroup (Taylor Group) are considered by some (Woolfe 1990) to be consistent with nonmarine deposition. Most previous studies have been conducted on a regional scale and insufficient data has been collected to establish sedimentary processes and depositional environment with confidence.

Improved understanding of the depositional system will contribute not only to resolving the trace fossils problem, but also to southern Victoria Land paleogeographic and tectonic reconstructions.

**Objectives:**

1 To reconstruct the depositional environment of the lower Taylor Group
2 To determine the habitats in which the trace fossils were made.
3 Further investigate the enigmatic Pivot Member (Arena Sandstone).

## Scientific Endeavours and Achievements

### Methodology

This study was designed to examine the lower Taylor Group in detail, collecting data from a relatively limited area and stratigraphic interval. Excellent 3-dimensional exposures at Table Mountain are ideal for lateral profiling techniques, which take into account lateral as well as vertical facies changes in order to provide a refined depositional model. Data was collected by measuring (primarily describing facies and recording paleocurrent directions) closely spaced vertical stratigraphic sections and laterally tracing individual bedding units.

### Depositional Environment

Detailed examination of the New Mountain Sandstone and casual observations of the Windy Gully Sandstone, Terra Cotta Siltstone, Altar Mountain Formation and Arena Sandstone revealed no conclusive evidence of deposition in a marine environment as previously suggested by other workers (e.g., Bradshaw, 1981; Gevers and Twomey, 1982). The majority of the 250 m thick New Mountain sandstone was deposited in an eolian environment, with increasing evidence of water-lain deposition in the upper part of the formation. Deposition in the uppermost 50 m of the New Mountain Sandstone, was likely in a complex intermixture of eolian, fluvial and possibly marginal marine environments.

The lower 50 m of the New Mountain Sandstone contains alternating tabular units of small-scale (0.5 m thick by 1-2 m wide) trough cross-bedded sandstones with pebble lags and units of nested low-angle large-scale trough to tangential cross beds (1-2 m thick by several 10's of m wide) with very thin ('flaggy') foresets. The tabular sandstone units, up to 2 m thick, extend laterally from several hundred metres to several kilometers. Paleocurrents recorded from trough cross beds indicate sediment transport towards the southeast. The low-angle cross beds, on the other hand, have paleocurrent directions towards the west. The bottom sets of the trough-tangential cross beds as well as the lower 0.5 m of some foresets commonly contain abundant *Heimdallia* burrows. The remainder of the lower part of the New Mountain Sandstone, contains a complex arrangement of the nested low-angle large-scale trough to tangential cross beds, with rare interludes of the tabular units.

The flaggy foreset beds are overwhelmingly the most common type of cross stratification. The beds consist of well-sorted upper medium- to lower coarse-grained sandstone laminae, generally less than 5 mm thick, with rare cross laminae and preserved ripple forms (with coarse tops and finer bases). Exhumed foreset beds reveal the laminae are oriented at a very low angle across the foreset dip direction. These laminae are climbing translatent strata (Hunter, 1977), the product of wind generated ripples migrating across the slipface of eolian dunes. The flaggy character of the foresets is a result of pin stripe laminations (thin silt-rich laminae), also distinctive of eolian cross beds (Fryberger and Schenk, 1988). Other types of cross beds recognised are grain fall and grain flow laminae. The latter type result from avalanching of non-cohesive sand on dune slipfaces. Grain fall laminae result from settling of suspended particles on the dune slipface.

Both small-scale features and large-scale bedding geometries (*cf.* Trewin, 1993a and 1993b) suggest deposition in a eolian environment with periodic flooding by braided fluvial systems (tabular units of trough cross bedding).

The middle to upper part (except for the upper 50 m) of the New Mountain Sandstone consists of very large-scale (up to 8 m thick) cross beds. The scoop to gently curving geometry of the cross bed sets suggest some curvature to the crest of the bedform that deposited them, but often the sets can be traced laterally (both along and perpendicular to foreset dip) for at least two hundred metres. Internally the cross beds are also composed of flaggy foresets, with grain-flow and grain-fall beds less common. Slumped foresets and breccias of foreset beds are relatively common on the upper parts of the cross beds. Although generally on the order of metres in scale, one slumped cross bed, up to 5 m thick, could be traced laterally for over 1 km. Another cross-bed type is featureless or massive sandstones, up to 0.5 m thick. Lenticular to tabular shaped, these beds are devoid of sedimentary structures but their external geometries (including scour bases) and faint internal grading indicate they are depositional features and not the product of post-depositional alteration. Laterally these features can be traced into bottomset beds and are often interbedded with the features outlined below, but in some areas intervals of mostly massive beds, up to 10 m thick, are found.

Other bottomset beds consist of thin laminated ripple strata, disrupted and wavy thin laminae, adhesion ripples, wave ripples, mudstone beds (less than 20 cm thick) and desiccation cracks. Together with the massive beds these features suggest some deposition in shallow water as well as damp and dry substrates.

Similar interbeds of eolian strata, with common slumping, and massive sandstones have been reported by Gradzinski and Jerzykiewicz (1974) and

Eschner and Kocurek (1986). The latter study describes coastal dune deposits flooded by trangressive seas. However, the New Mountain Sandstone contains no body fossils, and in the upper interval bioturbation is generally rare, except for trackways, which are generally found on (eolian) foreset beds. The formation described by Gradzinski and Jerzykiewicz (1974), interpreted as eolian deposits interbedded with sediments of intermittent rivers and lakes, is more akin to the New Mountain Sandstone beds. Thus it is inferred that the upper New Mountain Sandstone was deposited in a eolian setting with occasional inundation by a river system, resulting in flooding of the interdune areas and slumping of sand off the fronts of the eolian dunes into the ponded water.

The upper 50 m of the New Mountain Sandstone contains primarily low angle coarse beds, 1-2 m thick tangential cross bed sets and subhorizontal bedding. *Skolithos* bioturbation, commonly obliterating most of the sedimentary structures, is widespread in this interval. A regional and dramatic change in paleocurrent direction, back to an orientation similar to the lower tabular (fluvial) units, suggests a continued, but overwhelming, influence by the river system.

## Trace Fossils

Inspection of the lower Taylor Group resulted in several important observations that complement previous work of others, primarily the extensive study of Bradshaw (1981). Previously reported *Skolithos,* vertical to steeply inclined linear cylindrical burrows about 3-5 mm diameter, were discovered to be commonly (20-40%) curved. Strongly curved burrows may deviate from the vertical by as much as 45° for lengths up to 5 cm long. Because of the bending and grouping of burrows a braided pattern is commonly observed. However, whether the burrows are actually branched or whether they appear to branch because of the intersection of two or more burrows, could not be determined. Research into previously described *Skolithos* is currently being undertaken to determine if the curved tubes can be considered a feature of this type of trace fossils, or whether the burrows are of another variety. Furthermore, in several instances *Skolithos* was found in the same bedding units as *Diplichnites,* an occurrence not previously reported.

*Diplichnites* trackways occur throughout the New Mountain Sandstone, primarily on foresets (cross beds), some with up to 30° dip. In several examples the trails are very well preserved, with well-defined imprints (common), pushed piles of sediment at edges of individual prints (common), slide marks of the imprints (abundant), and tail drag (rare) indicating the trackways are primary (non-reworked) features. However, in many trackways, recent weathering of the outcrops has removed much detail. These conclusions differ from Bradshaw (1981), who suggested current reworking of trails. Furthermore, we believe that the preservation and clarity of many trackways is a result of eolian depositional processes (i.e., firm substrates a result of wind hardening) and not binding of subaqueous marine sands by algae (??Bradshaw, 1981; Gevers and Twomey, 1982). The trackways are nearly always preserved on foresets of ripple translatent strata, which apparently consists of very well packed sand. In a few instances, trackways were found on grain-flow cross beds, and the relatively loose-packing of the bed is manifested by the relatively deep imprint and the diffuse edges of the trail. 

A new type of trackway has been discovered which consists of prints previously described by Bradshaw (1981) as 'large isolated prints'. The trails, about 5 cm wide, consist of tear- to horseshoe-shaped prints up to 3 cm wide and 1 cm deep, that are tapered towards the inside of the trackway. Whether this type of trail has been previously described elsewhere is currently being investigated.

Another previously unrecognised trace fossil, 'pit and pile' structures, are common in bottomset beds of the very large-scale foresets in the New Mountain Sandstone. These features consist of a elongate pit (about 2-3 cm deep, 4-5 cm wide and up to 20 cm long) with a small (less than 2 cm tall by about 5 cm diameter) adjoining pile of sediment. Most occurrences were isolated, but on one bedding plane exposure about 20 of the features were found. The form of these clearly biogenic structures suggest they are excavation features. No trackways or other trace fossils appear to be associated with the pit and pile features.

*Heimdallia* burrows usually occur in the interdune areas, and also along reactivation surfaces on the foreset beds (extending upwards to less than 20 cm). The intensity of bioturbation attests to the slow rates of deposition of the New Mountain Sandstone. *Heimdallia* is associated with *Agrichnium*, epichnial grooves (Bradshaw, 1981), 'hairpin' beds (type H trace fossils of Plume, 1976), *Diplichnites*, *cylindricum*, and *Skolithos* (rare). Although frequently homogenised by bioturbation, the interdune deposits in the *Heimdallia*-bearing interval are generally devoid of mudstone beds and thick (>5 cm) massive or featureless sandstones. This may indicate that the organism(s) responsible for creating the *Heimdallia* burrows was not tolerant of subaqueous environments.

