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Coring for Antarctic Tectonic and Climatic History

Cape Roberts Project

SCIENCE PLAN

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Coring for Antarctic
Tectonic and Climatic History

Cape Roberts Project

SCIENCE PLAN

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(for the International Steering Committee)

VICTORIA
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WELLINGTON
*Te Whare Wananga
o te Upoko o te Ika a Maui*

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FOREWORD

This Science Plan is intended mainly as a guide for the activities of the science community of the Cape Roberts Project, as distinct from the Operations Plan, which is for the management of field operations in Antarctica. The Plan has been prepared by the Project Science Coordinator and most of it reviewed by the International Steering Committee. Thus it is reasonably representative of the collective view of the project leadership.

A project such as this is extremely complex, with its combination of national scientific, logistics, management and financial cultures and the challenges of the operating environment. The success of the project will depend largely on the understanding and cooperative spirit that we will all need to take with us to the ice. This plan is designed to help with the understanding.

The first sections bring together information on the goals of the project (Section 1), its origins and structure (Section 2) and the data concerning and rationale behind the selection of drill sites (Section 3). The central part of the Plan (Sections 4-6) outlines the scientific work to be carried out on the ice. Most of this section is a brief overview to bring together in one place a description of wide range of scientific activity in the project. The core processing procedure is set out in some detail, because it is the basis for most of the investigations to be carried out. Core management and sample distribution (Section 7) is especially important for scientists both now and in the future because it outlines procedures for requesting and approving samples for scientific study. After the drilling a range of analyses will be carried out to complete the core characterisation begun by the on-ice studies (Section 8). The nature and extent of these will plainly depend on the nature of the core recovered, and this will not become fully evident until the end of November, 1997. Still it seems useful to give some idea of the type of investigations that should be worthwhile. Section 9 is a guide to information about the project, and also provides a scheme for the publication of the initial results as a special issue of *Terra Antartica* (9.5).

Now for a cautionary word. Antarctic field work has always carried risks due to weather and mechanical failure and this project is no exception. Last season the project was postponed because southerly storms and swell from the Ross Sea broke up the fast ice fringe we needed for siting the drilling rig. As a consequence the fast ice was not thick enough for safe and full drilling season. However we have used last year's delay to good effect both scientifically and in improving the camp and drilling system.

This year the sea ice in McMurdo Sound developed well through April and May, but broke out in June and has been reforming since early July. Thus we are facing some uncertainty. The ISC has decided that we will make every effort to recover core this season, so we will proceed with the winter fly-in, and the subsequent ice reconnaissance on the ground in late August as soon as conditions allow. We are planning on deploying the science team as planned, but suggest that you also prepare yourselves for some delays. Keep in mind that we have a group with a lot of sea ice experience, committed to getting under way with the drilling as soon as it is safe to do so. Also let us remember that the sequence off Cape Roberts is unique and must be properly cored for any further development of early glacial and tectonic history of the region. *- P J Barrett, August 1 1997*

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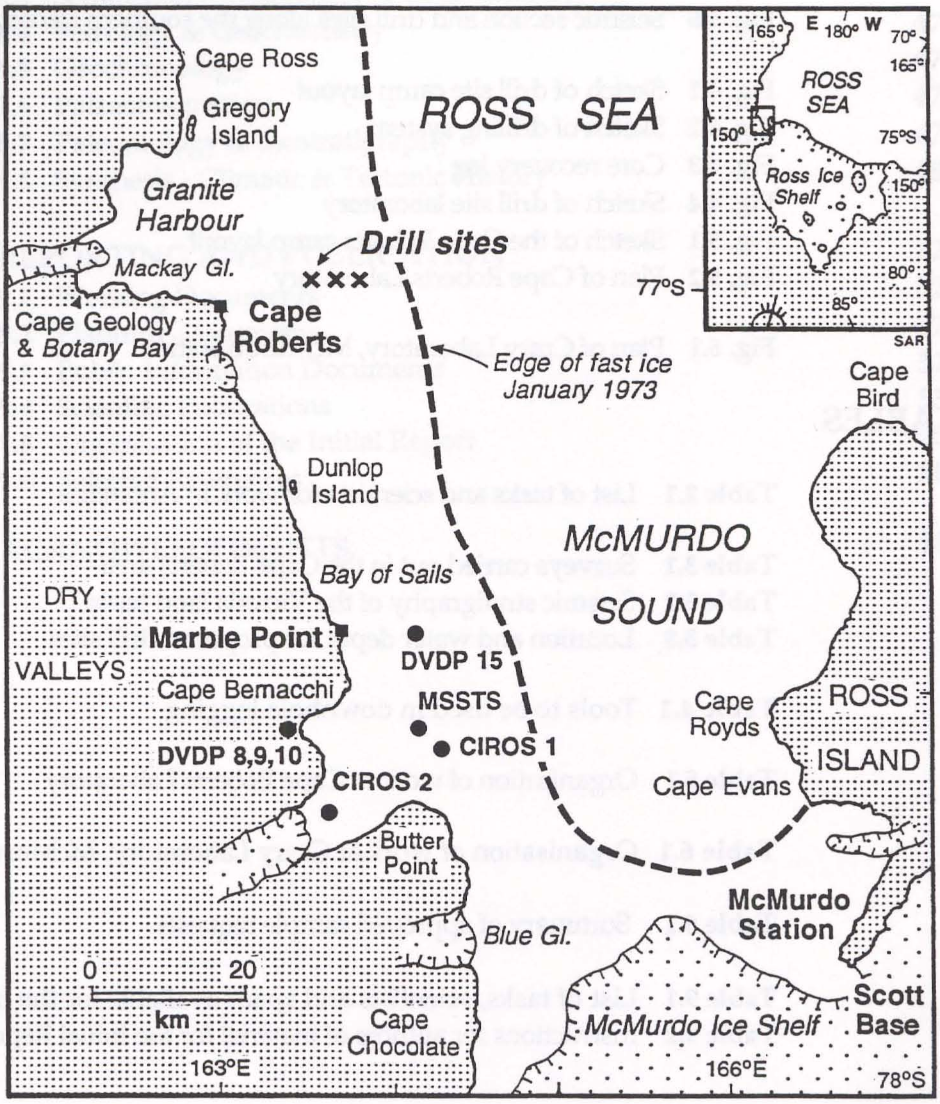

Fig. 1.1 Map of the southwest corner of the Ross Sea, showing the locations of Cape Roberts, the drill sites offshore, the Marble Point helicopter staging point and McMurdo Station/Scott Base, the main staging point for the project. Previous drilling locations and the normal edge of the fast ice are also shown.

SECTION 1
PROJECT OUTLINE

1.1 Cape Roberts Project

The Cape Roberts Project is a cooperative drilling project between the Antarctic programmes of Australia, Germany, Italy, New Zealand, UK and USA. The aim is to obtain continuous core through around 1300 m of strata from 30 Ma in age back to as much as 100 Ma in age beneath the western side of McMurdo Sound, Antarctica, in order to study the tectonic and climatic history of the region. Cape Roberts is located in the southwest corner of the Ross Sea, 125 km northwest of McMurdo Station and Scott Base, the main staging point for the project (Figure 1.1)

1.2 Science Plan & Related Documents

The purpose of the Science Plan is to provide an overview of the scientific work to be carried out and how it is to be managed. It also includes information on scientific practise by participating scientists and science groups, and plans for publication of the main reports of the project - the Initial and Research reports from each drilling season. A review of the geology of the region off Cape Roberts by Barrett, Henrys et al. (1995) is available with this plan as a separate document.

Other key documents for the project are

- a report published by the Royal Society of NZ (Misc Series no 23) on the 1992 workshop to plan the Cape Roberts Project. This outlines the scientific rationale, the drilling programme, logistic requirements and a plan for Comprehensive Environmental Evaluation (CEE).
- the Record of Understanding between Parties Contributors, and the subsequent addendum. This document was drafted at a meeting near Washington DC in September 1993. It established the project by setting up terms of reference and the two main bodies, the International Steering Committee (ISC) and the Operations/Logistics Management Group (OMG).
- the Operations Plan. This was drafted by the operators for the project (then NZ Antarctic Programme, now Antarctica NZ) in April 1996 and is the authoritative source for all practical aspects of the Antarctic phase of the project.
- the Drilling Manual. This documents drilling equipment and practise for the project.
- the Comprehensive Environmental Evaluation. This document has been circulated and approved by the Antarctic Treaty System, and is the project's guide to sound environmental practice.

A newsletter, Cape Roberts News, reports progress of the project (issues published in July 1994, March 1995, March 1996 and October 1996). In addition both the US and Italian scientists have produced reports on the work proposed by scientists in their respective countries (Webb and Wilson, 1995, Cape Roberts Project: Antarctic Stratigraphic Drilling; Cita, 1995, Cape Roberts Drilling Project, Italian Research Group).

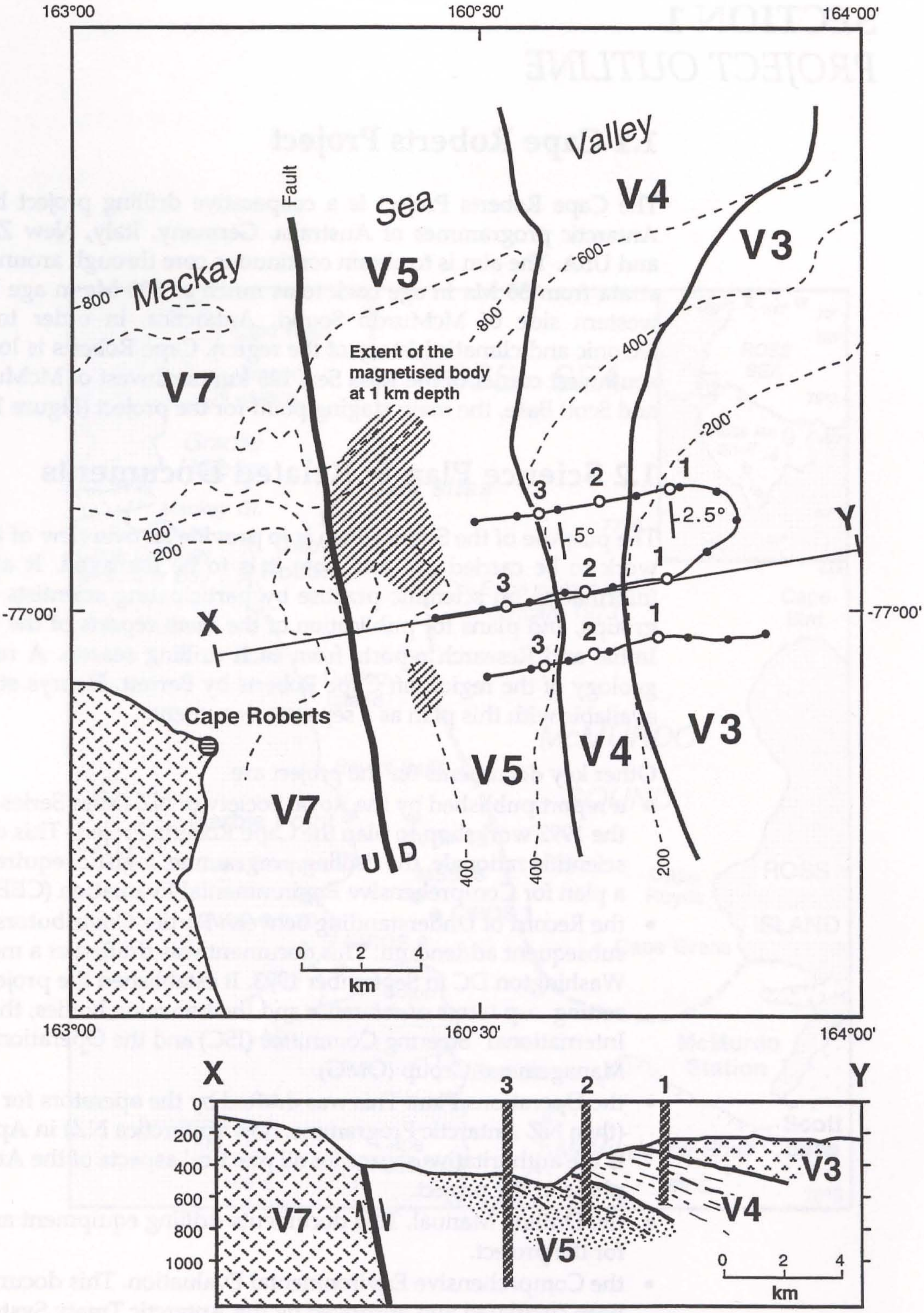

Fig. 1.2 Map and cross-section of the sea floor to the east of Cape Roberts, showing the current interpretation of the submarine geology and how the proposed drill sites will provide continuous core through 1300 m of strata. See section 3 for further information and discussion on drilling strategy.

1.3 Scientific Goals

The project is designed to address two major questions:

- Did ice sheets grow and decay on Antarctica, with attendant changes in global sea level, prior to the earliest Oligocene 34 Ma ago, when it is widely believed the first extensive ice formed on the continent?

- At what time did the continent begin to rift to form the Ross Sea and the Transantarctic Mountains?

Seismic surveys relating past drill cores to the strata off Cape Roberts indicate 3 sequences dipping east (V3, V4 and V5 - figure 1.2) and containing over 2000 m of strata more than 30 million years old. The project aims to core around 1200 m of this sequence by drilling at least three holes ranging in depth from 400 to 700 m and overlapping so as to ensure a continuously cored record.

The strata off Cape Roberts were selected for coring because they met three conditions

- they cover the right period of time

- they are close to the likely centre of glaciation - East Antarctica - over the last 100 Ma because the continent's polar position during this period

- they are in a location where shallow drilling from fast ice is logistically feasible.

1.4 Plan for Core Recovery & Study

Scientific work during the drilling phase of the project will take place at 3 sites - the Drill Site Laboratory, the Cape Roberts Camp Laboratory, and the Crary Laboratory at McMurdo Station (see Figure 1.1). This is because the core must be measured, split, described and packaged soon after drilling and because comprehensive description calls for study by more people than can be accommodated at a drilling camp or support base.

While the deployment of a large number of scientists to the ice adds to the logistic complexity of the project, it was considered important by ISC to have all significant scientific fields represented on the ice during the drilling phase so that initial characterisation and evaluation of the core could be both comprehensive and consistent. This aspect of the operation is comparable with a cruise of the Ocean Drilling Program in terms of numbers of scientists and the need for a scientific consensus when the drilling has been completed.

Initial work at the Drill Site Laboratory involves recovery, labelling, splitting and boxing into sampling and archive halves, as well as measurements of physical properties and fracture patterns. In addition, down-hole logging tools for rock density, velocity, temperature and other properties will be run in each hole part way through and at the end of drilling.

The core is moved every shift change (12 hours) from the drill site to the Cape Roberts Camp Laboratory for detailed core description and preliminary microscope study by a team of 5 sedimentologists.

The core is then moved bi-weekly to the Crary Laboratory at McMurdo Station, where it will be subject to comprehensive paleontological, petrological and palaeomagnetic observations. More on the procedures can be found in later sections.

During the preparation phase the main vehicle for information has been the occasional appearance of the Cape Roberts News. During the drilling phase the project chief scientist will report weekly to the International Steering Committee and the Operations/Logistics Management Group (see Section 2). Results from each drilling season will be published as an *Initial Report* finalised within a month of the end of drilling, and from laboratory work on samples a *Research Report* finalised 9 months later. Both reports will be special issues of *Terra Antartica*.