**Pivot Member**

The Pivot Member contains fine-grain sedimentary rocks that in places have been extensively altered to Fe-Ti minerals by hydrothermal fluids related to the emplacement of dikes and sills of the Ferrar Dolerite (Woolfe et al., submitted). Preliminary studies (Woolfe et al., submitted) of the mineralisation suggest that the mechanisms in this type of alteration may be relevant to mineralisation styles in economic deposits worldwide. Two important discoveries related to the Fe-Ti alteration were made on the expedition.

Reconnaissance of the Platform Spur area revealed that fine-grained deposits of the Terra Cotta Siltstone appeared to be altered by Fe-Ti mineralisation. Thus, the mineralisation may be more widespread stratigraphically that previously thought. The site was sampled and the rocks will be analysed by Woolfe.

Woolfe et al. (1989) speculated from observations at a distance, that altered Pivot Member sediments may crop out along the southern end of Sickle Ridge. Close inspection by helicopter and from ground observations on the lower part of the fine-grained sediments at Sickle Ridge revealed that they are not extensively altered by the intrusive Ferrar Dolerite. Thus, all occurrences of the Pivot Member are not significantly altered by Fe-Ti mineralisation.

## Contributions by Party Members

Dr. Woolfe, visiting from James Cook University in Townsville, Australia, had the unfortunate experience of having to be evacuated from the field for medical reasons. However, until the time that his condition precluded field work, he performed with great enthusiasm and efficiency. The knowledge, from several seasons of Antarctic fieldwork with NZAP, he was able to pass to the other, less experienced, members of the party was invaluable for the expedition's success.

Mr. Thornley, student at VUW, also performed admirably. Under the difficult circumstances of losing a third of the party, he was able to rise to the occasion and work at a sustained level of enthusiasm and excellence that assured sufficient data could be collected in the field to attain the event objectives.

## Publications

Two or possibly three abstracts will be presented at international meetings (Geological Society of America, 1994; VII International Symposium on Antarctic Earth Sciences, 1995, possibly 2 papers) as well two papers at the New Zealand Geological Society Conference (1994).

Dr. Wizevich will prepare for publication the principle findings on the depositional environments in an international journal of sedimentolgy (Journal of Sedimentary Petrology or Sedimentology) and also the results of the petrographic analyses (Antarctic Science, New Zealand Journal of Geology and Geophysics, or New Zealand Antarctic Record). Mr. Thornley, with assistance from Dr. Woolfe will be responsible for writing a paper on the trace fossils (New Zealand Journal of Geology and Geophysics). Dr. Woolfe intends to publish the results of the analyses of altered sediments, possibly in Economic Geology.

## Acknowledgments

We would like to thank the RDRC for approving the project, Victoria University (Internal Grants Committee) for funding the expedition (MW and ST), and NZAP for overseeing the logistics. Additional funding was provided by James Cook University (KW).

Special thanks to Peter Barrett (VUW) for his support throughout the project, to Alex Pyne (VUW) for his assistance and advice, to Gillian Wratt and Neville Jones (NZAP) for making additional helicopter time available and thus allowing the completion of our final objective, to Grant Avery and Bruce Jakes? for assistance in acquiring samples at Platform Spur, and to all the staff at Scott Base, whose thoroughness and professionalism enabled our expedition to achieve success.

References


BRADSHAW, M.A., 1981, Paleoenvironmental interpretations and systematics of Devonian trace fossils from the Taylor Group (lower Beacon Supergroup), Antarctica: New Zealand Jour. Geol. and Geophys., v. 24, p. 615-652.

ESCHNER, T.B., AND KOCUREK, G., 1985, Marine destruction of eolian sand seas: origin of mass flows: Jour. Sed. Petrology, v. 56, p. 401-411.

FRYBERGER, S.G. AND SCHENK, C.J., 1988, Pin stripe lamination: a distinctive feature of modern and ancient eolian sediments: Sed. Geology, v. 55, p. 1-15.

GEVERS, T.W., AND TWOMEY, A., 1982, Trace fossils and their environment in Devonian (Silurian?) Lower Beacon Strata in the Asgard Range, Victoria Land Antarctica: *in* CRADDOCK, C., ed., Antarctic Geoscience, Madison, Wisconsin, Wisconsin Press, p. 639-647.

GRADZINSKI, R, AND JERZYKIEWICZ, T., 1974, Dinosaur- and mammal-bearing aeolian and associated deposits of the Upper Cretaceous in the Gobi Desert (Mongolia): Sed. Geology, v. 12, p. 249-278.

HUNTER, R.E., 1977, Basic types of stratification in small eolian dunes: Sedimentology, v. 24, p. 361-387.

PLUME, R.W., 1976, Stratigraphy, sedimentology and paleocurrent analysis of the basal part of the Beacon Supergroup (Devonian and older (?) to Triassic), southern Victoria Land, Antarctica: unpublished M.S. thesis, Victoria University of Wellington, New Zealand, p. 205.

TREWIN, N.H., 1993a, Mixed aeolian sandsheet and fluvial deposits in the Tumblagooda Sandstone, Western Australia: *in* North, C.P., and Prosser, D.J., eds., Characterization of Fluvial and Aeolian Reservoirs, Geological Soc. Spec . Publ. No. 73, p. 219-230.

TREWIN, N.H., 1993b, Controls on fluvial deposition in mixed fluvial and aeolian facies within the Tumblagooda Sandstone (Late Silurian) of Western Australia: Sed. Geology, v. 85, p. 387-400.

WOOLFE, K.J., 1990, Trace fossils as paleoenvironmental indicators in the Taylor Group (Devonian) of Antarctica: Palaeogeography, Palaeoclim., Palaeoecol., v. 80, 301-310.

WOOLFE K.J., ARNOT, M.J., AND BRADLEY, G.M., (submitted), The formation of ilmenite-bearing stratiform ironstones at Pivot Peak, Antarctica by low-temperature replacement of phylosilicates: Submitted to Economic Geology.

K042
1993/94

# IMMEDIATE LOGISTICS REPORT

**K042 : Last Retreat of the Antarctic Ice Sheet**

**in the Ross Region**

**New Zealand Antarctic Programme 1993/94**

Event Personnel: A.R. Pyne (Leader)
A. Rennie
L. Singh
R. Leslie
R. Morgan (NZ Army Plant Operator)

November 1993 - December 1993

**Aims**

The principle objective of this seasons programme was to recover sea floor cores from Granite Harbour to date and track the retreat of Holocene ice in this region, specifically the Mackay Glacier since the Glacial Maximum 20,000 years ago. Minor objectives were to recover data from the Cape Roberts tide/Meterological instrumentation and measure seaice thickness offshore to help planning the Cape Roberts Project.

**Planning**

1. The operation of sophisticated oceanographic programmes from the sea ice away from Scott Base such as the vibracorer operation is difficult because large equipment operated through the sea ice is also exposed to surface weather conditions. Significantly greater logistic resources would be required to operate this equipment under cover to avoid the weather on the ice and this is not considered practical at present when all equipment must be transported from and returned to Scott Base each season. We then have a very limited period to operate from the sea ice starting from about 20-25 November when air temperatures have usually warmed up sufficiently and ending 5-7 December when sea ice travel with heavy plant normally must be completed because of the sea ice deterioration at some places along the coastal return route to Scott Base. The ice conditions in the Granite Harbour area however usually remain workable for a least another 7-10 days.

   For future successful sea ice operations such as the vibracorer programme we need to maximise the working period. We could expect up to 25 days (20 Nov. to 15 Dec.) working in the area if NZAP logistic resources allowed prepositioning of some equipment in Granite Harbour and winter storage of plant and some equipment at Cape Roberts at the end of the work period.

   The RDRC review process for 1994-95 university proposals appears to be less rigorous than for PGSF funded proposals. It is important to make both systems as equal as possible specifically in the peer review process. Finding New Zealand reviewers with expert knowledge is very difficult because of our small science community and we should expect as a matter of course to look to the International Antarctic community. A place should be made on the proposal where the proposer lists scientists (with addresses) from both New Zealand and the international community who would be suitable "expert" reviewers.

2. Several minor but irritating problems occurred during the NZAP planning phase of this seasons programme. The visit by Malcolm MacFarlane to VUW in March-April? to discuss the forthcoming programme was very useful. I believe that we discussed the use of the USCG Icebreakers and decided that it was not practical to deploy the vibracorer so our programme did not expect to use it this coming season. Unfortunately this point caused a misunderstanding in the planning later in the year when an icebreaker was requested for us by NZAP. These early season meetings should be encouraged and continue but should be structured so that changes and requirements are recorded for incorporation in planning later in the year, possibly by some sort of initial event summary form.

Two items noted in the NZAP Event Summary circulated in June-July were not acknowledged or incorporated in the finalised event directive. Event request information was not sent directly to A R Pyne the antarctic liaison person and event leader, consequently information requests were mislaid or the responses late. The requested excess baggage allowance of 300 lb was missed off the event directive but did not cause any problems with the movements section.