The *Initial Report* is designed to provide an authoritative record of the data gathered from the core and drill hole during the drilling phase. This will include core photographs, core properties, downhole logs, lithologic logs, lithostratigraphy, biostratigraphy, petrology and a number of other observations. This will be the collective product of the 50-strong science team on the ice.

Additional analyses will be needed to complete the characterisation of the core recovered in each drilling season. These include geochemical and geochronologic data, as well as further paleontologic, paleomagnetic, petrologic and sedimentologic data. These studies are to be published as the *Research Report* 9 months after the *Initial Report*. In some cases they will be extensions of work of on-ice scientists but in others the work of specialists chosen for the task for their particular expertise and experience. These contributions will be individually authored.

SECTION 2
PROJECT STRUCTURE & TIMETABLE

2.1 Foundation

The foundation for the project was laid at a meeting of programme managers and scientists in Washington DC in September 1993. At this meeting a Record of Understanding was negotiated and the following points agreed:

- that efforts to develop the project should continue
- that resources for the project should be provided in approximately the following proportions:

Britain	5-10%
Germany	10%
Italy/NZ/USA	20-30% each

  [Note: Since this time Australia has joined the project and proportions are now Australia 5%, UK 5%, Germany 10%, with the remainder shared equally between Italy, NZ and USA]

- that scientific participation from each country would be roughly in proportion to resources supplied
- that the NZ Antarctic Programme (now Antarctica New Zealand or ANZ) would be the Operator and manage the project
- that an Operations/Logistics Management Group, convened by NZ, run the field operation
- that there be an International Steering Committee with responsibility for oversight of the project, and the facilitation of its scientific programme.

2.2 International Steering Committee (ISC)

The guiding body for the project is the ISC, which is comprised of a science representative from each participating country (listed below). ISC members also act as National Coordinators for scientific work on the project in their countries. How they do this will vary from one country to another because of varying styles of management.

Members of the International Steering Committee are:

Dr Fred Davey (New Zealand)
Professor Maria Bianca Cita (Italy)
Dr Franz Tessensohn (Germany)
Dr Mike Thomson (UK)
Professor Peter Webb (USA)
Dr Ken Woolfe (Australia)

2.3 Operations/Logistics Management Group (OMG)

The OMG comprises the National Antarctic Operators from all six countries in the Cape Roberts group, and is convened by Gillian Wratt (NZ). The group is responsible for operational planning for the core recovery phase of the project. OMG has delegated details of logistic, operational and drilling planning to the Project Manager (see below).

2.4 Project Staff

Several people have been employed by Antarctica NZ especially for the project. These include Project Manager, Mr Jim Cowie, who is responsible for organising and shipping equipment and maintaining financial control of the project budget. During the drilling phases Mr Cowie will manage the project from Cape Roberts. Antarctica NZ also has employed a drilling consultant, Johnny Hampton, for advice on planning the drilling system, and Drilling Manager, Pat Cooper, for running the drilling team in Antarctica. Antarctica NZ will also employ the drilling staff.

Project staff also include Project Science Coordinator Peter Barrett, Professor of Geology at Victoria University of Wellington. He is responsible to the International Steering Committee for the development of the scientific aspects of the project. This includes preparation of this plan and leadership of the science team on the ice as Chief Scientist during the drilling phases. The project also has a Science Support Manager, Alex Pyne, Expedition Manager at Victoria University of Wellington, who is responsible to the Chief Scientist for environmental monitoring and core processing. He is also the liaison between the drilling team and scientists needing access to the drillhole or core for specialist measurements.

During the drilling phase of the project decisions on science operation and drilling strategy are the responsibility of the Chief Scientist and decisions on overall operations, including logistics, safety and environmental control are the responsibility of the Project Manager. Responsibility for science operations at the Crary Laboratory is delegated by the Chief Scientist to the Crary Lab Science Leader and for the Cape Roberts Project (Professor Peter Webb).

2.5 Science Work & Personnel Organisation

The main task of the drilling phase of the project is the characterisation of the core and the strata from which it has been recovered. This is being carried out through a wide range of techniques and personnel organised by location and task as indicated below.

Table 2.1 (next page) Tasks and science personnel working on the project in 1997. Those responsible for oversight in the various tasks and sections are marked with an asterisk (*).

PROJECT SCIENCE MANAGEMENT	P J Barrett (NZ)	
REGIONAL SURVEYS	(preceding drilling)	
Seismic & magnetic surveys	*F J Davey (NZ)	G Brancolini (Italy)
		S Henrys (NZ)
DRILL SITE		
Core processing/packaging Sea ice monitoring	*A R Pyne (NZ) B Morris (NZ)	N Jackson (NZ) Sonya Bryce (Australia)
Core fracture study	*T Wilson (USA)	T Paulsen (USA)
Core physical properties	*F Niessen (Germany)	C Kopsch (Germany)
Downhole logging	*R Jarrard (USA)	Jasumback/Scholz (USA)
	T Wonik (Germany)	F Hoelscher (Germany)
	S Bannister working from NZ	P Montone-working from Italy
CAPE ROBERTS LAB		
Stratigraphy (4 m/pg logs)	*K Woolfe (Australia) (Hole 1) R Powell	*R Powell (USA) (Hole 2) K Woolfe
Stratigraphy (1 m/pg logs) Smear slides	*L Krissek(Hole 1)(USA) M Claps (Hole 1) (Italy) W Ehrmann(Hole 1) (Germ'y)	*M Hambrey (Hole 2) (NZ) L De Santis (Hole 2) (Italy) M Lavelle (Hole 2) (UK)
CRARY LABORATORY		
PAL & BIOSTRAT	*S Wise (USA)	
Diatoms	*D Harwood (USA)	S Bohaty (USA)
Foraminifera	*P Webb (USA)	S Passchier (USA)
	P Strong (NZ)	
Macrofossils	*M Taviani (Italy)	
Nannofossils	*S Wise (USA)	G Villa (Italy)
Palynology	*M Hannah (NZ)	*I Raine (NZ)
	J Wrenn (USA)	J Simes (NZ)
		E Levac (USA)
PETROLOGY	*J Smellie (UK)	P Armienti (It)
	F Talarico (Italy)	M Tabecki (UK)
PALEOMAGNETISM	A Roberts (USA)	L Sagnotti (Italy)
	*K Verosub (USA)	F Florindo (Italy)
	G Wilson (USA)	
SEDIMENTOLOGY		
100 m/page logs & interp	*M Hambrey (Hole 1) (NZ)	*L Krissek (Hole 2) (USA)
Clay mineralogy	W Erhmann (Germany)	
Clast shape and fabric	C Atkins (NZ)	
Cyclostratigraphy	M Claps (Italy)	
Lamination in marine seds	J Howe (UK)	
Lamination in glacial seds	R Powell (USA)	
Organic geochemistry	R Kettler (USA)	
X-radiography	L De Santis (Hole 1)	J Howe (Hole 2)
Synthesis	*C Fielding (Australia)	Hambrey/Krissek
CORE MANAGEMENT	*M Curren (USA)	J Howe (UK)
REPORT PREP	Sonia Sandroni (Italy)	
	Sherry Kooyman (USA)	

2.6 Project Chronology

The main events in the life of the project are listed below.

1993 *September*
ROU negotiated in Washington DC

1994 *August*
ISC/OMG meetings at SCAR in Rome. Sufficent funding secured for first year's drilling.

1995 *January*
First camp and drilling equipment shipped to C Roberts on ITALICA
September
ISC meets in Siena. Australia joins. Funding secured for 2 years drilling.
October-November
Cargo moved to C Roberts. Camp commissioned on sea ice - all systems worked well.

1996 *January*
Remainder of camp and drilling equipment shipped to C Roberts on ITALICA.
May
ISC meeting and Southern Ocean Paleontology Workshop in Wellington
August
ISC/OMG meeting in Cambridge agrees ice break-out requires year's delay
November
Measurements confirm ice too thin. Camp & rig set up/tested off C Roberts.

1997 *May*
ISC meeting in Hannover
August
WINFLY party travels to Cape Roberts to set up camp & rig for drilling.
October 1-10
Personnel fly to McMurdo-Scott Base & set up for core studies.
October 1 - November 25
First drilling season. Copy deadline for Initial Report December 10.
Samples distributed for home lab studies.

1998 *February*
ISC meets in Washington DC to review results of season & plan for next.
June/July
Workshop in Cambridge UK to discuss results for Research Report
August
WINFLY party travels to Cape Roberts to set up camp and rig for drilling.
October 1 - November 25
Second drilling season.

1999 *January*
Removal of C Roberts camp begins. Area review for compliance with CEE
July
ISC meeting/workshop to review results, and plan follow-up research.
VIII International Symposium on Antarctic Earth Science, Wellington.
Session on results from project.

SECTION 3
SITE SURVEYS & DRILL SITE SELECTION

3.1 Geophysical Surveys

Since the geometry of the sequence off Cape Roberts was first revealed in 1980 by D J Bennett (unpublished manuscript) from data collected on the USCGC Glacier a number of surveys have been carried out to improve regional and local knowledge of the area and the offshore sequence (Table 3.1). Most have been to gather seismic data to improve knowledge of the geometry of the sequence, to date the strata by correlation with the CIROS-1 drill hole and to trace the major units throughout the Victoria Land Basin (Brancolini et al., 1995; Barrett et al., 1995); Bartek et al., 1996. The stratigraphy and ages from these efforts are summarized in Table 3.2, and the distribution of major seismostratigraphic units in Figures 3.1 and 3.2.

A significant survey additional to the seimic studies was the aeromagnetic survey carried out by GITARA in 1994 (Bozo et al., in press). This was in response to the report of a substantial magnetic anomaly just west of the planned drill sites and which could indicate the presence of a submarine volcano (Behrendt et al., 1987). The study greatly improved the definition of the magnetic bodies and suggests they are more likely to be fragments of stratiform basic igneous bodies. In any event they were well clear (more than a kilometre vertically and horizontally) of the westernmost drill hole (Figure 3.1).

Two other studies have been important from an operational standpoint. Theodolite surveys of sea ice movement in the 1980's showed modest rates of fast ice movement - around 5 m per month and well within the safe operational limits for drilling. More recently bathymetric surveys, first by the POLAR STAR with a 3.5 kHz sounder and then more recently by the NATHANIEL B. PALMER with a Multibeam swathe bathymetry sounder enabled detailed bathymetric mapping of the area in which drilling is planned.

3.2 Sea Ice Surveys

Surveys of sea ice movement and thickness were carried out by Alex Pyne as part of the CIROS project in the 1980's (Pyne, 1986). Measurements of ice movement indicated progressive ice movement of around 4-8 m per month for October and November, well within the limits of the rig for water depths of 150 m and more. Measurements of ice thickness are more variable, with thickness on good years reaching between 2.0 and 2.5 m in McMurdo Sound and in bad years on just reaching the safe drilling thickness of 1.5 m by mid October.

The Operations Plan for the project called for monitoring ice growth with satellite imagery received at McMurdo Station, and it was this monitoring that alerted project management to the break-out of early July 1996, which ultimately brought on a year's delay. A survey in early November, 1996 (Sea ice report to ISC by A R Pyne) showed that the sea had eventually stabilised and thickened, but had not reached a safe thickness for drilling by early October.

The sea ice monitoring system for 1997 is based on AVHRR images (1.1+ km resolution) received daily in New Zealand from McMurdo Station, and higher quality DMSP images (0.55 km resolution) to be received every two weeks. The sea ice initially formed well, with a good fast ice fringe, in response to colder temperatures in April and May, but southerly gales in June have moved the ice out of the Sound, resulting in a situation similar to that of last year. Nevertheless there is still time for the ice to freeze and grow provided the gales dissipate soon.

Work has started on an historical review of AVHRR/DMSP imagery over the last 10 years, which involves the time-consuming process of selecting one clear image per week from the thousands in storage at the Arctic and Antarctic Data Centre, San Diego. The results of 3 or 4 seasons will be available by August to help in the analysis of data arriving over the next few months. This work is overseen by the Science Support Manager, and will help operational decisions required of the Project Manager.

Table 3.1 Surveys carried out providing knowledge of the area and strata off Cape Roberts.

TASK & YEAR	ORGANISATION	DESCRIPTION
1. Seismic survey 1984	US Geol Survey	50 km of multichannel seismic track off Cape Roberts using S.P. LEE
2. Sea ice surveys 1983, 1984, 1985	VUW NZ Antarctic Prog	Resection survey of sites seaward of Cape Roberts during Oct & Nov to determine rate of horizontal movt.
3. Seismic survey 1990	OGS, Trieste	150 km of multichannel seismic track in the area off Cape Roberts using OGS EXPLORA
4. Seismic survey	Univ Alabama US Antarctic Prog	200 km of high-resolution seismic 1990 data gathered from R/V POLAR DUKE and used to correlate strata from CIROS-1 to Cape Roberts area
5. Bathymetric survey 1993	VUW US Antarctic Prog	200 km of 3.5kHz bathymetry covering the area for drilling with a 2 km grid were collected from the USCGC POLAR SEA
6. Seismic survey	UAL/VUW US Antarctic Prog	200 km of high resolution seismic 1995 data from R/V N.B. PALMER but all immediately to east of drilling area due to ice conditions
7. Magnetic survey 1995	GITARA ENEA	2000 km of aeromagnetic data collected by helicopter over an area of 800 square km off Cape Roberts.
8. Seismic survey 1996	UAL/UCSB US Antarctic Prog	400 km of swathe bathymetry, high resolution single channel and some multichannel data collected from N.B. PALMER off Cape Roberts for accurate sitting of drill holes.

3.3 Cape Roberts Bathymetry and Geology

The bathymetric data for the sea-floor east of Cape Roberts is largely based on Multi-beam data was collected over most of the area of the map by the R/V NATHANIEL B. PALMER in February 1996, with a few areas filled in with USCGC POLAR STAR 3.5 kHz data from 1993.

Tracks for the SP LEE (1984), the EXPLORA (1990) and the POLAR DUKE (1990) and the PALMER (1996) from which seismic data for identifying and mapping the sub-sea floor sequences were taken (Barrett, Henrys et al. 1995, S.A. Henrys, personal communication) are shown in figure 3.1 as dotted lines. Sufficient seismic profiles have now been collected to trace boundaries of the major seismic units over the whole area to the east of Cape Roberts. The strata are found to strike consistently just west of north and to dip gently east with dips rising from 2.5° for the upper part of the section to 5° for the lower part.

The sedimentary section off Cape Roberts is bounded on its western margin by a major steeply dipping, north-trending fault about 5 km offshore, upthrown to the west and bringing basement rocks to the sea floor (V7 of Cooper and Davey, 1987). These rocks are most likely to be granitoid bodies similar to the exposed rocks around Granite Harbour.

The large positive magnetic anomaly immediately east of the fault, and first recognised by Behrendt et al. (1987), has been confirmed by the German-Italian Aeromagnetic Research in Antarctica (GITARA) survey. The survey has defined the shape and extent of a stratiform basic intrusive body, which approaches the surface well to the west of the closest drill site. The model is considered to be fairly well constrained on account of the low altitude (125 m) and close spacing (500 m) of the survey lines.