We expected to cooperate with Dr Ross Powell (USAP S170) while in the field and informed NZAP of the extent of the planned cooperation, as did Dr Powell did the same for NSF. However there was reportedly some confusion in McMurdo prior to the event arriving on 7 November but was not evident during the S170 event briefing.

We had agreement with the facilities services officer to use and slightly modify the OSKAM-1 sledge for the event. The Field Operations Officer and Facilities Services Officer both responded positively to the special needs of this event.

3. The shortening of the Tekapo Training Course is a positive move to a more realistic course. The event briefs are a vital part of the course but are generally rushed so it is important to give several days lead time between event leaders receiving the initial event directive and the training course to give the time to respond to omissions and corrections.

4. The event medicals were sent to NZAP later than usual due to some confusion in the medical system, as a result of the significantly more complex testing requirements. Our doctor commented that NZAP medical requirements are now more complex than the USAP requirements which he was also doing.

The movement of our event personnel and cargo was controlled efficiently as usual, although delays to personnel flights were caused by weather.

## Cargo

Table 1 K042 Cargo to Antarctica

| WEIGHT lb (Kg) | CUBE ft (m) | DESCRIPTION |
|---|---|---|
| 1276 (580) | 112.5 (3.186) | Winch Frame |
| 1800 (820) | 79 (2.24) | Vibracorer Base/Bat. Housings |
| 1082 (492) | 39 (1.1) | Green Box, Science Equip. |
| 1220 (555) | 41 (1.16) | Green Box, Science Equip. |
| 374 (170) | 22 (0.62) | White Box, Science Equip. |
| 1110 (505) | 22 (0.62) | White Box, Batteries |
| 410 (186) | 9.5 (0.27) | Deployment frame strong back |
| 1830 (832) | 58 (1.64) | Vibracorer frame (green box) |
| 820 (373) | 60 (1.7) | Core Tubes (green box) |
| 965 (439) | 24 (0.68) | Deployment Frame Legs |
| 150 (68) | 6 (0.17) | Compressor |
| 1290 (586) | 46 (1.30) | Winch Rope (Pallett) |
| **12372 (5603)** | **519 (14.7)** | **TOTALS** |

In addition approximately 300 lb (136 kg) of delicate equipment went to Antarctica as accompanied baggage.

## Personnel

| | | |
|---|---|---|
| Mr A R Pyne | Event leader | Antarctic Research Centre VUW |
| Mr A Rennie | Mechanical Workshop VUW | |
| Mr L Singh | Geology Department VUW | |
| Mr R Leslie | Student Ass. | Geology Department VUW |
| Mr R Morgan | Plant operator | Scott base- NZ Army |
| Mr J Ridgen | #1 Mechanic | Scott Base (1993-94) |

## Preparations for the Field

1. Scott Base management and personnel were helpful and receptive to the special event needs. This year as in past years the event has had a base plant operator and mechanic as part of the field team. It is sometimes difficult for these people to assist with both the field preparation (cargo train) and their usual or unusual base tasks. Perhaps the timing when these people become temporary event personnel should be formalised to prevent any later misunderstandings.

2. The general field equipment we received this season was in excellent condition and the allocation quick and efficient. A special effort had be made to refit NZ1 and repair its Cantago sledge. Some modifications however are still required to NZ1 - see later field equipment section. The OSKAM-1 sledge was adapted to take our deployment frame and winch as planned earlier in the year with the NZAP Facilities Services Officer.

3. The Antarctic Field Training is a good introduction to the Antarctic environment for personnel new to Antarctica. However extra flexibility for special event needs could still be increased. For this event which is traversing the sea ice up to 150 km from Scott Base for example new personnel could do the local sea ice course primarily as an introduction to sea ice and specifically navigation and the local geography. The second part of the course could be the ice fall work and familiarisation with climbing equipment and general technique. I don't believe that the snow shelter building is relevant to either sea ice or Dry Valley event and could be omitted.

4. Several delays contributed to this event leaving Scott Base 4.5 days later than planned. Two full days were lost due to aircraft delays on the flight to scott base. Approximately half a day was lost due to late season snow clearing at Scott Base when the K042 plant operator and loader were unavailable for cargo train preparation. The last two days delay were caused by assembly of science equipment taking a day longer than expected and the immersion testing of the vibracorer at Scott Base. Cool windy conditions and in excess of 1 m of snow cover on the sea ice at the testing site meant that the tests took a day longer than planned. In retrospect the test at Scott Base in unsuitable conditions was probably not a good practice.

**Field Transport**

1. NZAP Vehicles

Caterpillar D5 LGP. This vehicle had broken a track connector at Scott Base prior to the event personnel arriving. Repair and servicing of this vehicle did not contribute to the event delays. However it is important that vehicles such as the D5 which are laid up during the winter get full checks and operational service to identify problems well before programmed field commitments.

Normal operational servicing was carried out in the field by the Plant Operator. The D5 towed 2 Cantago sledges (cargo 3.5 tonne each), NZ1/Cantago sledge and the OSKAM-1 container sledge (1.5 tonne cargo).

Nodwell RN75. This is an old machine originally purchased in 1962 and has been repowered in 1991 with a Iszu diesel engine intentionally similar to that in the Iszu truck at Scott Base. A HIAB crane with drilling attachment and new flat deck was also fitted. This vehicle was not used for towing loads and the deck loads were kept to a minimum because of the old (and weakened?) chassis.

We had some problems with this vehicle but due to a quick response from Scott Base we were not delayed significantly. The water pump leaked on the 2nd day from base and was replaced with the pump from the stores Iszu truck at Scott Base. Unusual noise was noted in the PTO/gearbox but draining the oil did not show any large metal debris. This is the 2nd season that we have used the HIAB drilling unit and noted again overheating and power loss of the hydraulic system after only drilling 2-3 holes. This problem doubles the time taken to drill 6 holes consecutively. Up to 4 track grousers were broken on the sea ice and replaced with parts temporarily borrowed from McMurdo. The broken grousers were significantly thinner where they broke than the replacements so they had probably been on the track for a long time. A tyre also went flat overnight at Scott Base after returning from the field.

The Nodwell requires some work and parts to maintain it for field work. The gearbox should be checked to determine the origin of the unusual noise apparent this season. Overheating of the hydraulic system during drilling could be eliminated by fitting a oil cooler with 24VDC fan, (about $1,000). Making a large ice hole (1.5 m diameter) by joining up to 6 drilled holes is still time consuming because it is difficult to cut between holes when the ice is up to 2.5 m thick. A solution to this might be a hydraulic powered chainsaw that fits to the HIAB crane in the same way as the drilling head. Spare grousers with replacement bolts and nyloc nuts and at least 1 tyre should be available for field traverses and operations.

Alpine II skidoos. AL1 and AL2 were allocated to this event and were in good condition and the engines generally ran well. Two undercarriage bogeys became detached due to fractures in the retaining brackets while in Granite Harbour. These were fixed by the mechanic with parts from Scott Base. A comparison with the S170 Alpine II showed that this was a common problem corrected by the manufactures of newer machines with a doubled bracket. These brackets and strengthened steering ski fitting should also be fitted to the older model NZAP machines.

Table 2 D5B LGP and Nodwell RN75 Fuel Use.

| Route | Distance km (hrs) | D5B LGP l.JP8 | Nodwell RN75 l.JP8 |
|---|---|---|---|
| Scott Base, via Daily Islands to off Blue Gl. | 45 (8.0) | 200 | 25 |
| To Gneiss Pt. Fuel cache | 58 (10.0) | 250 | 25 (tow 10 km) |
| Fuel cache to C.Roberts | 48 (10.75) | 175 | 25 |
| C.Roberts to off Butter Pt. | 85 (12.25) | 220 | 50 |
| To Scott Base via Daily Is. | 70 (8.0) | 180 | 40 |
| Scott Base to C.Roberts rtn. | **306 (49)** | **1025** | **165** |

NB Fuel usage for Nodwell RN75 is an estimate only because of the uncalibrated fuel tank.

2. Aircraft Operations

Helicopters were used sea ice reconnaissance in conjunction with S170 and for resupply of personnel and equipment parts while in the field. The quick response from Scott Base to our mechanical crisis was a pleasant surprise and much appreciated.

**Event Diary**

NOVEMBER

5 - Flight to Mcmurdo cancelled @ 0600 hrs.

6 - Boomerang, 6.5 hours in C141.

7 - Pyne, Rennie, Singh to Scott Base (5.5 hrs), 2 days behind schedule.

8 - Antarctic Field Training. Rennie and Singh on full 2 day course. Pyne at icefall in the morning. Helo ice recommaissance with Ross Powell (S170) to Granite Harbour in late afternoon. Planties pullout 2 cantago sledges and the OSKAM-1 sledge.

9 - Pyne checked field equipment allocation. Checked that the Hanger door could be raised for assembly of the vibracorer with Dave Lucas (engineering manager). Planties moved equipment near the helo pad for cargo train assembly. Rennie and Singh returned from AFT.

10 - Assembled deployment frame and winch for mounting to OSKAM sledge. Condition 1 in late afternoon. Leslie to Scott base in afternoon, also 2 days behind schedule. Event briefing @ 1515.

11 - Completed mounting to OSKAM-1 in garage cold porch, required drilling holes for foot pad and removing a welded cross guide for the "Ditch Witch". D5 in the garage overnight for servicing.

12 - Started loading vibracorer batteries in the Garage cold porch and moved vibracorer frame to the hanger to assemble feet and struts. Fitted Magellan GPS to Nodwell and recovered equipment from the university container.

13 - Continued assembly of vibracorer in the Hanger. Leslie on AFT course.

14 - Completed vibracorer assembly and charged batteries. Leslie completed AFT course. Began loading cargo train sledges.

15 - Moved vibracorer from the Hanger and continued loading sledges.

16 - ASA personnel with the Reed drill drilled 3 holes south west of Scott Base for testing the Vibracorer and the S170 ROV. One meter of snow cover on the sea ice made the clearing of the hole frustrating and time consuming. S170 tested their ROV.

17 - Deployed vibracorer just below the water surface. Winch required a packer plate fitted under the upper capstan pulley to help stop the rope overlapping when unwinding. Cold day and wind caused freezing of the air compensation regulators. Minor leak on chuck swagelok QC fitting. Deployed to 30m and systems ran OK via computer. On recovery hydraulic reservoir compensator had leaked letting 6-10 mm of water into the bottom of reservoir. Thawed, dried and reassembled the Motor/reservoir in the garage. Lifted vibracorer and winch on Cantago sledge for transport.

18 - Lowered deployment frame for transport and completed sledge packing. K042 (Pyne. Rennie, Singh, Leslie, Morgan and Ridgen) departed Scott Base at 1430. S170 with 2 Nodwell vehicles (T.Rex and Valdez) travelling with K042. Stopped north of the Daily Islands at 2230 to camp for the night; 77°49.334'S, 165°06.987'E. Ice thickness 1.78 m. Broke 2 Nodwell grousers (6 bolt holes, as per T.Rex.)

19 - Requested 3 new grousers (from Mcmurdo). At 1330 water pump on Noddy leaking; 77°35.914'S, 164°22.662'E, Informed Scott Base. Continued with Noddy towed by US Nodwell (Valdez) to 77°30'S, 163°59.6'E where Helo arrived with replacement water pump, Operations manager Neville Jones and #2 mechanic Gus McAllister. D5 and cargo train, and S170 continued to fuel cache offshore of Gneiss Pt. Noddy escorted by skidoo continued after repairs. Camped at fuel cache; 77°24.285'S, 163°50.76'E.

20 - Powell arrived by helo after ROV and electronics was under-slung to Cape Roberts. Left fuel cache at 1100. Arrive north bay at Cape Roberts 2145 hrs and camped on the sea ice. Ice conditions were rougher than "normal" from Gneiss Pt. to C.Roberts.

21 - Downloaded data from Tide Guage/Met installation. Unloaded K053 cargo at C. Roberts with Nodwell. Erected the deployment frame on the sledge for towing and dropped of bridging timbers. Packed up and moved with S170 to mid harbour site at; 76°56.6311'S, 162°48.1164'E.

22 - Drilled 6 holes with Noddy and T.Rex. T.Rex has a hydraulic leak, Noddy has a PTO-gearbox noise and loss of hydraulic power due to overheating after drilling 2-3 600 mm diameter holes. Drilling holes was slower than it should be. K191 surveyor John West arrived by Helo and #1 mechanic Jeremy Ridgen (JR) returned to Scott Base. MacKay Glacier Tongue (MGT) survey started by K191.

23 - S170 deployed the ROV in the hole. MGT survey continued. Requested fittings to replace leaking QC fittings on vibracorer chuck and Alpine II bogey brackets which arrived by helo in late afternoon with #1 mechanic JR. Drained oil in Noddy to check gearbox and fitted parts to the Alpine II skidoos.

24 - Cloudy, 5 knts from the south cooled in the afternoon. S170 departed for the MGT at midday.Set up vibracorer over the hole and lowered below the water surface. Leak in 1st stage air regulator so returned to surface exposing the 2nd stage regulator which froze and let in water to the sight tube on reimmersion. Pulled corer completely out of the hole and dismantled air system for cleaning and drying in the Wannigan. Reassembled air system. K191 and JR left for Scott Base by Helo in mid afternoon. Redeployed vibracorer when winch rope parted a few metres below the surface at about 1550 hrs. Vibracorer free-fell to the sea floor 350 m depth. Communicated with SENZREP about loss of corer and possible recovery. Asked if he could pass on to P. Barrett. To S170 MGT camp by skidoo to ask for help with the ROV to find the Vibracorer. Returned to camp at 2230 hrs.

25 - S170 returned to the vibracorer site at midday. Viewed the vibracorer on a 25°? slope in 356 m on the first deployment of the ROV. Deployed the ROV a 2nd time with the winch line attached and releasing hook from the 2 tonne chain hoist. Couldn't manoeuvre the ROV properly and didn't see the corer. The ROV camera tilt and sonar was not working correctly.

26 - Fixed ROV camera tilt and sonar, added small floats to the winch rope to compensate for the weight in water. ROV still couldn't manoeuvre and couldn't swim down slope to the sonar contact which was probably the corer. The winch rope and ROV umbilical became twisted and this dive and further recovery attempts abandoned.

27 - Blasted a ROV dive hole for S170 at the MGT off Cuff Cape. The ICI Powergell SX explosive was not detonating properly with Red Chord. Dismantled the deployment frame and winch and packed on sledges for transport. Moved camp to the south side of MGT; 76°59.0278'S, 162°25.05222'E to make another hole for S170.

28 - Made a ROV hole by drilling 4 holes with the Noddy and blasted the central ice plug and cleared the hole of platelet ice.
Started the next hole in a crack in front of the MGT.

29 - Completed the 2nd ROV hole, packed camp and returned to Cape Roberts via the vibracorer site to pick up the deployment frame and winch sledges.

30 - Worked on Tide Gauge/ Met. installation, temporarily connected replacement transducer to check CR10 datalogger and AVW1. Used underwater video camera to check if the tide transducer cage was still in place and attempted to free the old transducer with isopropyl alcohol. All K042 travelled to Ice edge offshore of C.Roberts to measure ice thickness.

DECEMBER

1 - Itemised Polar Haven floor panels and bearers cached at C. Roberts for Neville Jones. K042 departed C. Roberts at 1045 hrs. Refuelled at catch of Gneiss Pt. and picked up empty fuel drums. Camped at 2300 hrs offshore Butter Pt. 77°41.2147'S, 164°42.3301'E.

2 - Left camp site at 0910 hrs arriving the Daily Island 59 about 1200 hrs. Arrived Scott Base at 1700 hrs and pulled sledges up the hanger transition.

3 - Returned cleaned field equipment and packed science equipment for RTNZ. Singh to Razorback Island until mid-afternoon. Debrief in late afternoon. Prepared winch and rope in the evening.

4 - Rennie and Leslie RTNZ 0630 hrs. Pyne and Singh pack equipment and Sign cleaned NZ1. Pyne on Helo ice reconn. for S170 return to McMurdo (1200-1700 hrs). Pyne and Jones identify drilling equipment in the ballpark at McMurdo.

5 - Finish cleaning equipment and return to University container. Pyne and Singh RTNZ 2100 hrs.

**Weather**

Poor weather caused some delay in our equipment preparation and testing at Scott Base. The weather conditions were generally good on the traverses to Cape Roberts and return to Scott Base although low light (cloudy) caused poor ground definition for a lot of the trip to C.Roberts. In Granite Harbour air temperatures were generally cooler (< 5°C) and it was cloudier than some previous seasons for this mid November to early December period. The cooler air and weak sunlight makes operating water immersed equipment ,such as the vibracorer, in the open very difficult. From 19 Nov. to 2 Dec. field met readings were made at 0900 hrs and these were logged with the Scott Base technician on our return.

**Incidents**

The loss of the corer is the only incident experienced this season and this is reported fully in annex 1.

Minor physical injuries occurred to Mr Rennie during the AFT course when he incurred cold induced wrist strain while digging a snow mound. Two of Mr Rennies' fingers were also crushed but no bones were fractured when releasing the vibracorer from the chain block during the lifting test at Scott Base. Our procedures were later modified to minimise potential injury during this operation. Incident and ACC reports were completed for both these injuries.

**Field Equipment**

1. The new waterproof gloves are a useful addition to the clothing issue for personnel working with immersed equipment.

2. The retrofitting of NZ1 has improved the usefulness of this wannigan but some refinements still need to be carried out. The LPG oven needs to be raised so that all heights of 9 kg bottles can be retained properly underneath. The ovens cook top needs a fixed framework to stop pots etc from falling of like on a boat. We were unsure if the oven has pizeo ignition, if not a igniting wand should be available. The newly fitted cuphooks are too small for the NZAP cups and mugs. The current microwave appears to be underpowered faulty and should be checked. Tests with generators and the voltage drop of different length cables connected to the microwave should be made as in field situations. Permanent solar panels with diode discharge

protection should be fitted to both sides of the wannigan or on a tilting roof mount because sometimes it is not practical to orientate NZ1 for wind protection and to make the best use of midday sunlight. A permanent 230VAC - 12VDC charger/discharger should be installed for both the permanent radios (VHF and SSB) and handheld radio batteries. We had to connect our event 50 Ahr sealed battery to the radio system this season when the solar panel charging was insufficient.