V5, the oldest sedimentary seismic unit in the area (Table 3.2) , is of unknown age and lithology. It rises from deep in the Victoria Land basin to reach the sea floor from 12 to 5 km east of Cape Roberts, where it is truncated by a north-trending fault. V5 is estimated to reach a thickness on seismic sections of between 2 and 5 km. Likely age lies between between 105 and 55 Ma; lithologies could include either or both shallow marine or terrestrial facies (see Barrett, Henrys et al., 1995, for discussion and comparisons with possible New Zealand counterparts).

Table 3.2 Seismic stratigraphy of the Victoria Land basin [after Cooper et al., 1987]. Modified to take into account seismic correlation of the Cape Roberts sequence with CIROS-1, and the revision of the age of the lower part of the hole [Hannah et al., 1997].

Unit	Thickness (km)	Velocity (km/sec)	Age	Lithology
V1	<1.2	1.7-2.3	mid Pliocene to Recent	Glacial marine sediments
V2	0.2-1.3	2.1-2.9	mid Miocene to Pliocene	Glacial marine sediments
V3	0.3-2.5	2.7-4.1	late Oligocene to early Miocene	Glacial marine sediments
V4	<1	4.0-4.9	early Oligocene and older	Marine sediments?
V5	<8	4.5-5.6	Cretaceous to early Paleogene	Marine sediments?
V6	<8		Paleogene-Recent	Basaltic volcanics
V7		5.0-7.4	Precambrian-mid Paleozoic	Basement

V4 is presumed from correlative strata at CIROS-1 to be largely marine mudstone of Eocene-early Oligocene age, and underlies the west flank of the ridge 20 km off Cape Roberts, curving eastward into the Mackay Sea Valley. The curve is solely in response to valley bathymetry, for structure contours on the base of V4 indicate the surface to be a plane dipping gently just north of east. Isopachs constructed for V4 (Figure 3.1) show it also to thicken eastward seaward quitely rapidly at around 100 m/km. Thickness varies little from south to north.

V3 is the youngest of the exposed strata of the Victoria Land basin in the mapped area. The sequence underlies Roberts Ridge and the area to the east with a maximum thickness of a little over 200 m attained for V3 just east of the ridge crest. It is inferred to comprise alternating diamictite, shallow marine mudstone and sandstone of late Oligocene to early Miocene age, like similar strata in the CIROS-1 drill hole, and records many advances of east Antarctic ice beyond the mountains and into the basin.

V3 and V4 can been further sub-divided on single channel profiles, with at least 6 sequences recognised in V3 in some places. However track line coverage is not sufficient to resolve them across the whole area and they have not been delineated on the maps. Facies inferred for each unit (Table 3.2) are based on correlation with the CIROS-1 drill hole 70 km to the south.

Compilations of bathymetric and seismic data from off Cape Roberts are shown on two maps using a Lambert Conformal projection at a scale of a little less than 1:200,000 (Figures 3.1 and 3.2). Figure 3.1 shows the bathymetry, track lines from which the geological boundaries have been inferred, and isopachs for sequence V4. Figure 3.2 shows the same information as a base but is mainly intended to show structure contours on the base of V3 and the base of V4.

3.4 Drilling Constraints & Site Selection

The drilling plan allows for drilling to a depth of 500 m below the sea floor. We have decided to be conservative and plan for drilling to 400 m sub-bottom for each of the first two holes. If time and material are available for the extra preparation of the hole, drilling can proceed safely to a depth of 700 m sub-bottom, and this is proposed for a third hole. This preparation includes cementing of casing over an interval of 100 m for controlling any excess fluid pressure encountered down the hole. The sea ice time window of around 50 days in a normal season allows for the drilling of two shallow holes or one deep hole.

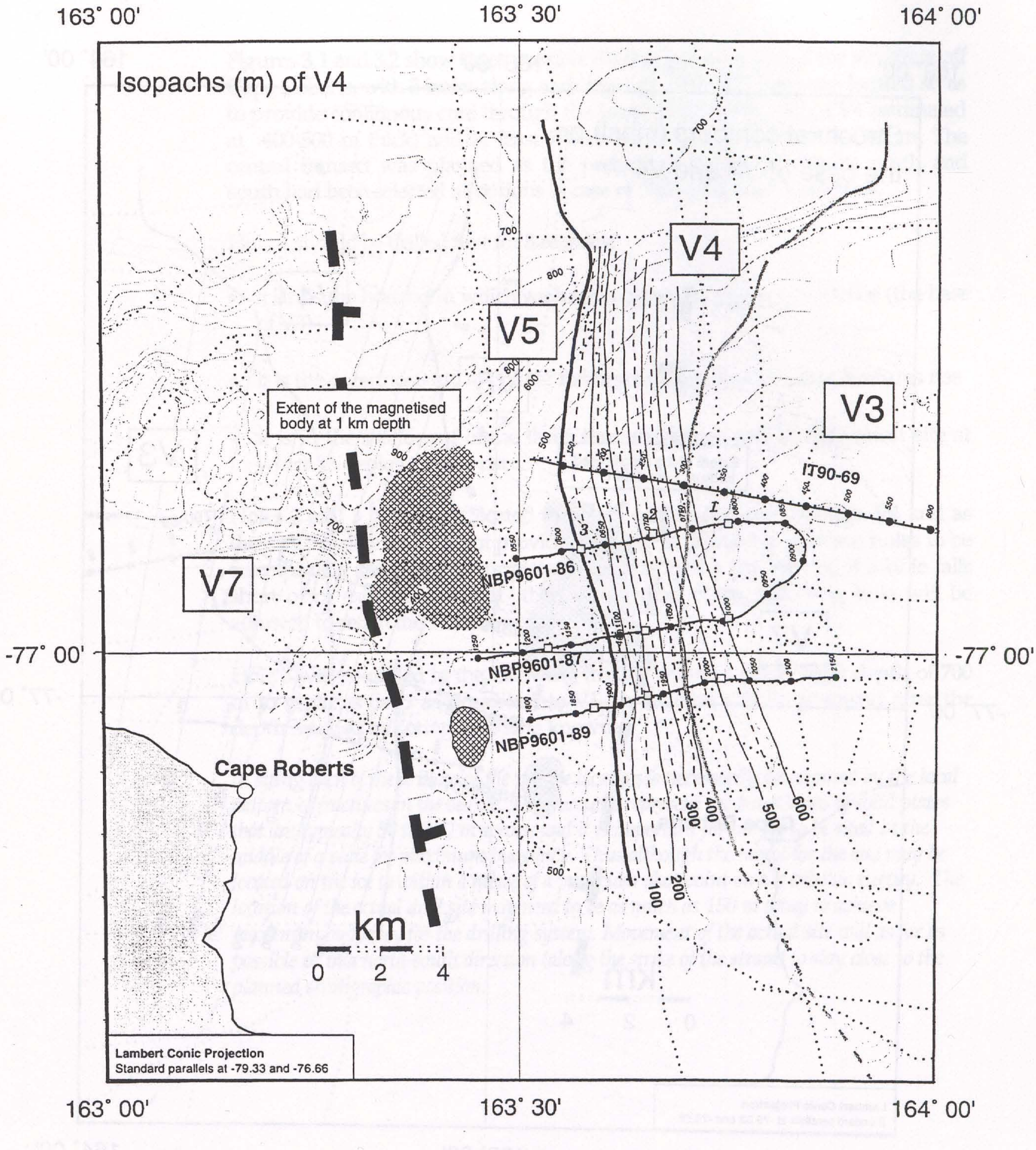

Fig. 3.1 Map showing bathymetry off Cape Roberts (25 m isobaths), the distribution of the sedimentary seismic sequences in the area (V3, V4, V5) and isopachs for V4 in metres. The heavy dashed line is the main boundary fault that separates the sedimentary sequence from basement granitic rocks (V7), which crop out at the coast. The extent of a shallow stratiform basic igneous body, inferred from magnetic data, is also shown. The track lines from which the seismic data were used for mapping the extent of the sequences are shown as dotted. The three lines on which the proposed drill sites are located have been labelled NBP 9601, and seismic images from each are shown and interpreted in Figures 3.3 to 3.5.

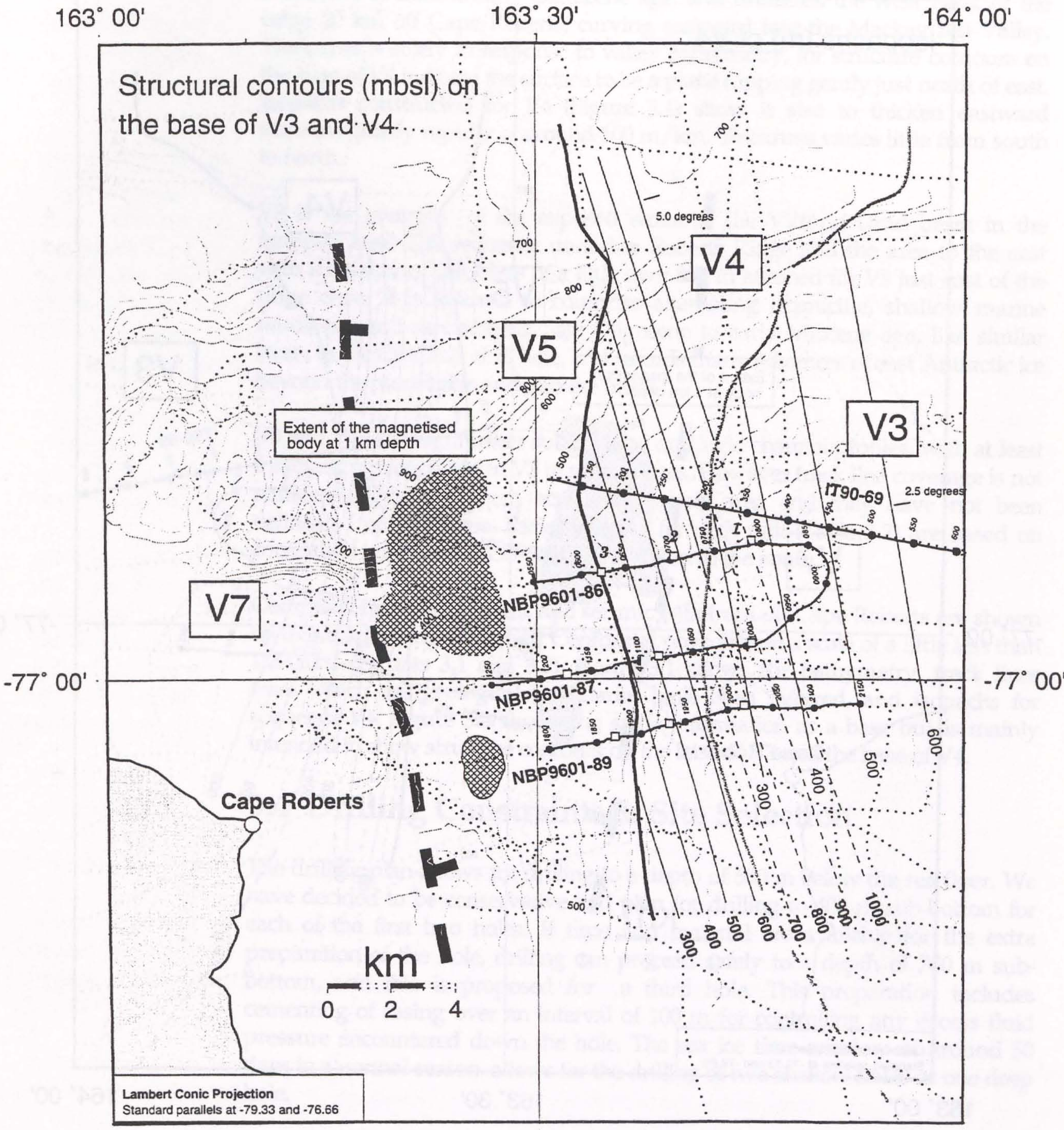

Fig. 3.2 Map like figure 3.1, showing bathymetry off Cape Roberts (25 m isobaths) and the distribution of the sedimentary seismic sequences in the area (V3, V4, V5) but instead of isopach structure contours on the base of V3 and V4.

Figures 3.1 and 3.2 show three possible drilling transects across the structure off Cape Roberts, with 3 holes along each transect. The drill holes are located so as to provide continuous core through the lower 100 m of V3, all of V4 (estimated at 400-500 m thick) and at least 700 m into V5, a total of 1200-1300 m. The central transect was planned as the preferred location - transects north and south had been selected as options in case of difficult sea ice conditions.

Hole 1 should be drilled first for 3 reasons:

- it drills the horizon in which we have most stratigraphic confidence (the base of V3)
- it is the outermost and at greater risk from ice break-out as temperatures rise
- it is in the shallowest of the three sites and hence will be the easiest site at which to deploy the sea riser.

Holes 2 and 3 have been located to obtain continuous core through V4 and as deep as possible into V5, but providing for 100 m of overlap between holes to be sure that the strata can be correlated within at least a few metres. If a hole falls short of or exceeds its target then the location of the following hole will be adjusted to retain the 100 m overlap.

Hole 3 will be drilled in the following drilling season with a target depth of 700 m to reach as deep as possible into V5. Its location will be reviewed after the depth reached by coring in 1997 is known.

In siting each of the drill holes,the precise location is necessarily determined by the local pattern of fractures in the sea ice. The fractures represent the boundaries of solid plates that are typically 50 to 300 m across, and it is important for the rig to be sited in the middle of a plate for maximum buoyancy. Thus although the target for the site may be located on the ice to within a metre of a particular shot point on the seismic survey. The location of the actual drill site may need to be as much as 150 m away to achieve maximum buoyancy for the drilling system. Movement of the actual site will as far as possible be in a north-south direction (along the strike of the strata) to stay close to the planned stratigraphic position.