3. A manual start Yanmar YDG 3000 diesel generator was used this season without breakdown but it is difficult to start. The electric start version of this generator is superior and would be preferred. A Honda EM650 was also used connected to low computer load. This generator was rechecked at Scott Base and performed with a moderate load but continued to stop under light loadings.

ICI Powergel SX explosive was used by Mr Pyne to blast and clear sea ice holes. The powergel was placed in sea water (-1.8°C) and initiated with red cord but often did not detonate completely and certainly did not have the force of AN 60 gelignite used in previous seasons. This was reported during the Scott Base debrief and the Operations Manager was expected to arrange with the McMurdo Master Blaster to test the explosive. The ICI data sheets on powergel SX state that the explosive is reliable to -20°C and can be stored in excess of 12 months but can be desensitised with rough handling. Perhaps prolonged storage at temperatures below -20°C during the winter may also desensitise the product. The use of detonating cords (red cord) is also not the preffered means of initiation but is used with No.8 plain detonators for convience and saftey reasons in Antarctica. In McMurdo ICI Powerfrac is now used instead of Powergell which was found to have low yields in the past. I suggest that Scott Base also adopt this explosive in place of their present stock of Powergell SX.

**Radio Communications**

VHF communications were used almost exclusively by K042 this season. The Crater Hill repeater could be used until we were north of Butter Pt. then the new Erebus was used and gave excellent communications this season. We were surprised that this repeater could still be used when we were not in line of site at our camp on the south side of the MacKay Glacier Tongue. The new permanent VHF set in NZ1 is very helpful but the battery and charging system now needs increasing (see NZ1 comments above).

**Refuge Huts**

The Cape Roberts hut was visited by K042 but not used. It was in good condition but possibly low on the supply of LPG for cooking. Fifteen litres of isopropyl was left at the hut for the tide gauge transducer replacement next season.

**Environmental Impact**

No permanent impacts occurred from the sea ice field activities of this event except potentially from the loss of the vibracorer (see Annex 1). An NZAP Environmental Return is also attached to this report.

# NZAP ENVIRONMENTAL RETURN 1993-94 SEASON

Office use only

Complete all relevant sections and include in both Immediate Science And Logistics Reports

## *Use of chemicals including radionucleides in Antarctica.*

Complete the following for each chemical and Radionucleide taken to Antarctica

| Chemical form | Locations used | Quantity (u Curies where applicable) |
|---|---|---|
| 40% Sulphuric acid in sealed Lead Acid batteries. | Granite Harbour | 12.5 kg |

Were all chemicals returned to New Zealand........................................ ☐ Yes ☒ No

If NO detail why, location, quantities of material released or stored

Batteries are in the Vibracorer currently residing on the sea floor in Granite Harbour.

## *Use of explosives.*

Detail any use of explosives.

| Date | Location (inlc reference) | Explosive type | Size of charge kg | Number exploded |
|---|---|---|---|---|
| 27-11-93 to 29-11-93 | MacKay Gl. Tongue | Powergel SX | 1kg | Total=5 kg |

## *Details of entry to Protected Areas.*

List any protected area, Specially Protected Area (SPA) or Site of Special Scientific Interest (SSSI) or Specially Reserved Area (SRA), you entered.

| Permit No. | Name of SSSI, SPA or SRA | Date Visited | Party size | Total person-days in Area |
|---|---|---|---|---|

## *Other impacts*

Detail any

Loss of the Vibracorer on the sea floor of Granite Harbour (see Annex 1 attached)

Annex 1.

ver. Jan 17 1994

# REPORT

# LOSS OF VUW VIBRACORER IN GRANITE HARBOUR AND OPTIONS FOR ITS RECOVERY

A R Pyne
Antarctic Research Centre

December 1993

**Summary**

A specially designed battery powered vibracorer was developed and built at VUW over a period of 4 years to take cores up to 6 m long from the Antarctic continental shelf in water depths to 1000 m. The cores were to be used for research into the region's climate and glacial history over the last 20,000 years. The vibracorer, which weighed 1.5 tonnes, was designed to be deployed by a small mobile crane through 1.5 m diameter holes in the fast ice fringe around McMurdo Sound as well as from ships (Figure 1). For sea ice deployments a polyester winch line was chosen for lightness and ease of handling, with a breaking load of 6.75 tonnes, giving a safety factor of 4.5.

On 24 November 1993 the vibracorer was lost when the winch rope failed at the spliced eye used to connect winch rope to corer. Lowering into the water had just begun and the vibracorer free-fell 350 m to the sea floor. A remotely operated vehicle (ROV) operated by US colleagues nearby was used to look for the vibracorer, which was found upright on the first dive and with no visible damage. Two subsequent dives with a recovery line attached to the ROV did not find the corer because the ROV could not manoeuvre properly with the line attached and the dives were endangering the ROV. Further recovery attempts were abandoned. The site is located precisely using GPS at 76° 56.631'S and 162° 48.116'E, and a position surveyed independently to within 2 m will be available at a later date.

No reason for failure of the winch rope has been ascertained at this time. It had performed satisfactorily the previous season for 2 deployments in Antarctica and had been tested off Scott Base 7 days prior to 24 November with the full corer load lowered to a depth of 50 m.

The prospect of the corer's recovery from a ship in late January/February when the fast ice is weak or broken out is considered low. The option favoured in terms of least support requirements and most chance of success is to make another recovery attempt from new fast ice in October 1994 with the assistance of the US ROV, which will be working in the area, and a purpose built tool for attaching a cable to the corer.

**Equipment Concept and Design**

Background

The vibracorer was developed to recover a complete and undisturbed sample of the sea floor for glacial and climate history studies. This was difficult for the sea floor around Antarctica because sampling both soft mud in the upper metre or two and compact diamictite beneath, a mixture of mud, sand and stones deposited by the last expansion of the Antarctic ice sheet, can only be satisfactorily achieved with a vibrating tube. Existing vibracorers either were limited to water depths of 200 m (but most Antarctic sea floor is deeper, to 1000 m), or they were too large and heavy to move and operate from the fast ice, where at least part of the science goal could be met and where VUW had considerable operational experience. VUW decided then to build its own corer, which would also have sensors for recording tilt and orientation of the core, important for studying changes in past sedimentation and magnetic field directions.

The corer was successfully checked out in a series of tests in early October 1992, culminating with the recovery of a 3.7 m core from Petone Wharf on the northern margin of Wellington Harbour, and was first deployed in Antarctica a few weeks later. The first two Antarctic deployments were made in 700 m of water in Granite Harbour, outlet for the well-studied Mackay Glacier 150 km northwest of Scott Base. On both occasions the corer tilted on the soft sea floor mud as the core barrel was driven in, the barrel bending as retrieval was attempted. On its return to Wellington the corer was redesigned with larger feet and a lower centre of gravity, and successfully tested in the middle of Wellington Harbour (which is muddier than Granite Harbour). It should be noted that the mechanical and electrical systems in the corer have consistently performed well from the time of the recovery of the first core from Petone Wharf.

Logistic operation and constraints

The first part of the programme, to core from the fast ice at about 10 sites in Granite Harbour, would not only provide near shore scientific data but also a safe and stable platform from which to gain experience with the corer before ship deployment, with the considerable time pressures involved, in subsequent seasons. The party moved equipment and personnel with a D5 bulldozer, 2 five tonne cargo sledges, a sledge mounted accommodation/ laboratory wannigan, a steel sledge and a RN75 Nodwell vehicle with HIAB crane for lifting and drilling ice holes. This mode of operation has been used successfully for some years, and allows about 3 weeks field time after getting to Antarctica, testing equipment at Scott Base, travelling to the site and returning by around December 6, when summer warming cracks the sea ice.

The style of operation constrained the concept and design of the corer, putting a premium on lightness to reduce weight for the cargo sledges and for air cargo to and from Antarctica. Also because the equipment was developmental and had potential uses in back in New Zealand it was not considered feasible to send it to Antarctica the previous season by ship so it had to be air transported at the beginning of the season.

For operation from the fast ice up to 2.5 m thick the vibracorer needed to fit down a reasonably small hole, say 1.5 m in diameter. Also it was designed to operate from batteries to avoid an expensive and heavy power umbilical and large generator (15-20 KVA?) at the surface. It weighed 1.6-1.8 tonne in air and 1.2-1.5 tonne in water, though the exact weight is not known because of modifications to the legs in early 1993.

The winch was designed to have a line pull of 2-2.5 tonne and again be kept as light as possible. It was powered from the Power Take Off of the hydraulic system on the Nodwell tracked vehicle. The line chosen was a polyester 20 mm diameter double braid rope with a breaking load of 7.5 tonne driven by a capstan onto a separately driven take up drum. A thimble eye splice at the end reduced the breaking load to 90% of the rated value, down to 6.75 tonne. With the corer weighing a maximum in water of 1.5 tonne the safety factor is 4.5. Polyester rope is low stretch and has the best resistance to UV, freezing temperatures and abrasion of the commonly used synthetic fibres.

## Operating Procedures and Checks

The following safety procedures and checks are followed during each deployment:

1. Core barrel is moved up and down via computer, and sensor readings checked to ensure all parts of the electrical and mechanical system are responding.

2. Battery housing purge valves are closed and air compensation system is checked.

3. Winch hydraulic connection to Nodwell is checked and winch is operated for several minutes to purge hydraulic system.

4. Vibracorer is lowered into water with a 2 tonne chain hoist and load is transferred to winch rope to check load holding and backup prussic knot brake. Air compensation system is visually checked with underwater camera.

5. Chain hoist is disconnected and lowering of vibracorer begins.

6. Separate twin core flex communication line let out as corer is lowered.

## Loss of Vibracorer in Granite Harbour

Normal checks and operating procedures were followed in this, the first deployment for the season. We arrived on the evening of November 22 and made the access hole in 2.3 m thick fast ice the following day. The vibracorer was assembled and operating systems checked. A small leak in the hydraulic system was stopped. On November 24 the weather was fine but overcast with an air temperature estimated at -5°C in the afternoon. Initially we had a leak in the air compensation system when the corer was first immersed, so it was returned to the surface and the air regulators washed and dried. On the second immersion of the corer the air compensation system functioned correctly, the weight of the corer was transferred to the winch rope and the chain hoist disconnected. Lowering of the corer proceeded until the winch rope eye was 3 or 4 m below the surface, when the rope parted, letting the corer free-fall about 350 m to the sea floor, The time was 1550 hrs.

## Attempted Recovery of Vibracorer

Within 4 hours we were in contact with Dr Ross Powell, Northern Illinois University, USAP event S027, whose group had deployed their ROV (remotely operated vehicle) at the site the previous day (23 November). The next day their ROV was back and searching by late afternoon. The vibracorer was located and recorded on video about 20 m to one side of a point on the sea floor directly below the access hole and was sitting upright on the sea floor which sloped between 15 and 25°. The corer appeared intact with no visible structural damage. The feet were penetrating up to 15 cm into a surficial mud blanket over harder sea floor, indicated by scattered boulders covered with mud and encrusting organisms. The air compensator water trap appeared to be clear of water, though it probably would not stay like this for long because of pressure cycling due to tidal action and because once the air bottle pressure is equal to the water pressure the system is then open to the sea.

These observations suggest that the corer spiralled to the sea floor and landed on its feet without external damage. Internal damage within the four battery housings, air compensated electric motor and vibrator, and data logger instruments could not be determined.

Two further attempts were made to recover the corer with the ROV through the access hole in the fast ice on November 25 and 26. A hook and line were devised for the ROV to carry down and attach to the corer using a hook from the chain hoist and the winch rope. The hook was held by a release mechanism so that if the corer could be caught the ROV could detach itself and return to the surface before the corer was hauled up. The hook and winch line were partly buoyed with 3 kg net floats.

On both recovery dives the ROV reached the sea floor but could not swim and turn properly because the drag of the winch rope was too great for the propulsion unit. The corer was not seen on the first dive, On the second dive the ROV sonar picked up an object behind it and thought to be the corer. However attempts to turn the ROV and swim towards the object caused the ROV umbilical and the winch line to become intertwined, endangering the ROV. At this point attempted recovery was abandoned.

## Requirements for Successful Recovery

We consider the best chance of recovering the corer to come from attaching a line by which it can be hauled vertically to the surface. This could most easily be done by a party on the fast ice with an ROV, winch and crane. Dr Powell's ROV would be suitable for attaching a purpose-built device (yet to be constructed) to the corer. We envisage the device to comprise a hook to grab the corer, a spool of doubled line on a pulley and a means of attaching this all to and releasing from the ROV. There would be no trailing line to the surface, which caused the previous recovery attempts to fail. Once the ROV had located the corer and hooked it, the spool would be released but for the ends of the double line which the ROV would carry back to the surface. Then a stronger line could be drawn down from the surface around the pulley, and finally the (pre-tested) winch rope itself to haul the corer to the surface.

We understand Dr Powell's ROV would be available for this purpose next November for 3 to 4 days, as he has scientific work planned in the area.

We also considered the possibility of recovery by trawling from a ship, but believe this has little chance of success. The boulders scattered on the sea floor would make it difficult or impossible to know whether the trawl had caught the corer or boulders before it was brought to the surface. Boulders in the trawl would most likely add to the damage caused by the trawling process. Also, pinpointing the location of the corer would require a ship with dynamic positioning, not available on ice breakers.

## Likely Condition of the Corer on Retrieval

The ROV has shown that the exterior structure of the corer was intact about 24 hours after impacting the sea floor. We have no idea of the internal damage caused by the impact but expect that the 288 kg of sealed lead acid batteries will be damaged, although they are contained within high tensile steel housings( > 6 mm thick) designed for water depths of 1000 m. The electro-hydraulic motor housings and vibrator are pressure compensated with air which is likely to leak in the short term and allow sea water ingress.

The vibracorer is made primarily of mild and high tensile steel, coated with industrial grade paints, 316 and 304 stainless steel, marine grade aluminium alloy and high tensile aluminium alloys. These metals are in contact with each other and no sacrificial anode protection was installed because planned immersions were for only a few hours duration for each deployment. The sea water in the Ross Sea is well oxygenated at depth and we expect that corrosion will occur at normal or accelerated rates especially where electrolytic action can occur between dissimilar metals.. The presence of any electrical change remaining in the battery packs is likely to enhance corrosion.

We believe that all the electrical components will suffer irrevocable damage in the short term. The main battery packs were probably damaged internally on impact. Instruments in a stainless steel pressure housing with anodised high tensile aluminium (Alumec 79) closures will become damaged in the longer term when the housing is corroded through. Part of the main lifting structure is built of 3 aluminium tubes (100 mm OD, 6 mm wall), which will corrode and weaken the structure with time.

## Potential Environmental Impact of Non-retrieval

Environmental impact of the corer remaining on the sea floor depends on rates of corrosion of the metal components, biological response (encrustation, biocorrosion), and on the release of sulphuric acid and lead to the sea some time in the next few years. The main sealed lead acid batteries contain a total of 12.5 kg of sulphuric acid and approximately 240 kg of lead and lead compounds. Rates for all of these reactions are unknown.

The impact on the corer on organisms and sea floor within a few metres could well be significant, but insignificant on a decameter - kilometre scale. Any localised toxic effects are expected to be short term and dissipate within a few years.

An important argument for retrieval, beyond the obligation to endeavour to keep the Antarctic environment pristine, is to provide information on rates of encrustation and corrosion on metals in Antarctic marine waters, and hence obtain realistic estimates of the environmental impact of the loss of equipment in Antarctic waters.

**Impact of Loss of Vibracorer on Programme**

We must now postpone the ice sheet retreat study approved by RDRC and funded by the University, and withdraw our application for the 1994/95 season. We would nevertheless like to build another corer because the scientific problem of dating the ice sheet retreat remains and is likely to attract increasing scientific interest. We hope this will be possible with funds from the insurance cover. We would also like to build another corer because of the expertise developed over the last three years in such a sea floor sampling system, and the research funds committed to it. We would like to see a tangible product for that time and investment.

We expect drawings, construction and testing to take around two years from the time funding became available. Construction time could also take longer over the next 3-4 years because of our primary commitment to the support of the Cape Roberts Project from 1994 to 1997. Nevertheless we think it realistic to oversee the construction of a new corer in parallel. We therefore do not expect to submit a proposal for pursuing this project until the 1997/98 season.

**Acknowledgements**

The corer was built at the VUW Mechanical Workshop which is funded as a VUW Science Facility. We especially thank Graham Hewitt, Alan Rennie and the other workshop personnel who made significant contributions to the design and construction of the corer.
Eric Broughton VUW Geophysics Institute designed and built the electronic control componentry.

Funding support for the construction of the corer and its Antarctic operations has come from the University Grants Committee in 1990 and subsequently the VUW Internal Grants Committee.

The New Zealand Antarctic Programme and the Ross Dependency Research Committee has supported this programme since 1991.

K042
1993/94

# IMMEDIATE SCIENCE REPORT

**K042 : Last Retreat of the Antarctic Ice Sheet**

**in the Ross Region**

**New Zealand Antarctic Programme 1993/94**


Event Personnel: A.R. Pyne (Leader)
A. Rennie
L. Singh
R. Leslie
R. Morgan (NZ Army Plant Operator)


November 1993 - December 1993

## 1. Popular Summary

The main aim of this programme to recover sea floor cores from Granite Harbour to study the Holocene retreat of the MacKay Glacier has been unfortunately postponed because of the loss of our developmental vibracorer this season. Recovery options for the corer are currently under consideration but if recovery is attempted then this will probably be done from the sea ice in November 1994.

## 2. Proposed Programme

The principle objective of this seasons programme was to recover sea floor cores from Granite Harbour to date and track the retreat of Holocene ice in this region, specifically the Mackay Glacier since the Glacial Maximum 20,000 years ago. Minor objectives were to recover data from the Cape Roberts tide/Meterological instrumentation and measure sea ice thickness offshore to help planning the Cape Roberts Project.

## 3. Scientific Endeavours and Achievements

Vibracorer Programme

The main part of the programme to recover sea floor cores was not achieved due to the loss of the vibracorer in Granite Harbour. Annex 1 to this report describes in detail the loss of the device, including testing in New Zealand and at Scott base and the loss in Granite harbour on its first deployment.