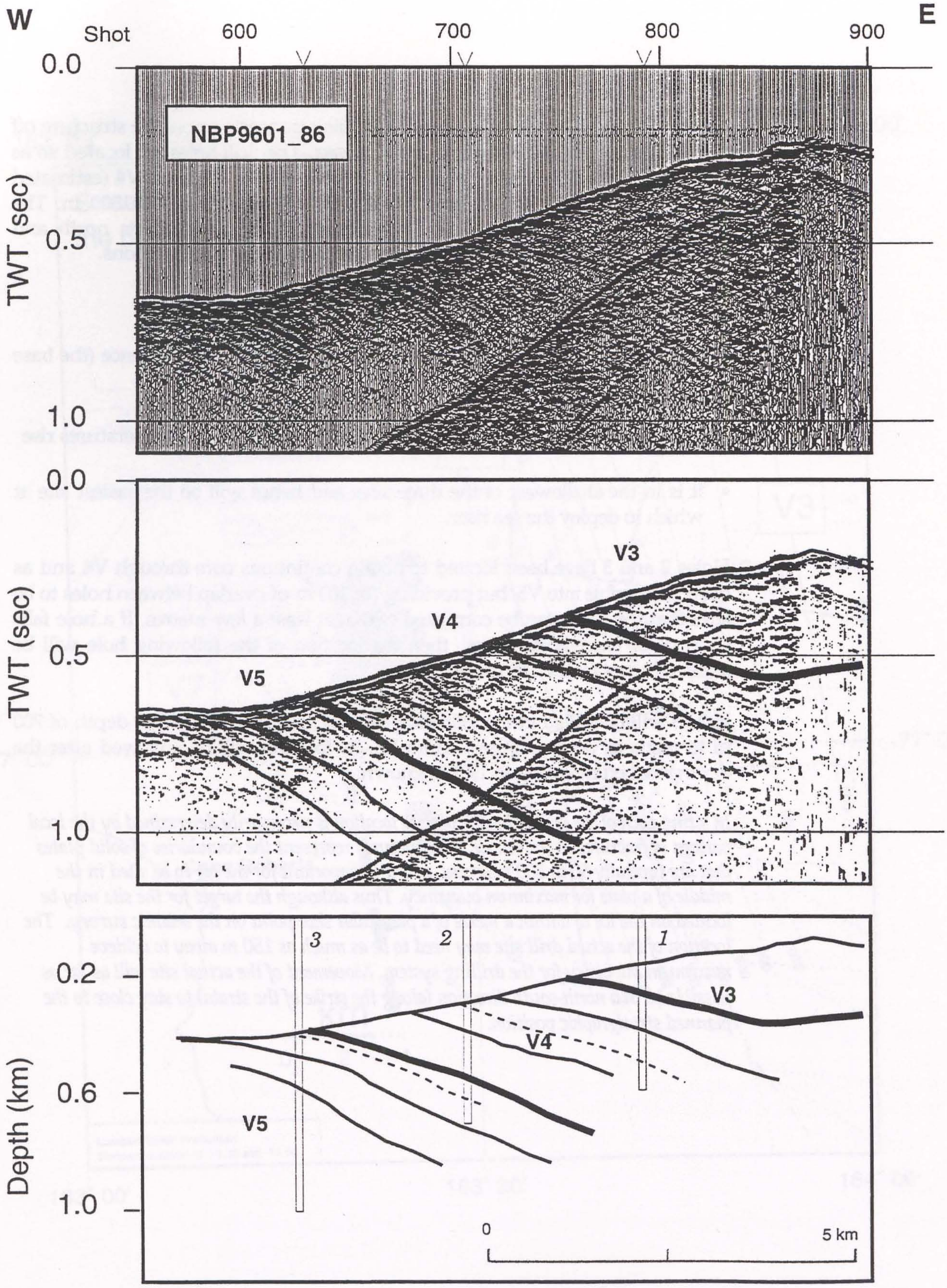

Fig. 3.3 Seismic section and drill sites along northern transect (NBP9601_86). The sites have been located to obtain continuous core from a level 100 m above the base of V3, through to at least 700 m into V5, with 100 m overlap between holes to ensure precise correlation of strata. If a hole falls short or exceeds its target depth the location of the following hole will be adjusted to still retain the 100 m overlap.

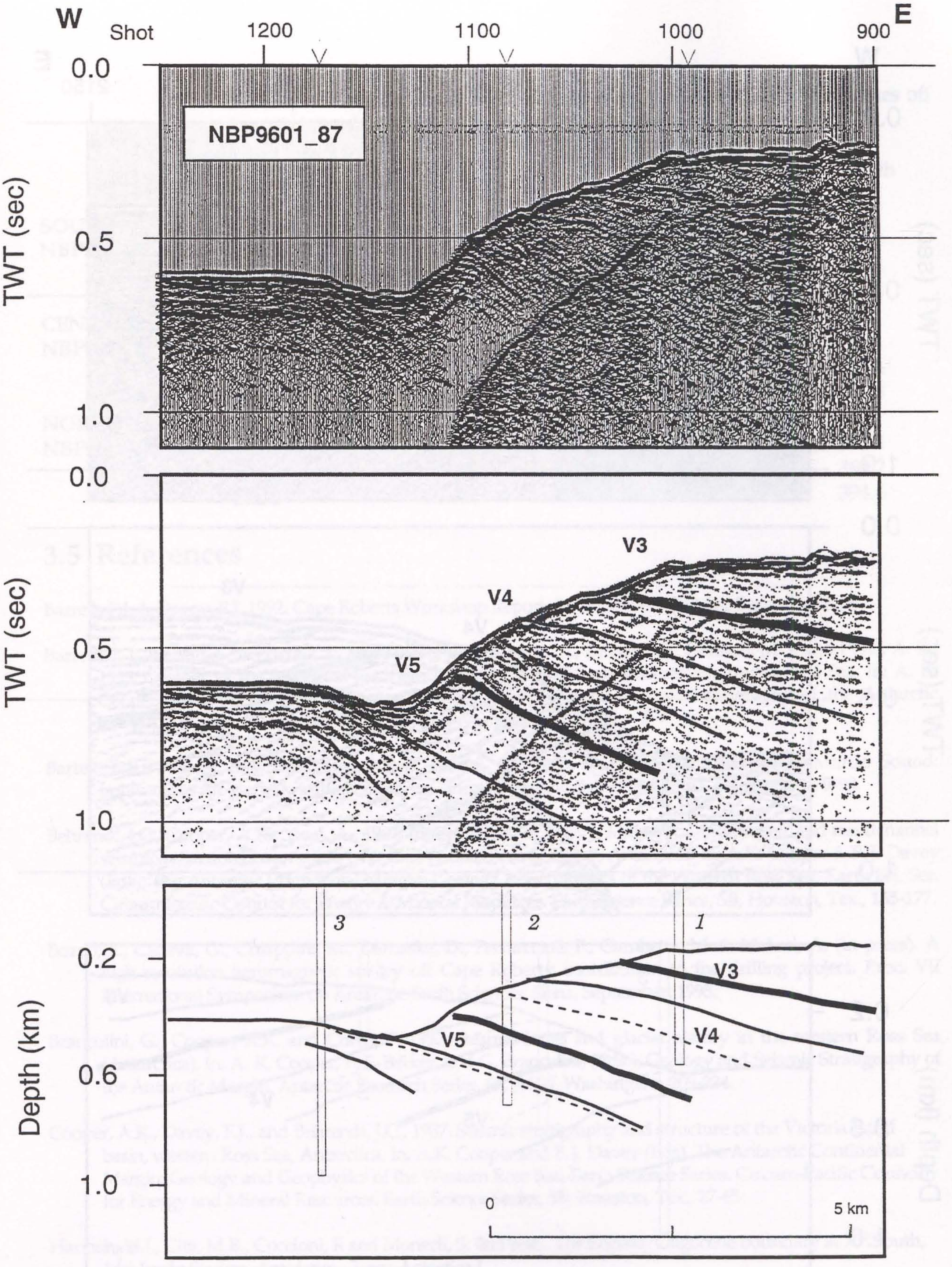

Fig. 3.4 Seismic section and drill sites along the central (preferred) transect (NBP9601_87). See fig. 3 for explanation on siting.

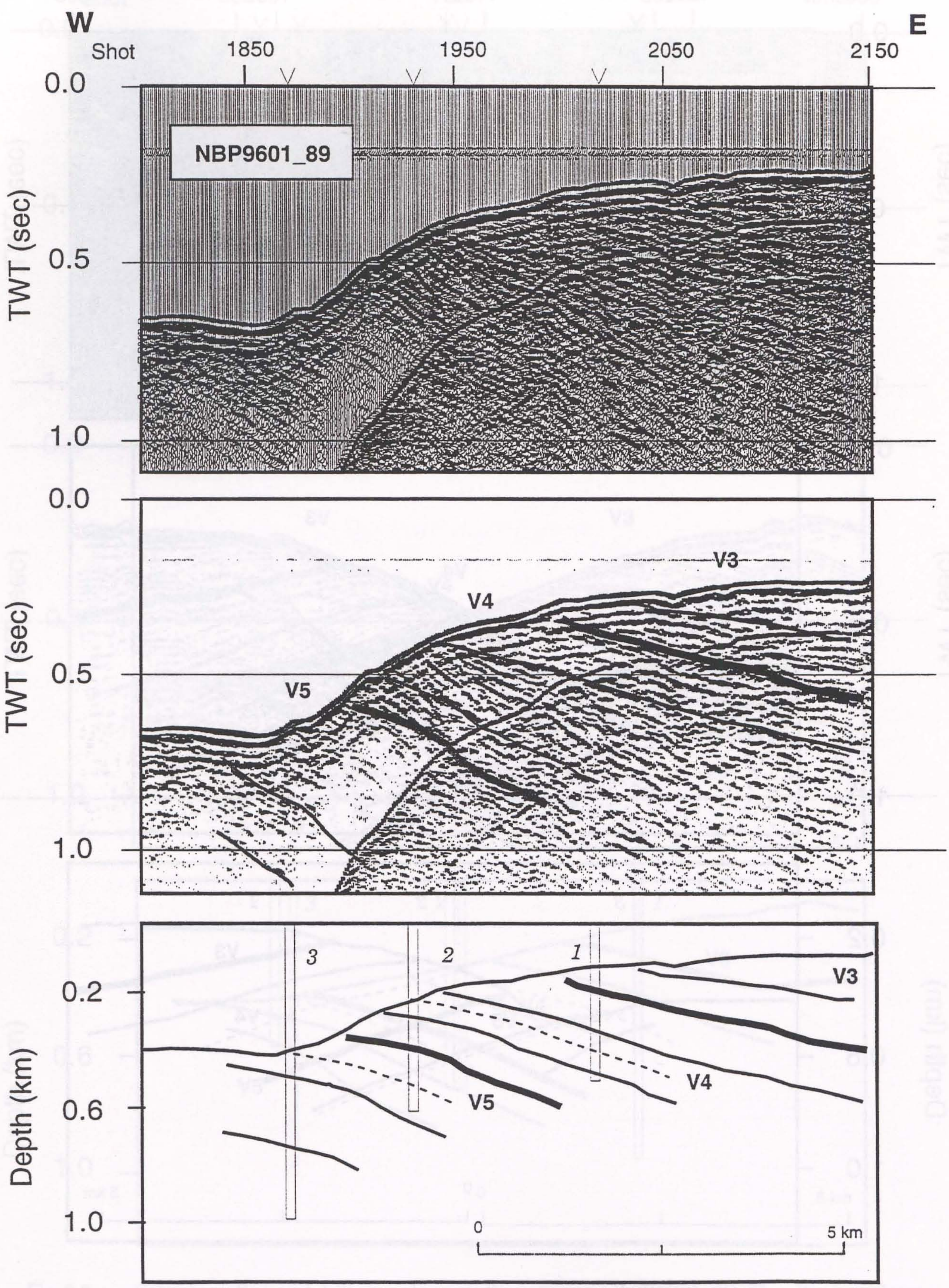

Fig. 3.5 Seismic section and drill sites along southern transect (NBP9601_89). See fig. 3 for explanation on siting.

Table 3.3 Locations of planned drill sites along three east-west seismic lines off Cape Roberts (as originally shown on figures 1-5)

	Line/Hole	Longitude	Latitude	Shot No	Water depth (m)
SOUTH					
NBP9601_89	Site 1	163.755	-77.0078	2032	153.5
	Site 2	163.662	-77.0123	1942	240.4
	Site 3	163.648	-77.0128	1928	269.3
CENTRAL					
NBP9601_87	Site 1	163.727	-76.9916	1013	180.1
	Site 2	163.644	-76.9947	1078	304.4
	Site 3	163.625	-76.9953	1095	364.3
NORTH					
NBP9601_86	Site 1	163.747	-76.9654	0788	181.4
	Site 2	163.618	-76.9710	0666	369.2
	Site 3	163.602	-76.9713	0651	394.6

3.5 References

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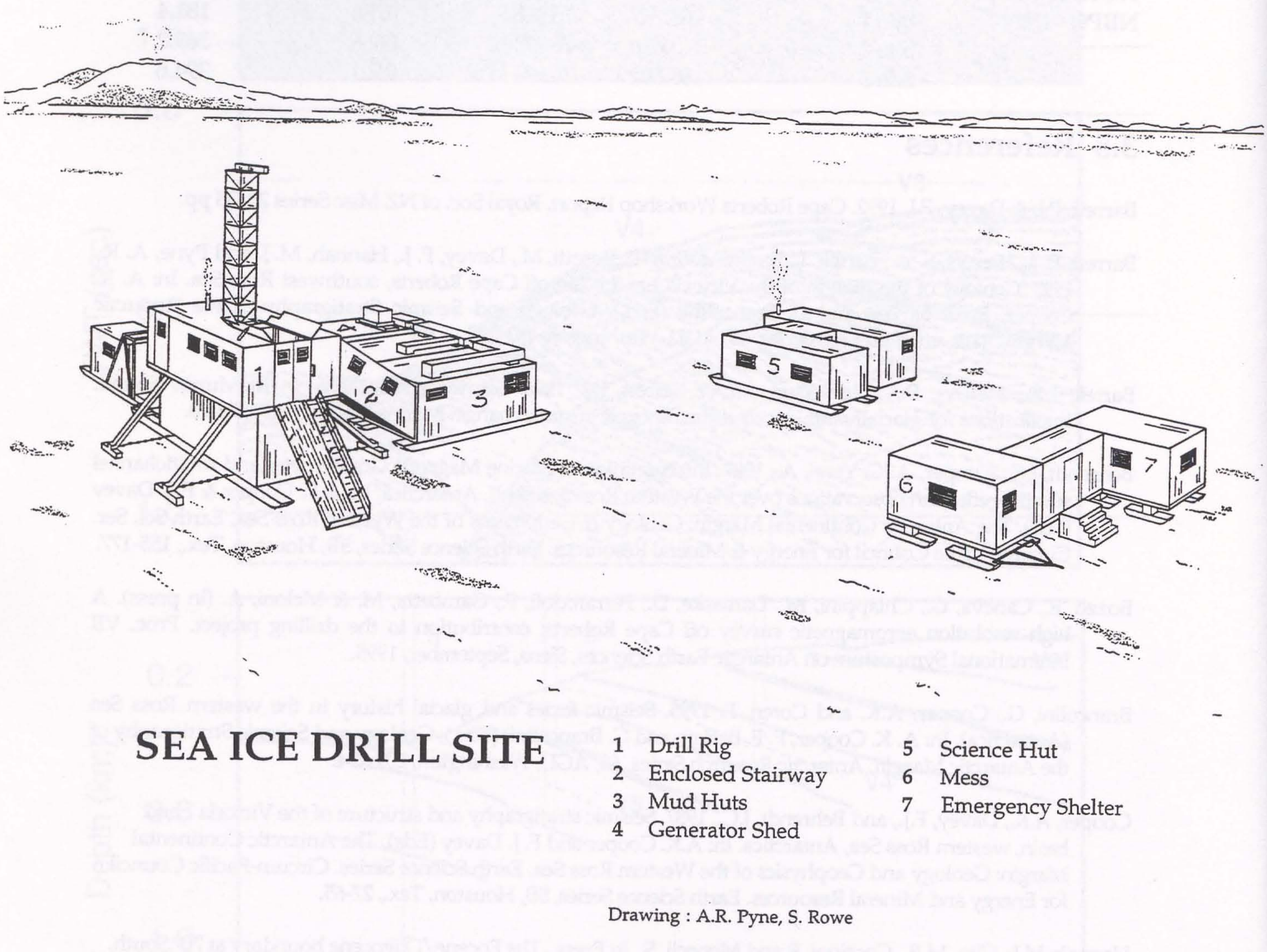


Fig. 4.1 Sketch of drill site layout. The ice must be at least 1.5 m to cope with the 50 tonne drilling system.

SECTION 4
SCIENTIFIC WORK AT THE DRILL SITE

4.1 Background & Management

The drilling will be carried by a Longyear 44 Heavy Duty rig operating in specially designed housing for rapid setup and movement on the ice (Figs 4.1, 4.2). The drilling system weighs 50 tonnes and requires a sea ice thickness of 1.5 m for safe operation. The support system for drill pipe in the water column beneath (the "sea riser") is designed for drilling in water depths in the range from 100 to 500 m. A submarine video system is set up to monitor every part of the sea riser for both environmental and safety reasons. The drilling will produce core in 6 m lengths at a rate of 20 to 30 metres a day. Core diameter will be 61 mm in diameter for the first 200 to 300 m and 45 mm in diameter below that. Target depths for holes one and two are 400 m.