The operation of sophisticated oceanographic programmes from the sea ice away from Scott Base such as the vibracorer operation is difficult because large equipment operated through the sea ice is also exposed to surface weather conditions. Significantly greater logistic resources would be required to operate this equipment under cover to avoid the weather at on the ice and this is not considered practical at present when all equipment must be transported from and returned to Scott Base each season. We then have a very limited period to operate from the sea ice starting from about 20-25 November when air temperatures have usually warmed up sufficiently and ending 5-7 December when sea ice travel with heavy plant normally must be completed because of the sea ice deterioration at some places along the coastal return route to Scott Base. The ice conditions in the Granite Harbour area however usually remain workable for a least another 7-10 days.

For future successful sea ice operations such as the vibracorer programme we need to maximise the working period. We could expect up to 25 days (20 Nov. to 15 Dec.) working in the area if NZAP logistic resources allowed prepositioning of some equipment in Granite Harbour and winter storage of plant and some equipment at Cape Roberts at the end of the work period.

Cape Roberts Tide/Meterological Programme

Data from the Tide/Met. installation at Cape Roberts was downloaded on 21-11-93 and again on 30-11-93. The wind speed sensor, which had seized at low speed, and the wind direction sensors, were replaced with refurbished sensors on 21-11-93.

Review of the downloaded data showed that the tide gauge transducer failed on 26-09-93. The transducer resistance was measured and still appears to be connected but may have failed internally or have somehow become frozen. A visual inspection of the transducer head with a underwater video camera showed that the ice foot-pressure ridge extended deeper than usual near the transducer and that a film of submarine ice covered the rock where the transducer head exited. We attempted to unfreeze the transducer with isopropyl alcohol for inspection on 30-11-94 but this had not worked within 24 hours and the attempt was abandoned this season.

If the transducer has failed because of external icing then it should resume measurements by February when the ice melts around Cape Roberts. New data will then continue to be recorded. If the transducer has failed electronically then it should be replaced. This will require active thawing of the transducer which would take 3-5 days in November 1994. We would also plan to refurbish the CR10 data logger at this time to overcome a minor problem with an excitation channel detected this season.

The failure of the tide gauge transducer in 1993 should not detract from the overall success of this programme which has continuously collected 1041 days of hourly tidal data since 20 November 1990 from continental Antarctica. The design of the installation will permit accurate replacement of the transducer without extensive recalibration and only a 26 hour survey calibration.

Sea Ice Measurements

This season the sea ice in McMurdo was expected to be significantly thinner than in most previous seasons. A major winter storm in early June caused the seaice to breakout nearly to the Mcmurdo Ice Shelf and Hut Point consequently it was expected by some people that the ice would be thin or absent later in the spring/summer. By the time we travelled to Granite Harbour on 18-20 November the seaice along our coastal route was between 1.68 and 2.0 m thick. Offshore of Cape Roberts in the area interest for drillsites ice thickness varied from a normal thickness of 2.3 m within Granite Harbour to 1.15 m thick about 18.3 km ENE offshore of Cape Roberts. At 21 km offshore pack ice had refrozen against a developed ice edge with about 300 mm of ice between floes.

Table 1 Ice thickness Granite Harbour and offshore Cape Roberts.

| Position (GPS) Lat. Long. | Distance and direction from Cape Roberts | Sea ice, (snow) thickness | Date measured |
|---|---|---|---|
| 76°56.6311S 162°48.1164E | 14 km @ 320°T | 2.3 m | 22-11-93 |
| 76°59.1104S 163°13.5294E | 6 km @ 017°T | 1.7 m (70 mm) | 30-11-93 |
| 76°58.7336S 163°26.7000E | 9.3 km @ 047°T | 1.5 m (70-100 mm) | 30-11-93 |
| 76°58.4220S 163°38.3397E | 13.8 km @ 060°T | 1.4 m (100 mm) | 30-11-93 |
| 76°57.9076S 163°50.2555E | 18.3 km @ 065°T | 1.15m (100 mm) | 30-11-93 |
| Ice edge 76°57.7074S 163°56.0544 | 21 km @ 066°T | <300 mm | 30-11-93 |

The sea ice surface was generally smooth within Granite Harbour and offshore north of the thickness measurement positions in Table 1. Immediately to the south however the ice was rough from winter breakout and refreezing and was likely to be thicker. The ice thickness was certainly a bit thinner than usual in areas affected by the early June breakout but of normal thickness in Granite Harbour. If this season had been a drilling season then it would have unlikely that heavy transport could have traversed to Cape Roberts until early October. One or 2 of the planned inshore drillsites could probably have been occupied this season especially along the Rice Seismic line PD90-10. The planned study of winter sea ice formation from satellite imagery is expected to confirm this.

**Acknowledgements**

We were grateful to all the Scott Base personnel who helped us with a difficult season and especially mention Rick Morgan and Jeremy Ridgen who worked with us in the field and Neville Jones (operations manager) whose rapid response with unscheduled help operations kept us operational.

NZAP staff once again provided efficient pre season field/technical and cargo/personnel assistance including acting on our suggestions of improvements from previous seasons.

Several people have helped with the development of the vibracorer and they are acknowledged in the vibracorer report attached.

Annex 1

ver. Jan 17 1994

# REPORT

## LOSS OF VUW VIBRACORER IN GRANITE HARBOUR AND OPTIONS FOR ITS RECOVERY

A R Pyne
Antarctic Research Centre

December 1993

**Summary**

A specially designed battery powered vibracorer was developed and built at VUW over a period of 4 years to take cores up to 6 m long from the Antarctic continental shelf in water depths to 1000 m. The cores were to be used for research into the region's climate and glacial history over the last 20,000 years. The vibracorer, which weighed 1.5 tonnes, was designed to be deployed by a small mobile crane through 1.5 m diameter holes in the fast ice fringe around McMurdo Sound as well as from ships (Figure 1). For sea ice deployments a polyester winch line was chosen for lightness and ease of handling, with a breaking load of 6.75 tonnes, giving a safety factor of 4.5.

On 24 November 1993 the vibracorer was lost when the winch rope failed at the spliced eye used to connect winch rope to corer. Lowering into the water had just begun and the vibracorer free-fell 350 m to the sea floor. A remotely operated vehicle (ROV) operated by US colleagues nearby was used to look for the vibracorer, which was found upright on the first dive and with no visible damage. Two subsequent dives with a recovery line attached to the ROV did not find the corer because the ROV could not manoeuvre properly with the line attached and the dives were endangering the ROV. Further recovery attempts were abandoned. The site is located precisely using GPS at 76° 56.631'S and 162° 48.116'E, and a position surveyed independently to within 2 m will be available at a later date.

No reason for failure of the winch rope has been ascertained at this time. It had performed satisfactorily the previous season for 2 deployments in Antarctica and had been tested off Scott Base 7 days prior to 24 November with the full corer load lowered to a depth of 50 m.

The prospect of the corer's recovery from a ship in late January/February when the fast ice is weak or broken out is considered low. The option favoured in terms of least support requirements and most chance of success is to make another recovery attempt from new fast ice in October 1994 with the assistance of the US ROV, which will be working in the area, and a purpose built tool for attaching a cable to the corer.

## Equipment Concept and Design

### Background

The vibracorer was developed to recover a complete and undisturbed sample of the sea floor for glacial and climate history studies. This was difficult for the sea floor around Antarctica because sampling both soft mud in the upper metre or two and compact diamictite beneath, a mixture of mud, sand and stones deposited by the last expansion of the Antarctic ice sheet, can only be satisfactorily achieved with a vibrating tube. Existing vibracorers either were limited to water depths of 200 m (but most Antarctic sea floor is deeper, to 1000 m), or they were too large and heavy to move and operate from the fast ice, where at least part of the science goal could be met and where VUW had considerable operational experience. VUW decided then to build its own corer, which would also have sensors for recording tilt and orientation of the core, important for studying changes in past sedimentation and magnetic field directions.

The corer was successfully checked out in a series of tests in early October 1992, culminating with the recovery of a 3.7 m core from Petone Wharf on the northern margin of Wellington Harbour, and was first deployed in Antarctica a few weeks later. The first two Antarctic deployments were made in 700 m of water in Granite Harbour, outlet for the well-studied Mackay Glacier 150 km northwest of Scott Base. On both occasions the corer tilted on the soft sea floor mud as the core barrel was driven in, the barrel bending as retrieval was attempted. On its return to Wellington the corer was redesigned with larger feet and a lower centre of gravity, and successfully tested in the middle of Wellington Harbour (which is muddier than Granite Harbour). It should be noted that the mechanical and electrical systems in the corer have consistently performed well from the time of the recovery of the first core from Petone Wharf.

### Logistic operation and constraints

The first part of the programme, to core from the fast ice at about 10 sites in Granite Harbour, would not only provide near shore scientific data but also a safe and stable platform from which to gain experience with the corer before ship deployment, with the considerable time pressures involved, in subsequent seasons. The party moved equipment and personnel with a D5 bulldozer, 2 five tonne cargo sledges, a sledge mounted accommodation/ laboratory wannigan, a steel sledge and a RN75 Nodwell vehicle with HIAB crane for lifting and drilling ice holes. This mode of operation has been used successfully for some years, and allows about 3 weeks field time after getting to Antarctica, testing equipment at Scott Base, travelling to the site and returning by around December 6, when summer warming cracks the sea ice.

The style of operation constrained the concept and design of the corer, putting a premium on lightness to reduce weight for the cargo sledges and for air cargo to and from Antarctica. Also because the equipment was developmental and had potential uses in back in New Zealand it was not considered feasible to send it to Antarctica the previous season by ship so it had to be air transported at the beginning of the season.

For operation from the fast ice up to 2.5 m thick the vibracorer needed to fit down a reasonably small hole, say 1.5 m in diameter. Also it was designed to operate from batteries to avoid an expensive and heavy power umbilical and large generator (15-20 KVA?) at the surface. It weighed 1.6-1.8 tonne in air and 1.2-1.5 tonne in water, though the exact weight is not known because of modifications to the legs in early 1993.

The winch was designed to have a line pull of 2-2.5 tonne and again be kept as light as possible. It was powered from the Power Take Off of the hydraulic system on the Nodwell tracked vehicle. The line chosen was a polyester 20 mm diameter double braid rope with a breaking load of 7.5 tonne driven by a capstan onto a separately driven take up drum. A thimble eye splice at the end reduced the breaking load to 90% of the rated value, down to 6.75 tonne. With the corer weighing a maximum in water of 1.5 tonne the safety factor is 4.5. Polyester rope is low stretch and has the best resistance to UV, freezing temperatures and abrasion of the commonly used synthetic fibres.

## Operating Procedures and Checks

The following safety procedures and checks are followed during each deployment:

1. Core barrel is moved up and down via computer, and sensor readings checked to ensure all parts of the electrical and mechanical system are responding.

2. Battery housing purge valves are closed and air compensation system is checked.

3. Winch hydraulic connection to Nodwell is checked and winch is operated for several minutes to purge hydraulic system.

4. Vibracorer is lowered into water with a 2 tonne chain hoist and load is transferred to winch rope to check load holding and backup prussic knot brake. Air compensation system is visually checked with underwater camera.

5. Chain hoist is disconnected and lowering of vibracorer begins.

6. Separate twin core flex communication line let out as corer is lowered.

## Loss of Vibracorer in Granite Harbour

Normal checks and operating procedures were followed in this, the first deployment for the season. We arrived on the evening of November 22 and made the access hole in 2.3 m thick fast ice the following day. The vibracorer was assembled and operating systems checked. A small leak in the hydraulic system was stopped. On November 24 the weather was fine but overcast with an air temperature estimated at -5°C in the afternoon. Initially we had a leak in the air compensation system when the corer was first immersed, so it was returned to the surface and the air regulators washed and dried. On the second immersion of the corer the air compensation system functioned correctly, the weight of the corer was transferred to the winch rope and the chain hoist disconnected. Lowering of the corer proceeded until the winch rope eye was 3 or 4 m below the surface, when the rope parted, letting the corer free-fall about 350 m to the sea floor, The time was 1550 hrs.

**Attempted Recovery of Vibracorer**

Within 4 hours we were in contact with Dr Ross Powell, Northern Illinois University, USAP event S027, whose group had deployed their ROV (remotely operated vehicle) at the site the previous day (23 November). The next day their ROV was back and searching by late afternoon. The vibracorer was located and recorded on video about 20 m to one side of a point on the sea floor directly below the access hole and was sitting upright on the sea floor which sloped between 15 and 25°. The corer appeared intact with no visible structural damage. The feet were penetrating up to 15 cm into a surficial mud blanket over harder sea floor, indicated by scattered boulders covered with mud and encrusting organisms. The air compensator water trap appeared to be clear of water, though it probably would not stay like this for long because of pressure cycling due to tidal action and because once the air bottle pressure is equal to the water pressure the system is then open to the sea.

These observations suggest that the corer spiralled to the sea floor and landed on its feet without external damage. Internal damage within the four battery housings, air compensated electric motor and vibrator, and data logger instruments could not be determined.

Two further attempts were made to recover the corer with the ROV through the access hole in the fast ice on November 25 and 26. A hook and line were devised for the ROV to carry down and attach to the corer using a hook from the chain hoist and the winch rope. The hook was held by a release mechanism so that if the corer could be caught the ROV could detach itself and return to the surface before the corer was hauled up. The hook and winch line were partly buoyed with 3 kg net floats.

On both recovery dives the ROV reached the sea floor but could not swim and turn properly because the drag of the winch rope was too great for the propulsion unit. The corer was not seen on the first dive, On the second dive the ROV sonar picked up an object behind it and thought to be the corer. However attempts to turn the ROV and swim towards the object caused the ROV umbilical and the winch line to become intertwined, endangering the ROV. At this point attempted recovery was abandoned.

**Requirements for Successful Recovery**

We consider the best chance of recovering the corer to come from attaching a line by which it can be hauled vertically to the surface. This could most easily be done by a party on the fast ice with an ROV, winch and crane. Dr Powell's ROV would be suitable for attaching a purpose-built device (yet to be constructed) to the corer. We envisage the device to comprise a hook to grab the corer, a spool of doubled line on a pulley and a means of attaching this all to and releasing from the ROV. There would be no trailing line to the surface, which caused the previous recovery attempts to fail. Once the ROV had located the corer and hooked it, the spool would be released but for the ends of the double line which the ROV would carry back to the surface. Then a stronger line could be drawn down from the surface around the pulley, and finally the (pre-tested) winch rope itself to haul the corer to the surface.

We understand Dr Powell's ROV would be available for this purpose next November for 3 to 4 days, as he has scientific work planned in the area.

We also considered the possibility of recovery by trawling from a ship, but believe this has little chance of success. The boulders scattered on the sea floor would make it difficult or impossible to know whether the trawl had caught the corer or boulders before it was brought to the surface. Boulders in the trawl would most likely add to the damage caused by the trawling process. Also, pinpointing the location of the corer would require a ship with dynamic positioning, not available on ice breakers.

## Likely Condition of the Corer on Retrieval

The ROV has shown that the exterior structure of the corer was intact about 24 hours after impacting the sea floor. We have no idea of the internal damage caused by the impact but expect that the 288 kg of sealed lead acid batteries will be damaged, although they are contained within high tensile steel housings(>6 mm thick) designed for water depths of 1000 m. The electro-hydraulic motor housings and vibrator are pressure compensated with air which is likely to leak in the short term and allow sea water ingress.

The vibracorer is made primarily of mild and high tensile steel, coated with industrial grade paints, 316 and 304 stainless steel, marine grade aluminium alloy and high tensile aluminium alloys. These metals are in contact with each other and no sacrificial anode protection was installed because planned immersions were for only a few hours duration for each deployment. The sea water in the Ross Sea is well oxygenated at depth and we expect that corrosion will occur at normal or accelerated rates especially where electrolytic action can occur between dissimilar metals.. The presence of any electrical change remaining in the battery packs is likely to enhance corrosion.

We believe that all the electrical components will suffer irrevocable damage in the short term. The main battery packs were probably damaged internally on impact. Instruments in a stainless steel pressure housing with anodised high tensile aluminium (Alumec 79) closures will become damaged in the longer term when the housing is corroded through. Part of the main lifting structure is built of 3 aluminium tubes (100 mm OD, 6 mm wall), which will corrode and weaken the structure with time.

## Potential Environmental Impact of Non-retrieval

Environmental impact of the corer remaining on the sea floor depends on rates of corrosion of the metal components, biological response (encrustation, biocorrosion), and on the release of sulphuric acid and lead to the sea some time in the next few years. The main sealed lead acid batteries contain a total of 12.5 kg of sulphuric acid and approximately 240 kg of lead and lead compounds. Rates for all of these reactions are unknown.

The impact on the corer on organisms and sea floor within a few metres could well be significant, but insignificant on a decameter - kilometre scale. Any localised toxic effects are expected to be short term and dissipate within a few years.

An important argument for retrieval, beyond the obligation to endeavour to keep the Antarctic environment pristine, is to provide information on rates of encrustation and corrosion on metals in Antarctic marine waters, and hence obtain realistic estimates of the environmental impact of the loss of equipment in Antarctic waters.

**Impact of Loss of Vibracorer on Programme**

We must now postpone the ice sheet retreat study approved by RDRC and funded by the University, and withdraw our application for the 1994/95 season. We would nevertheless like to build another corer because the scientific problem of dating the ice sheet retreat remains and is likely to attract increasing scientific interest. We hope this will be possible with funds from the insurance cover. We would also like to build another corer because of the expertise developed over the last three years in such a sea floor sampling system, and the research funds committed to it. We would like to see a tangible product for that time and investment.

We expect drawings, construction and testing to take around two years from the time funding became available. Construction time could also take longer over the next 3-4 years because of our primary commitment to the support of the Cape Roberts Project from 1994 to 1997. Nevertheless we think it realistic to oversee the construction of a new corer in parallel. We therefore do not expect to submit a proposal for pursuing this project until the 1997/98 season.

**Acknowledgements**

The corer was built at the VUW Mechanical Workshop which is funded as a VUW Science Facility. We especially thank Graham Hewitt, Alan Rennie and the other workshop personnel who made significant contributions to the design and construction of the corer.
Eric Broughton VUW Geophysics Institute designed and built the electronic control componentry.

Funding support for the construction of the corer and its Antarctic operations has come from the University Grants Committee in 1990 and subsequently the VUW Internal Grants Committee.

The New Zealand Antarctic Programme and the Ross Dependency Research Committee has supported this programme since 1991.