Core recovery, processing and environmental monitoring are the responsibility of the Science Support Manager, Alex Pyne. He has also supervised development of the Drill Site Laboratory, liaised with science teams to ensure that their equipment will work there, and worked with the Drilling Manager to allow for downhole logging as part of the drilling programme. He should be advised of any changes to pre-existing plans.

Work at the drill site will begin with recovery and measurement of the core, allocating downhole depths to each 1 m section. The depths assigned at this stage are those that will be used throughout the project for all core management and sampling. Then follows the first scientific measurements, inspection and video scanning for fracture patterns, and whole core scanning for physical properties. The core is then split length-wise, boxed and labelled. This process is described in some detail in the next section.

Continuous downhole logging of a wide range of physical properties, to aid correlation between holes and help interpret depositional and tectonic setting, will be carried out about half way down, when the drill string is changed from HQ to NQ, and at the end of each hole.

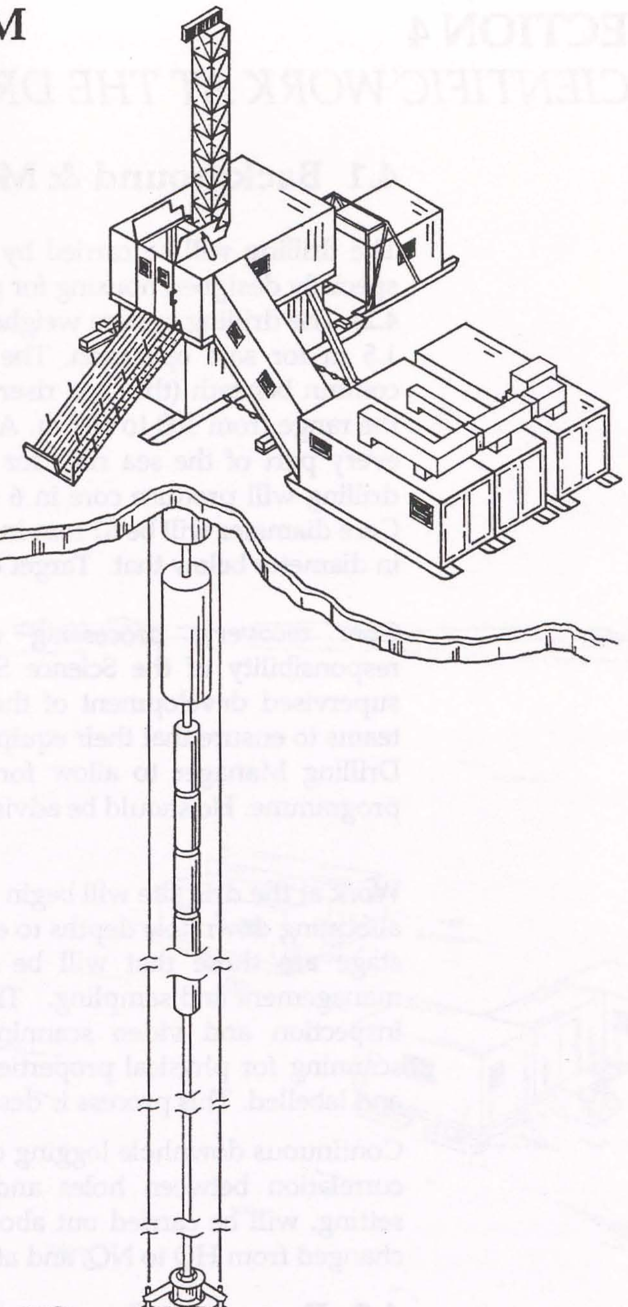
4.2 Recovery Log and Core Processing

A staff of 4 headed by the Science Support Manager will be responsible for logging core recovery, processing, measurements, packaging and core box photography soon after the core is retrieved from the drill rig. The flow of core through the Drill Site Laboratory (Fig. 4.3) and the stages at which measurements and processing occur are detailed below. The aim of the operation is to have a smooth core flow that processes core as quickly as possible to reduce drying of the core and other undesirable effects.

Conventions

1. Each drill hole will be given a number ie CRP #1 and the holes will be numbered sequentially as they are begun.
2. Downhole depths are expressed in metres and measured to the nearest centimetre. They represent the depth in metres below the sea floor (mbsf) .

DRILLING SYSTEM



Drawing : A.R. Pyne, S. Rowe

Fig. 4.2 **Sketch of drilling system. The rig is technically capable of drilling in water up to 500 m deep and then a maximum of 1000 m into the sea floor. However for this project the most demanding conditions will be in water 400 m deep with planned penetration 700 m below the sea floor. The core is brought up in 3 or 6 m lengths on a (NQ) wireline. Core diameter for the first 200 to 300 m is 61 mm (HQ), and is reduced to 45 mm deeper in the hole.**

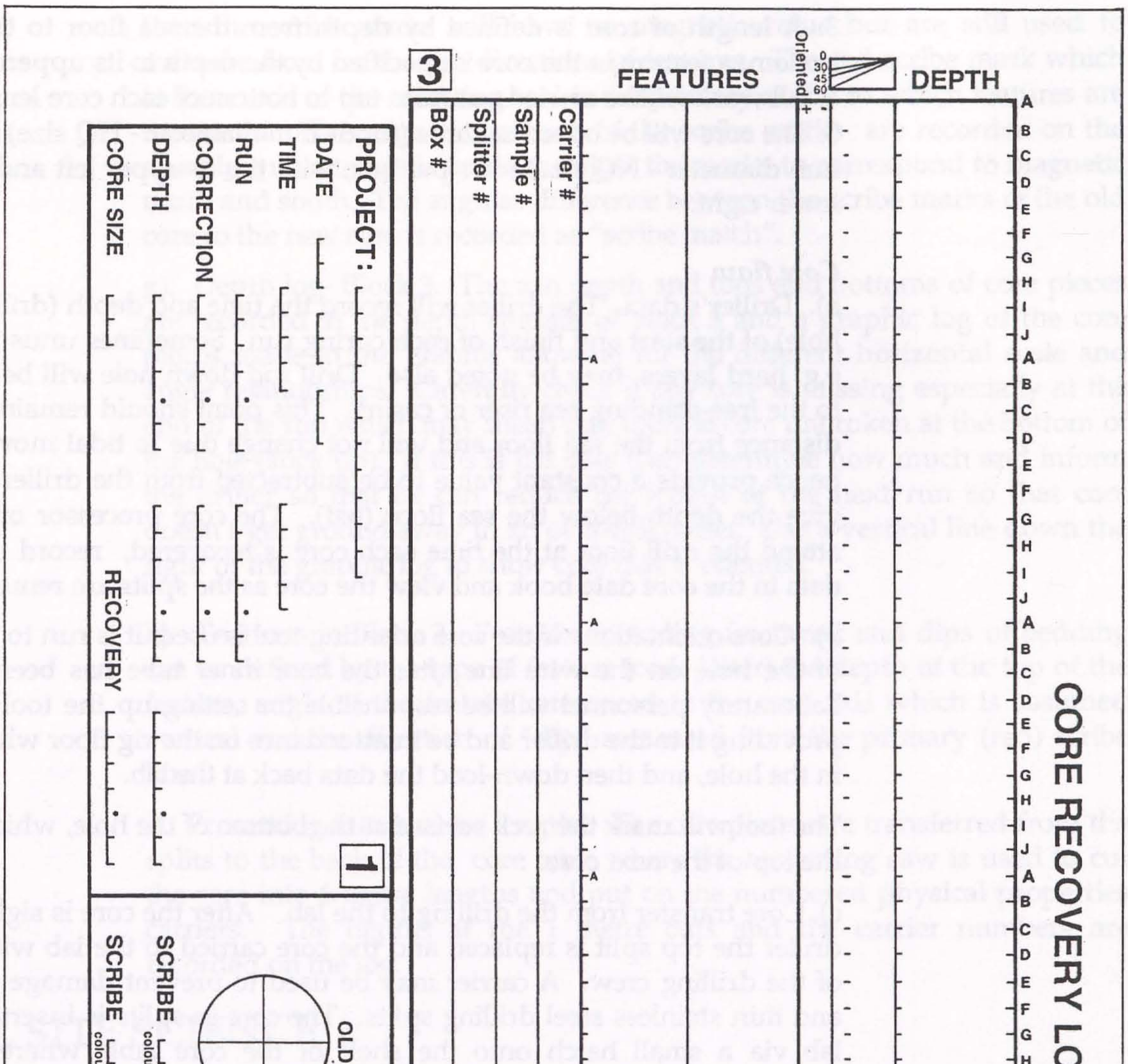


Fig. 4.3 Page of the recovery log, which is filled out at the drill site by the core processing team.

3. A length of core is defined by depth from the sea floor to the top and bottom; a feature in the core is specified by the depth to its uppermost part.
4. All work will be carried out from top to bottom of each core length.
5. The core will be boxed as three (for 61 mm diameter - HQ size) or 4 (for 45 mm diameter - NQ size) rows per box, with **top** to upper left and **bottom** to lower right.

Core flow

a). Driller's data. The driller will record the time and depth (drill rod down hole) of the start and finish of each coring run. Sometimes unusual drilling, e.g. hard layers, may be noted also. Drill rod down hole will be referenced to the free-standing sea riser or casing. This point should remain a constant distance from the sea floor and will not change due to tidal movement and hence provide a constant value to be subtracted from the driller's depth to give the depth below the sea floor (bsf). The core processor on duty will attend the drill floor at the time each core is recovered, record the driller's data in the core data book and view the core as the splits are removed.

b). Core orientation. If the core orienting tool is used, it is run to the bottom of the hole on the wire line after the core inner tube has been removed. Laboratory personnel will be responsible for setting up the tool at the lab, providing it to the driller and be in attendance on the rig floor while it is run in the hole, and then down-load the data back at the lab.

The tool will mark the rock surface at the bottom of the hole, which becomes the top of the next core.

c). Core transfer from the drill rig to the lab. After the core is sighted by the driller the top split is replaced and the core carried to the lab with the help of the drilling crew. A carrier may be used to prevent damage to the core and thin stainless steel drilling splits. The core in splits is inserted into the lab via a small hatch onto the shelf of the core table where it can be transferred to the table top by the lab personnel.

d). Core depth and recovery. For each coring run a sequentially numbered CORE RECOVERY LOG is filled out. [Six metre runs may require 2 sheets.] Block #1 which is used to calculate the core depths and recovery based on drillers data is completed first. The sea riser correction is subtracted from the run depth to give depth in mbsf.

e). The core in the splits is transferred to the top of the core table and the top split removed. The top of the core is compared to the bottom of the previous core which is retained unsplit to check the fit, and this recorded in block 2. The core is fitted down its entire length and the length of recovered core measured and recorded in block 1. Measurements should be made consistently from and to the top of core fractures or breaks.

f). Core orientation. Block 2 is used to record and visualise the relationship between orientation marks and the scribe marks on the core. The previous core will have red and blue scribed marks 180 degrees apart along the entire length whether the core is continuous or orientated. If the top of the core has been oriented the depth of the core top is recorded and the marks shown on the new compass figure. These marks are then transferred to the outside of the core and scribed along both sides of the split for the entire core length. For the parts of the core that fitted together and were continuous then the scribe marks now have a magnetic azimuth. If orientation has not been done or cannot be transferred from the last core then the scribe marks will have no magnetic value but are still used to measure from for the dip directions of features. The red scribe mark which is the x axis of the orienting tool is the primary scribe to which features are measured. The magnetic azimuth of the scribe marks are recorded on the sheet but no attempt is made to adjust the marks to correspond to magnetic north and south. The angular difference between the scribe marks of the old core to the new core is recorded as "scribe match".

g). Depth log- Block 3. The run depth and tops and bottoms of core pieces are recorded in the depth column of block 3 and a graphic log of the core pieces made in the graphic allowing for the different horizontal scale and angle relationships. Carefully check if any core is missing especially at the end of the run which may mean that there is core unbroken at the bottom of the hole (stick up). If this is the case then determine how much and inform the driller so that he can reduce the length of the next run so that core doesn't get ground away in an over-full barrel. Use a vertical line down the right of the graphic log to show core that is oriented.

h). Features in Block 3. Features including fractures, and dips of bedding can be defined by the type of feature (code letter) the depth of the top of the feature, angle of the feature referenced to the core axis which is assumed vertical and the direction of "dip" measured from the primary (red) scribe line.

i). Processing into 1 metre lengths. The core pieces are transferred from the splits to the back of the core table where the sectioning saw is used to cut the core into 1 metre lengths and put on the numbered physical properties carriers. The depths at the 1 metre cuts and the carrier numbers are recorded on the log.

DRILL SITE SCIENCE LABORATORY

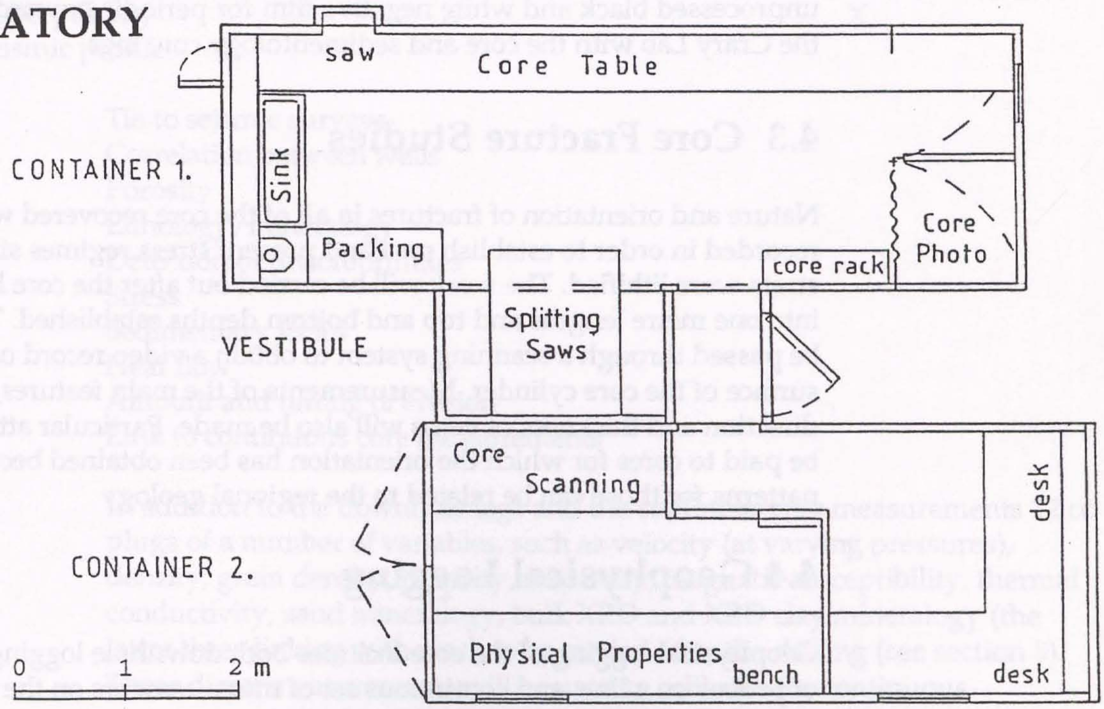


Fig. 4.4 Sketch of drill site laboratory by A. Pyne. Here the core is scanned for data on fractures and stress, scanned again for physical properties, cut into 1 m sections, split lengthways, boxed, labelled and photographed.

j). Core fracture study. The core in 1 metre lengths are now available for core scanning, detailed fracture measurement and photography and should be worked on a metre at a time (section 4.3 below).

k). Physical properties measurements. Each metre length of core on its carrier is transferred to the physical properties area for measurement (section 4.3 below) then returned to the core table.

l). Core Splitting. Remove any whole core sample pieces [macrofossils or physical measurement samples]. The metre lengths of core are transferred to the splitting holders and then split with diamond saws along the core length. Ensure that the blue scribe mark is loaded face down so that the scribe marks are not lost during cutting. After splitting the holders are opened on the packaging table and the cut faces washed.

m). Packaging. The core half with the blue scribe is boxed as the archive half and the red scribed half is the sample half. Place the cut faces upwards in the boxes and use core markers to label the top of each section, any missing core and core pieces removed and the bottom of the box. Label both tray and lids. Close and seal the archive box and store ready for transport. Note the core box boundaries on the core recover log

n). Core Box Photography. Photograph the sample half core box ensuring the core faces are horizontal and moistened. Change film backs so both a colour transparency and black and white negative are made of each box and record these in the photography log book. Close the core box and seal for transport to the Cape Roberts Camp Laboratory.

o). Core transport and documentation. Core will be transported with a core processor at each shift change. Note that the archive and sample boxes should be transported separately. The pink copy of the core recovery log should be hand carried to the camp lab at the same time together with the unprocessed black and white negative film for periodic onward transport to the Crary Lab with the core and sedimentology core logs.

4.3 Core Fracture Studies

Nature and orientation of fractures in all of the core recovered will be recorded in order to establish past and present stress regimes since the strata were lithified. The work will be carried out after the core has been cut into one metre lengths and top and bottom depths established. The core will be passed through a scanning system to obtain a video record of the entire surface of the core cylinder. Measurements of the main features, such as direction and thickness of veins will also be made. Particular attention will be paid to cores for which the orientation has been obtained because fracture patterns for those can be related to the regional geology

4.4 Geophysical Logging

Geophysical logging of the core includes both downhole logging with a set of probes on a line, and continuous set of measurements on the core itself after it is recovered.

Continous core measurements will be made on the whole core (i.e. prior to splitting) immediately after its examination for fracture studies. They include porosity (from gamma-ray attentuation), magnetic susceptibility, and velocity. Downhole logging measurements include sonic velocity, density, resistivity, spontaneous potential, spectral gamma ray, dip meter, borehole televiewer, temperature and magnetic susceptibility (Table 4.1). The running of these logs will take around 32 hours and will take place at the end of HQ drilling (between 200 and 300 m) and after drilling has been completed. Vertical seismic profiles will also be obtained, and these will take a further 12 hours.

Table 4.1 lists the tools and also notes which are to be used in the interpretation of the logs. The broad interpretive objectives such as changes in sea level and climate are not shown, but instead the paths by which those objectives are reached lithology/ mineralogy, sedimentary facies, timing and amoutn of erosion) have been indicated. Although there may seem to be redundancies, different tools respond to the same set of variables with different sensitivities, yielding complementary scientific insights.

Table 4.1 Tools to be used in downhole logging and the uses for each each set of measurements. X - major value, x - minor value

Tool	TIE	COR	POR	LITH	UNC	STR	FAC	HEAT	EROS	CORE
velocity	X		X	x	x				x	
density	X		X	x	x				x	X
resistivity	x		X	x	x					
spont potential				X						
spectral gamma		X		X	X			x		
dipmeter					X	X	X			
borehole televiewer				x		X				
temperature								X		
mag susceptibility		X		X					X	
vert seismic profile	X									

TIE	Tie to seismic surveys
CORR	Correlation between wells
POR	Porosity
LITH	Lithology/mineralogy
UNC	Detection of unconformities
STR	Stress
FAC	Sedimentary facies
HEAT	Heat flow
EROS	Amount and timing of erosion
CORE	Link to continuous core measurements

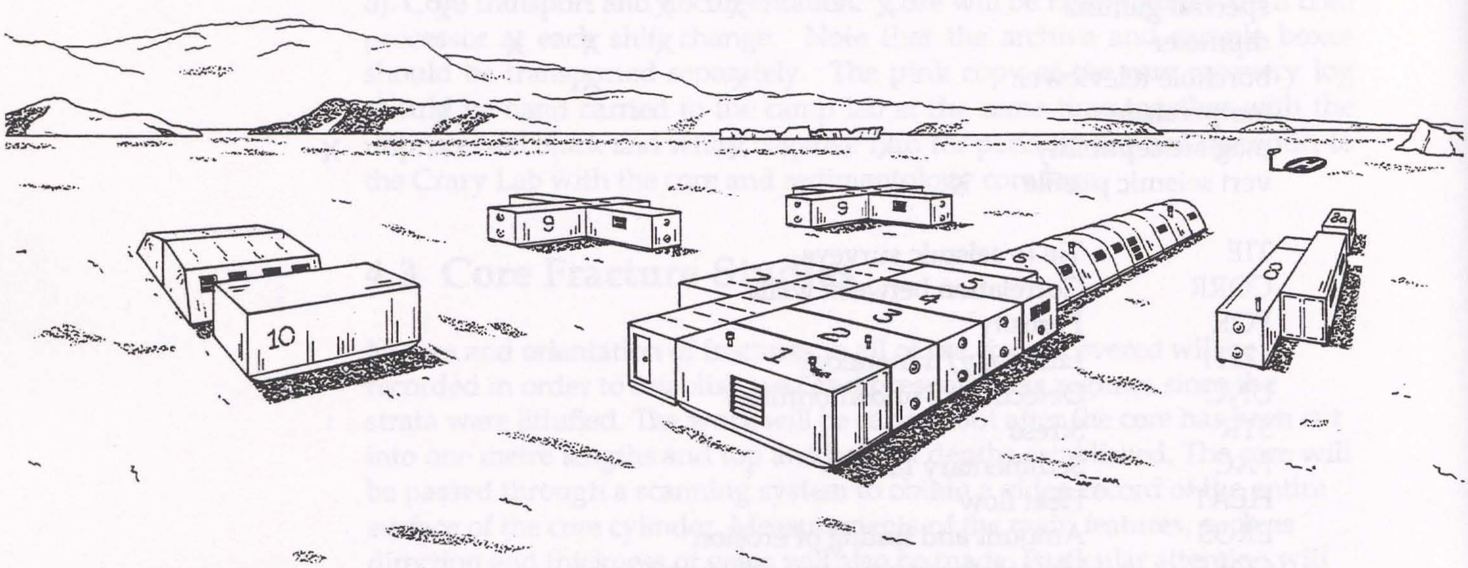
In addition to the downhole logs and the continous core measurements 12 cc plugs of a number of variables, such as velocity (at varying pressures), density, grain density, porosity, resistivity, magnetic susceptibility, thermal conductivity, sand mineralogy, bulk XRD and XRD clay mineralogy (the latter three linking with work to be carried after the drilling (see section 8). These direct measurements will be used to calibrate the continuous measurements and enable these to used to make better inferences on the history represented by the core.

SECTION 5
SCIENTIFIC WORK AT CAPE ROBERTS

5.1 Science Management

Cape Roberts camp (Fig. 5.1) provides the base for the drill crew and the science team carrying out the early stages of core processing and description. It is also home for the Project Manager, Chief Scientist, Science Support Manager and Drilling Manager, who have to make the critical decisions concerning the drilling i.e. whether to proceed, to terminate, to relocate drilling, and if so where to. On safety and environmental issues, the Project Manager, Jim Cowie, is responsible and will take decisions on advice from the drilling manager and the science support manager, though consulting with the Chief Scientist, Peter Barrett, to assess the impact of any decisions on the science of the project. Details on this are outlined in the project's Operations Plan.

The Chief Scientist is responsible for science issues, and will take decisions based on advice from science staff, the science support manager and the drilling manager. Critical to most decisions will be the age of the strata reached by the drilling. Scientists at Crary Laboratory will be represented by the Crary Lab Science Leader for the Cape Roberts Project, Peter Webb (see Section 6.1). Communication by both voice and e-mail will link Crary Laboratory and Cape Roberts, and although some decisions may need to be taken quickly, wide and active discussion on all options will be encouraged.



CAPE ROBERTS CAMP

1 Generators	7 Toilets/Drying Room
2 R/O Plant	8 Science Laboratory
3 Water Storage/Laundry	8a Project Office
4 Ablutions	9 Sleeping Accommodation
5 Kitchen	10 Workshop
6 Mess and Rec.	

Drawing : A.R. Pyne, S. Rowe

Fig. 5.1 Sketch of the Cape Roberts camp layout. The camp provides accomodation for 35 drillers, scientists and camp support staff, as well as laboratory facilities for detailed core examination.

5.2 Core Description

While drilling is proceeding, several boxes of core, each containing 3 or 4 one metre lengths, will arrive every 12 hours from the drill site for a full lithologic description at the Cape Roberts Laboratory. Following this, the boxes will be moved several times a week to Crary Lab, McMurdo Station.

Scientific work at Cape Roberts Laboratory will consist almost entirely of visual core description assisted by smear slides for microscopic study, and will involve subdivision of the core into individual beds, subunits and units, following ODP practise. A Core Description Manual has been prepared by the Sedimentology group and edited by Dr Hambrey. It summarises classifications and procedures to be used for the core examination and description, and also contains notes on interpretation.

Tasks as currently allocated are shown in Table 5.1. It was considered important to examine and describe the core at 3 levels of detail to ensure that no detail was lost and yet larger trends were appreciated.

At the finest level of detail the core will first be described on a scale of 1: 5 (1 m per page) for reference and sampling. These descriptions will be made in triplicate (one for retention in the Cape Roberts Laboratory and one set to accompany each shipment of core (working and archive). These will not be published, but may be copies and used for subsequent detailed sampling and core study.

At the next level of detail the core will be described on a scale of 1:20 (4 m per page). This set of descriptions will represent the primary sedimentary descriptive data that will be published. It will be readily available through copying and is expected to be published at the same time as the Initial Report.

The more detailed core descriptions will be reviewed, summarised on a scale of 1:500 (100 m/page) and interpreted. The process will involve re-examination of the core. This work will be carried out at Crary Lab to allow consultation with palaeontologists, palaeomagnetists and petrologists to ensure that the widest possible range of information about the core is taken into account as interpretations develop in all fields of the project.

Other work to be carried out as part of the core description procedure at Cape Roberts is the petrographic study of smear slides and macrophotography of significant core features, from which a selection showing characteristic features of each facies will be published in the Initial Report. No samples will be taken at this stage, though parts of the core may be identified for later sampling at Crary Laboratory.

Table 5.1 Organisation of work at Cape Roberts Laboratory. * = responsibility for hole.

ASK	HOLE 1	HOLE 2
Lithology (1 m/page)	L Krissek* M Claps	M Hambrey* L De Santis
Lithology (4 m/page)	K Woolfe* R Powell	R Powell* K Woolfe
Smear slide petrography	W Ehrmann	M Lavelle

CAPE ROBERTS SCIENCE LABORATORY

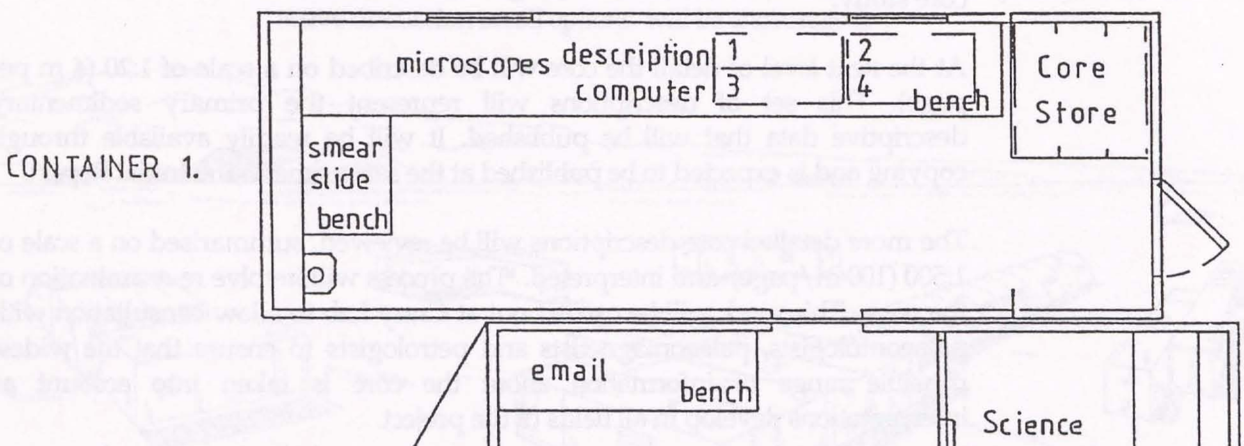


Fig. 5.2 Plan of Cape Roberts Laboratory. Here the core is first examined and logged in detail by a team of 5 sedimentologists.

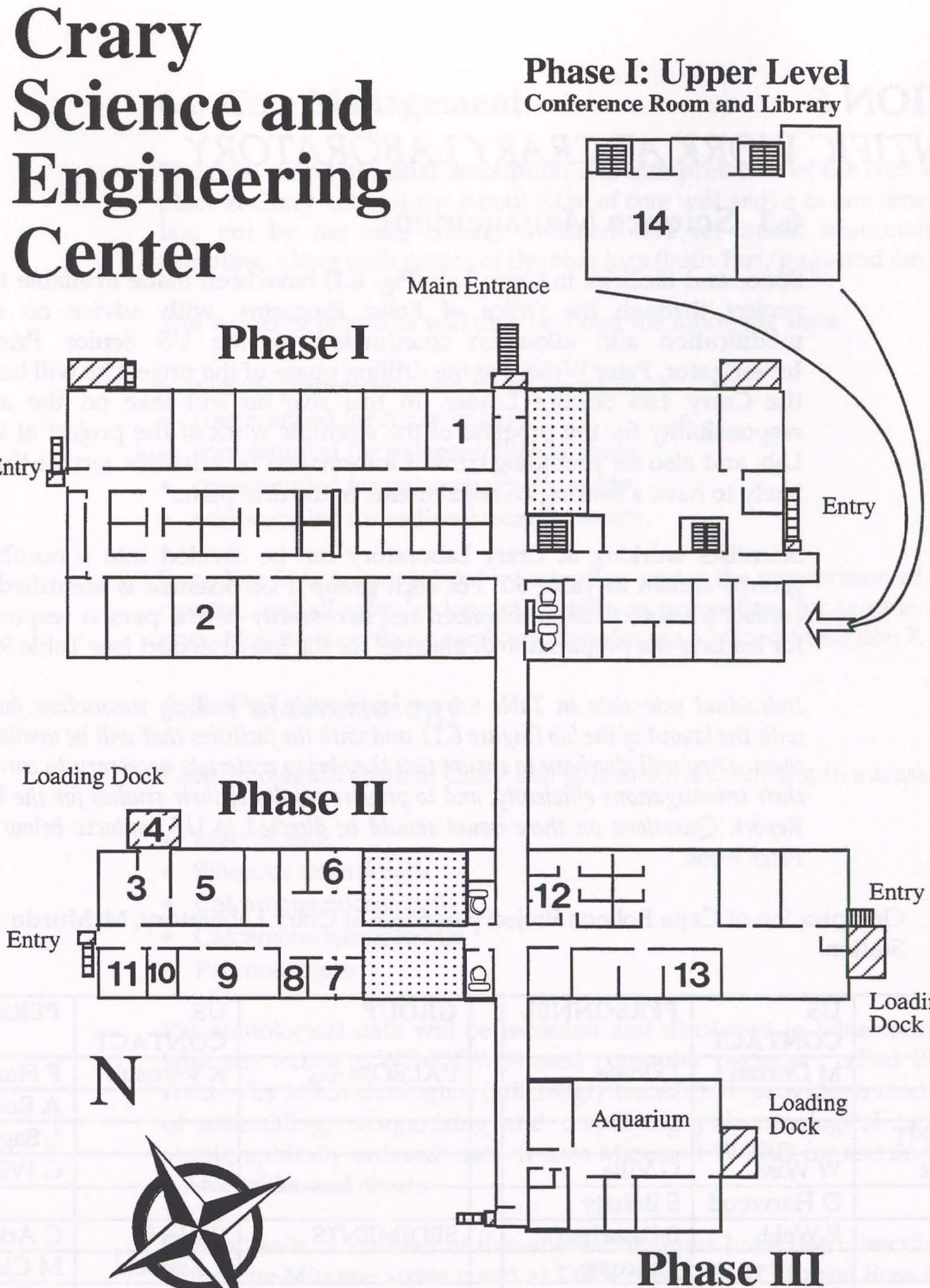


Fig. 6.1 Plan of Crary Laboratory, McMurdo Station. Here the core is sampled and examined for a range of studies in paleontology, petrology, magnetostratigraphy and sedimentology. The numbers indicate the following rooms and functions:

1 R 108 - Microfossil lab (calcareous & siliceous
2 R 143 - Macrofossil lab
3 R 201 - Core display/sampling
4 Loading dock C - palaeomag sampling
5 R 204 - Temporary core storage
6 R 207-8 - Palynology
7 R 216-7 - Editorial staff
8 R 218 - Science Leader
9 R 219 - Palynology processing/organic chem
10 R 220 - Rock sectioning
11 R 221 - Petrology microscopy
12 R 230-2 - Petrology/sedimentology offices
13 R 242 - Palaeomagnetics Lab
14 Conference Room for meetings

SECTION 6
SCIENTIFIC WORK AT CRARY LABORATORY

6.1 Science Management

Space and facilities in Crary Lab (Fig. 6.1) have been made available to the project through the Office of Polar Programs, with advice on space modification and allocation coordinated by the US Senior Principal Investigator, Peter Webb. For the drilling phase of the project he will become the Crary Lab Science Leader. In this role he will take on the added responsibility for the progress of the scientific work of the project at Crary Lab, and also for providing current information on scientific results that are likely to have a bearing on adjustments to the drill plan..

Scientists working at Crary Laboratory can be divided into a number of groups shown in Table 6.1. For each group a US scientist is identified as a contact person, though this need not necessarily be the person responsible for leading the preparation of material for the Initial Report (see Table 9.1)

Individual scientists in Table 6.1 are responsible for making themselves familiar with the layout of the lab (Figure 6.1), and with the facilities that will be available to them. They will also have to ensure that they bring materials necessary to carry out their investigations efficiently, and to prepare results of their studies for the Initial Report. Questions on these issues should be directed to US contacts below or to Peter Webb.

Table 6.1 Organisation of Cape Roberts Project personnel at Crary Laboratory, McMurdo Station.

GROUP	US CONTACT	PERSONNEL	GROUP	US CONTACT	PERSONNEL
CORE	M Curran	J Howe	PALEOMAG	K Verosub	F Florindo
					A Roberts
PALAEONT					L Sagnotti
Coccoliths	W Wise	G Villa			G Wilson
Diatoms	D Harwood	S Bohaty			
Forams	P Webb	S Passchier	SEDIMENTS	P Webb[1]	C Atkins
		P Strong		L Krissek[2]	M Claps
Palynology	J Wrenn	J Simes			W Ehrmann
		E Levac			C Fielding
		M Hannah			M Hambrey
		I Raine			J Howe
					L De Santis
PETROLOGY	P Webb	P Armienti			
		J Smellie	REPORTING	P Webb	Sonia Sandroni
		M Tabecki			Sherry Kooyman
		F Talarico	ORGANIC GEOCHEMISTRY	R Kettler	

[1] for Hole 1
[2] for Hole 2

6.2 Core Management

The final round of initial description and interpretation of the core will take place at Crary Laboratory. About 50 m of core will arrive at one time, and be laid out by the core curator in Room 201 for initial examination and sampling, along with copies of the core logs (both 1 m/page and 4m/page).

The sequence of events will then be along the following lines:

- sample points identified for all on ice work
- core scanned for X-ray images
- core sampled for palaeontological study
- core sampled for palaeomagnetic study
- core sampled for sedimentological study.

Sampling is to be carried out by scientists under the supervision of the core curator, and all samples logged. Details on procedures for sample requests and obligations on those receiving samples are outlined in Section 7.

6.3 Palaeontology

Palaeontological work at Crary Lab falls into the following five areas:

- Macrofossils
- Siliceous microfossils
- Calcareous microfossils
- Calcareous nannofossils
- Palynomorphs

Palaeontological data will be recorded and displayed in tables and graphs with the aid of a WINDOWS-based computer package called BUGWIN written by Mitch Covington (mitch@gly.fsu.edu). It provides a ready means of assembling, reorganising and displaying palaeontological (and other stratigraphically ordered) data. It uses Microsoft WORD for text and EXCEL 5.0 for tables and charts.

Macrofossils. A number of thin-shelled molluscs have been described from Oligocene-Miocene strata cored at DSDP sites 270-273 in the Ross Sea, and from the lower part of CIROS-1 70 km south of Cape Roberts, and more are expected from Cape Roberts core. Plant macrofossils may also be encountered.

The core processors at the drill site are expected to spot and sample macrofossils before the core is split, and further macrofossils may be revealed after the core is split and described. All macrofossil samples will be curated and briefly described by Marco Taviani, who will also report on trace fossils in the core, and provide an interpretation of depositional environment from these. More detailed work will be carried out by specialists to be decided after coring has been completed.

Siliceous microfossils: The core will be sampled at 2 m intervals for diatoms, which have proved biostratigraphically very important as far back as the early Oligocene in the Ross Sea. The material will be studied by David Harwood, with technical assistance from Steve Bohaty. Other siliceous microfossil groups will be briefly reported on. Larger but less frequent samples will also be taken and processed for radiolaria, for study by Chris Hollis, Institute of Geological Sciences, Lower Hutt.

Calcareous microfossils: The core will be sampled at around 10 m intervals for foraminifera for study by Peter Webb and Percy Strong. Oligocene strata from the CIROS-1 drill hole provided small numbers of relatively age-insensitive benthic forms after much effort by Peter Webb, but a range of processing techniques will be tried by Sandra Passchier for better recovery, and older strata likely to represent warmer times are expected to be more productive. Any ostracods will be recovered as part of the processing and studied by Richard Dingle.

Calcareous nannofossils: The core will be sampled at 2 m intervals by Woody Wise and Giuliana Villa for coccoliths and other calcareous nannofossils. These were found in small numbers in the CIROS-1 core but have provided very useful age datums.

Palynomorphs: The core will be sampled for palynomorphs every 4 m, and the samples processed in a specially constructed HF digester by John Simes. The focus of study will be the marine palynomorphs and especially dinoflagellates, a group with much biostratigraphic potential in the warmer part of the Paleogene and of special interest to both Mike Hannah and John Wrenn. Terrestrial palynomorphs will be studied by Ian Raine, who will be able to report on not only contemporaneous microflora but also that reworked from the Devonian-Jurassic largely terrestrial Beacon strata in the hinterland.

6.4 Palaeomagnetism

Samples will be taken every 0.5 m for both magnetic polarity and magnetsusceptibility measurements. The samples will be taken by drilling 1" diameter plugs from the core in Loading Dock C; the magnetic measurements will be made on spinner magnetometers set up in Room 242. The results from this work should provide a magnetic polarity zonation for intervals where sedimentation has been relatively uniform and fine-grained. This will help both in correlation between drill sites and in dating of the cores through the Magnetic Polarity Timescale.

Magnetic susceptibility measurements on the samples will be integrated with whole core susceptibility logging and down hole logging at the drill site. Together these are expected to provide an additional effective means of correlation between drill sites in the area.

On site measurements will be followed up in laboratories in Davis, California, and Rome with further palaeomagnetic and mineral magnetic studies, including anisotropy of susceptibility, to help in deciphering the sedimentological, tectonic and palaeoclimatic histories from the Cape Roberts sequence.

6.5 Stratigraphy & Sedimentology

Clast features

Clasts more than a cm long will be logged and described by Cliff Atkins in terms of their dimensions, roundness and surface features. A close study will be made of striations, their depth, length and the patterns they show in an effort to distinguish between those formed under glacial ice and striae formed by sea ice, debris flows or other processes. Sets of clast orientations will be measured in some diamicts and conglomerates in sections of oriented core to obtain the direction of movement of the depositing medium. The main goal of this work is to establish whether the clasts and the sediment enclosing them had a subglacial origin, and whether they were deposited subglacially or seaward of the grounding line.

Clay analysis

Samples will be taken by Werner Ehrmann for XRD analysis of clay mineralogy at 2 m intervals throughout the core, and representative samples from critical stratigraphic intervals will be processed and analysed at Crary Lab. Work by Werner on CIROS-1 and other cores in the region records a shift both in smectite crystallinity and in clay mineralogy from smectite to illite-chlorite close to the Eocene-Oligocene boundary, making the measurements valuable both for assessing weathering events on land and for stratigraphic correlation.

Cyclostratigraphy

Detailed studies of small core intervals will be undertaken by Michele Claps on a range of properties (grain size, bedding thickness, sedimentary structures etc) to identify, characterise and seek patterns in cycles on a small time scale. This work will be extended with results of grain size and carbonate analysis in the post-drilling phase.

Lamination

John Howe will study the detail of lamination in deep marine intervals of the core, using both direct observation and X-radiographic images to characterise the features (thickness, boundary characteristics, mm-scale patterns) and identify the causes.

Summary lithologic logs for each hole and sedimentary synthesis

For each hole a lithologic log will be prepared at a scale of 1:500 (100 m/page). It will show core recovery, main lithologies and lithologic units and a description of each unit, and it will be accompanied by an interpretation of the depositional history of the site. The basis for the summary will be the 1:20 m logs, but the core will be re-examined for this smaller scale log so that major unit boundaries are geologically reasonable in the context of the whole core. The log for Hole 1 will be prepared by Mike Hambrey and for Hole 2 by Larry Krissek, in consultation with Chris Fielding.

Chris Fielding will use a sequence stratigraphic approach to develop a synthesis of the entire sequence in consultation with Hambrey, Krissek and others. Following core inspection and discussions with Crary Lab sedimentologists a preliminary interpretation of facies and depositional environment will be made, from which will come an initial relative sea level reconstruction. As biostratigraphic, paleomagnetic and downhole logging data become available they will be integrated into the working model to provide a more complete stratigraphic framework.

6.6 Organic Geochemistry

Samples will be taken every 5 m through the core for organic geochemical analyses by Richard Kettler to be carried out on equipment already housed at Crary Lab. The samples will be split in three, with one set used for carbonate carbon and another for total carbon, nitrogen and sulfur. Solvent-soluble organic matter and elemental composition of kerogen for selected samples. The data will be useful to other researchers in several ways:

1) the C:N ratios provide information on sources or organic matter and hence conditions on land and in the water column.
2) whole rock C:S ratios can be used to evaluate depositional environments and especially distinguish marine from non-marine sediments.
3) Total organic carbon measurements are necessary to obtain quantitative estimates of palaeoproductivity
4) abundances of various n-alkanes or isoprenoids can be used to make inferences about the source of organic matter and diagenetic environment.

6.7 Petrology

Samples will be taken every 5 m through the core for organic geochemical analyses by Richard Kettler to be carried out on equipment already housed at Crary Lab. The samples will be split in three, with one set used for carbonate carbon and another for total carbon, nitrogen and sulfur. Solvent-soluble organic matter and elemental composition of kerogen for selected samples. The data will be useful to other researchers in several ways:

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4) abundances of various n-alkanes or isoprenoids can be used to make inferences about the source of organic matter and diagenetic environment.

SECTION 7
CORE MANAGEMENT & SAMPLE DISTRIBUTION

7.1 Sample Request Policy

The project is expected to yield around 800 m of core in each drilling season. Core diameter is relatively small (61 mm in the upper part of the hole and 45 mm in the lower part of the hole) and only one half of the core will be available for sampling during the project. The main aim of sampling during the drilling and immediate post-drilling phases is for core characterisation and the development of a chronology. Samples made available during these phases are to provide information for the Initial Report and Scientific Report. The deadlines for these reports are two weeks and 9.5 months after completion of drilling, respectively. A time table for further post-field season sampling will be announced at a later date by the International Steering Committee (ISC).

To ensure that adequate material is available for both the core characterisation phase and subsequent studies the following rules and protocols apply to sampling of Cape Roberts core material and the depth intervals for both on-ice and off-ice studies will be flagged for sampling.

A) Submission of sample requests prior to, and during the drilling phase of the project, a written sample request must be submitted to the International Steering Committee (or their nominated representatives). Sampling during the drilling phase should be for processing at Crary Lab only, unless prior approval is given by the ISC. On-ice scientists will have priority for sampling programs during the drilling phase and for the following year, but requests from off-ice scientists are also encouraged. Second season scientists may request material to familiarise themselves with it before going to Antarctica.

A sample request should contain the following information:
Investigator's name, address, telephone, fax, email:
Purpose of request: Short (10 line) summary of proposed research
Proposed sampling program: Specify lithology, size (vol), depth interval(s)
Note any specialized sampling techniques or storage requirements needed.

B) After the drilling phase of the project is completed, the archive half of the core will be stored at the Antarctic Research Facility at Florida State University in Tallahassee, Florida and sampling half at the Core Repository at the Alfred-Wegener-Institute for Polar and Marine Research in Bremerhaven Germany. Requests for core material should be submitted to the Alfred-Wegener Institut. The request should contain all the information outlined above in Part A of this section. The curator will forward the request to an ISC designated panel of scientists for consideration for approval. Upon approval, the curator will sample the cores and dispatch the material.. The addresses of these facilities are:

The Curator	**The Curator**
Antarctic Marine Geology Research Facility	Core Repository
Florida State University	Alfred-Wegener-Institut,
Florida 32306-3026	Bremerhaven
USA	GERMANY
Tel +1 (904) 644 2407	Tel +49 (471) 4831 0
Fax +1 (904) 644 4214	Fax +49 (471) 4831 149
e-mail: curator@gly.fsu.edu	e-mail: hgrobe@awi-bremerhaven.de

Upon completion of work on the samples and publication of a manuscript the investigator will be required to:
1) submit a reprint of published work to the curatorial center
2) submit final analytical data from the samples to the curatorial center.
3) return unused samples to the curatorial center

7.2 Core Handling & Sampling Procedures

Core box management: The "Archive half" core boxes received from Cape Roberts will be first logged-in and stacked systematically in the CSEC-Core Storage Facility (CSEC-CSF) building adjacent to the Crary Science and Engineering Center(CSEC). This facility will be maintained at 2°C. The "Archive half" core boxes then will be packed for shipment to the core repository in Tallahassee. The "Working half" core boxes will be brought to room CSEC 201, logged-in, and then displayed for examination and sampling (Room CSEC 201 is at normal room temperature). When sampling has been completed, the "working half" core boxes will be transferred to the CSF and packed into containers for shipping to Bremen.

Because CSEC 201 is maintained at much higher temperatures (and lower humidity), core dehydration will occur and must be counteracted by regular spraying with water. Viewing and sampling will take place in CSEC 201, whole core X-radiography in CSEC 204, and palaeomagnetic sampling in by drill press in Loading Dock C. Core will be returned to the Core Storage Facility as soon as examination and sampling are completed in order to reduce core degradation.

On-site and Crary Lab sampling: During the drilling phase of the project samples may be taken only by the science operations manager (primarily at the drill site) and by the curator (and designated personnel) at the Crary laboratory. Sampling during the drilling phase will take place in two stages. The first stage will occur upon receipt of core at the Crary Lab. Approximately every 3-4 days during periods of drilling 80-100 meters of core will arrive at the Lab. These 80-100 m of core will be laid out in CSEC room 201. Next, the core will be moved, only one box at a time, into CSEC room 204 for whole core X-radiography. After the cores are x-rayed the curator and/ordesignated personnel for each discipline (paleomagnetics, sedimentology, paleontology,etc.) will flag the intervals to be sampled. Palaeontological samples will be taken prior to paleomagnetic and general sampling.

After paleomagnetic sampling is completed, general sampling will be completed by the curator and designated personnel. Priority will be given to sampling for on-ice studies at this stage. After all the sampling is completed the cores will be returned to the CSF. Any differences that may arise will be resolved prior to sampling through discussions with the on-ice parties involved, the Project Science Coordinator (and/or ISC representative), and the curator.

A second stage of sampling will occur after the first hole is completed in order to ensure that adequate material is taken for off-ice studies for the Research Report. At this point all the core for the hole will again be laid out for sampling. Prior to sampling, however, the Chief Scientist will review the sampling plan with on-ice scientists any further sampling proposed by them, and will also review with them requests for samples from off-ice scientists. At this stage it will be necessary to reach a consensus among all scientists receiving core samples material on work to be carried, the shape of the manuscript to be submitted for Initial and Research Reports (short summary of expected content and authorship for the manuscript will be needed before material can be dispatched for study for the Research Report).

If an obvious overlap occurs between requests from on-ice and off-ice scientists the PSC will seek an acceptable solution via email. If off-ice scientists cannot be reached in a timely manner then resolution will be sought with the on-ice scientist nominated by off-ice colleagues to carry out their sampling. Both stages of sampling procedures will be repeated for the second hole.

Sampling at the Crary Lab will be conducted largely by scientists under the supervision of the Curator. It will be important for those sampling to follow instructions on proper sampling techniques to ensure minimal contamination and disturbance of the core as well as proper labeling of core boxes and samples.

Post-Drilling Phase Sampling: All post-drilling phase core sampling will be conducted by the curators of the FSU and Bremerhaven facilities or by investigators under the supervision of the curators. Sampling will be conducted only after submission and approval of sampling requests by the ISC or their designates.

7.3 Sample & Data Management

On Site Data Management: At the Crary Lab, the following information will be entered into a database maintained by the curator:

Investigator
Core designation
Depth interval in core
Size of sample
Comments.

At the end of each sampling session the on-ice scientists will be supplied with a list of samples taken by all scientists. This list will include the above information as well as the types of analyses to be conducted on the samples (e.g. Paleontology-diatoms, Sedimentology-XRD, etc.)

Post-Drilling Data Management: The curatorial facilities at FSU and Bremerhaven will establish and maintain mirror databases and World Wide Web sites that will include coring information (Core descriptions, etc.), samples taken to date, investigator addresses and project proposals, and any final data produced on site (e.g., multi-sensor track data, biostratigraphic data, etc.). In addition, the facility databases and Web sites can also be used to maintain data submitted after the drilling phase. The data will be available to any Cape Roberts investigator via the internet (FTP, WWW, gopher) from either facility.

SECTION 8
SCIENTIFIC WORK BEYOND ANTARCTICA

This section outlines work based on core samples made available during and after drilling (Table 8.1) to be submitted for the Research Report by August 15 1998. The outline is offered as a guide only - teams and authors should agree on the way in which results will be reported and advise the Project science Coordinator of authorship responsibilities as the samples become available in December 1997. A workshop to review the results of the project will be held at University College, London, in late June, 1998. We hope all science areas of the project will be represented, so that manuscripts that are submitted in August can take adequate account of results from other parts of the project.

8.1 Geophysical Surveys & Rock Properties

This work will comprise at least four elements:

- results of strength tests by Crosta (U Milano)
- integration of petrophysical test results from core samples with whole core and downhole logging results, following by an interpretation of the logs, taking into account the sedimentological and petrological descriptions of the strata.
- the linking of the cored sequence to regional seismic surveys through logging and other information
- a review of the seismic stratigraphy of the basin based on the results above.

The way in which work for the latter three elements is to be organised is currently under discussion between NZ, German and US investigators.

8.2 Sedimentology

New information will come from 2 main sources:

- carbonate and grain size analysis, and
- studies of micro structure using petrographic thin sections and X-radiography.

Carbonate and grain size analyses will be carried out at 1 m intervals to characterise the core and help interpret depositional environment. Carbonate analyses will be carried out at BGR by Dietrich and grain size analysis at JCU by Woolfe. A comparative grain size data set will also be generated by de Santis at VUW, Wellington. Claps at U Ferrara will use these and other data for detailed cyclostratigraphical analysis.

Analysis of microfabric features from thin sections of glacial sediments will be used to identify style of deposition (by lodgement, melt-out, flow, rain-out etc). This work will be carried out by van der Meer (U Amsterdam). Thin section study of lamination of deep water (Howe, BAS) and glacial (Powell, NIU) sediments is also proposed to look for microscopic features to help interpret environment of deposition.

Microscopic study of clasts surface features will be carried out by Atkins (VUW) to determine the extent of the glacial imprint on the sediments.

8.3 Sedimentary Mineralogy & Geochemistry

Provenance studies will be carried out using bulk chemical analyses and thin section observations(Armienti, U Pisa/Kyle, New Mexico Institute of Mining Technology), bulk and isotope chemistry (Bellanca et al. U Calabria), clay, silt and heavy mineralogy (Ehrman, U Halle), chemistry of clays and other minerals (Messiga, Setti et al., U Pavia) and Sm/Nd ratios (Lavelle, British Ant Survey).

Climate-related studies include the use of bulk geochemistry for weathering (Krissek, Ohio State U; Bellanca et al. U Calabria). and C/O isotopes for marine/ice volume temperature trends (Kennett, UC Santa Barbara).

8.4 Petrology & Geochemistry

Chemical analyses of clasts will be carried to support thin section studies for provenance of both basement (Talarico, U Siena) and volcanic clasts (Armienti/Kyle) from the core. The results will link with provenance studies and contribute to knowledge of the evolution of the Transantarctic Mountains/Victoria Land basin system and rift-related volcanism as it developed.

8.5 Geochronology

Isotopic dating on suitable material will be carried out by Ar-Ar and U-Series techniques (McIntosh, New Mexico Institute of Mining & Technology and Pankhurst, British Ant Survey). This may include ashlayers or flows, or more likely clasts eroded from pre-existing volcanoes. Some dating may be carried out on clasts to help identify their origin. Sr $^{87/86}$ ratio of shell fragments will also be determined, providing indirect isotopic ages for the enclosing strata.

8.6 Palaeomagnetism

A range of tests will be carried out on samples already taken to check their magnetic stability and verify the magnetic stratigraphy obtained from samples measured in Antarctica. Susceptibility measurements will also be made and as well as chemical and petrographic studies carried out on the nature of the magnetic carrier minerals.

8.7 Palaeontology & Biostratigraphy

It is expected that most if not all on-site paleontologists will want to work on additional material to improve age designations and environmental interpretation. Currently the additional contributions include study of molluscan macrofossils by Beu and radiolaria by Hollis (both at IGNS, NZ). Several on site paleontologists will be sharing material and getting advice from the following season's counterparts (eg for palynomorphs, nannos forams, diatoms). The goal of this work is to establish regional correlation and obtain environmental and proxy climate data. An Italian group led by Cita (U Milano) will be reviewing materal with the focus on improving correlation with European stages.

8.8 Synthesis - Climatic & Tectonic History

Results of the project to date will be summarised around two main themes:

- the record of sediment deposition and climate
- the record of basin subsidence and uplift of the adjacent mountains.

Table 8.1 Summary of approved sample requests. Preliminary results from some material, e.g. micropalaeontological samples, will appear in the Initial Report, and results from other samples should appear in the Research Report. Except for a few samples taken at the drill site, sampling is expected to be carried out by those designated below under the supervision of the core curator at Crary Laboratory.

FIELD / PURPOSE / INVESTIGATOR	LITHOLOGY	VOL	INTERVAL (m or No.)
PHYSICAL PROPERTIES			
Por, dens, vel, resist, mag susc (Jarrard) +	*All*	12 cc	10 m
Plugs to obtain direct measurements of core properties for calibrating downhole & whole core logs.			
Strength testing on core cylinders (Crosta) **	*All*	200 g	20
Triaxial strength tests on whole core 10 cm long to evaluate fine sediment over-consolidation in upper part of each hole. Samples to be taken at roughly 20 m spacing in upper 200 m of each hole.			
SEDIMENTOLOGY			
Coaly debris (Moore) *	*Coal fragments*	10cc	30
For thin section identification of composition and nature of plant debris for Research Report.			
Clast shape and surface features (Atkins) +	*Pebbles*	Large	As they occur
For documentation of rounding and glacial features such as facetting and striae - for Initial & Research reports.			
Glacial microfabric study (van der Meer) *	*Diamictite*	50 cc	20
For identification of features associated with grounded and floating ice. For Research Report.			
Grain size (Woolfe) *	*All*	1 cc	1 m
For sediment texture through the core to detect short and long period trends. For Research Rept			
Grain size/Cyclostratigraphy (Claps) +	*All*	20 cc	50
4-5 samples from each facies for thin section and facies characterisation.			
Thin section and peel study (Howe) +	*Deep marine*	5 cc	10 m
For seeking effects of deep water current flow for Research Report			
Structures in glacial sediment (Howe/Powell) +		X-radiography tapes	
Working half of core to be x-radiographed at Crary Lab before sampling. For Initial and Research Report			

\+ sampled by requestor
* sampled by Fielding/Bryce
** sampled by Pyne at drill site

FIELD / PURPOSE / INVESTIGATOR	LITHOLOGY	VOL	INTERVAL (m or No.)

PALAEOMAGNETISM

Magnetic stratigraphy + | *Mudstones* | 10 cc | 0.5 m
(Florindo, Roberts, Sagnotti, Verosub, Wilson)
Close-spaced sampling for magnetic stratigraphy and susceptibility with related testing for identifying stability and source of magnetisation. For both Initial and Research Report.

PALEONTOLOGY

Coccoliths (Wise, Villa, Watkins) + | *Marine seds* | 5 cc | 2 m
For on-site biostratigraphy for the Initial Report and subsequent refinement

Diatoms (Harwood, Scherer) + | *Fine seds* | 2 cc | 2 m
Radiolarians for Hollis for Research Report + | | 15cc | 40
For on-site biostratigraphy for the Initial Report and subsequent refinement

Foraminifera (Webb, Strong, Huber) + | *Mudstones* | 20 cc | 10 m
Ostracods for Dingle for Research Report +
For on-site biostratigraphy for the Initial Report and subsequent refinement

Macrofossils (Taviani, Beu and others) + | *All* | | As they occur
Macrofossils to be taken from core if possible before the core is split at the drill site, but otherwise as core is studied at Crary Lab. Material is to be described initially, along with sedimentary setting, by Taviani for the Initial Report, with further study for the Research Report by specialists selected in consultation with the Palaeontology Coordinator.

Palynology + | *Mudstones* | 5 cc | 4 m
(Hannah, Raine, Wrenn, Askin, Graham Wilson)
For on-site biostratigraphy for the Initial Report and subsequent refinement

Calcareous microfossils x | *Mudst, marls* | 10 cc | 50
(Cita/Coccioni/Erba/Galeotti/Monechi/Nocchi/Premoli-Silva/Reale)
To compare with sedimentary successions in other Ross Sea drillholes and other standard reference sections where the GSSP of the Eo/Oligocene and Olig/Miocene boundaries have been defined. Work programme to be discussed with Palaeontology Coordinator to minimise duplication of the efforts of on-ice micropalaeontologists. For Research Report.

FIELD / PURPOSE / INVESTIGATOR	LITHOLOGY	VOL	INTERVAL (m or No.)

PETROLOGY

Clast thin sections (Smellie/Talarico) + | *Clasts* | 40 cc | up to 200

For description with modal and microprobe analyses on typical samples of both volcanic & basement clasts for Initial and Research Reports

Clast chemistry (Talarico/Armienti/Kyle) + | *Clasts sampled for thin section*

Xenolith geochemistry (Gamble) ++ | *Volcanics*
Ar-Ar dating & chemistry (McIntosh) ++ | *Volcanics*
U-series dating (Pankhurst) ++ | *Volc & basement*

Sampling for these purposes is for the Research Report, and depends on occurrence of suitable material in the core.

+ sampled by requestor
x sampled by Taviani
++ sampled by Kyle/Smellie

MINERALOGY & GEOCHEMISTRY

Bulk chemistry (Armienti/Kyle) * | *Sand/mudst* | 40 cc | 200

Armienti to do hole 1 with 100 XRF + 100 INAA analyses; Kyle to do hole 2 with 100 XRF + 50 ICP analyses. 10% of samples to be analysed in both labs. Standards to be run on both geochem & microprobe - data archive with Kyle. Palaeoclimate interpretation with Krissek. Some collaboration/comparison with Bellanca et al. data needed.

Sediment chemistry (Bellanca et al) * | *Mudstones* | 10 cc | 50

To distinguish detrital, biogenic, authigenic and diagenetic sediment components, using XRF and AA techniques on bulk sediment samples, and trace element and isotopic measurements on individual particles, for aiding core interpretation. Some collaboration/comparison with Armienti/Kyle data needed.

Carbonate content (Dietrich) * | *All* | 2 cc | 1 m

Provides % calcite, dolomite, siderite with method of KLOSA, 1994. For Research Report

Clay mineralogy (Ehrmann) * | *All* | 10 cc | 1 m

Provides % illite, chlorite, kaolinite, smectite + crystallinities of smectite & illite from clay fraction (<2 microns). Data already obtained from other holes in Antarctic region on similar sampling frequency. To link with studies of bulk and heavy mineralogy on same samples. Some results for Initial Report but main results in Research Report

Silt mineralogy (Ehrmann) | *Ehrmann's clay mineralogy samples*

Quantitative XRD analysis of 2-20 & 20-63 micron fractions for provenance information for Research Report

Heavy minerals (Ehrmann) | *Ehrmann's clay mineralogy samples*

Proportions & types of heavy minerals in sand fraction using petrographic microscope for Research Report.

FIELD / PURPOSE / INVESTIGATOR	LITHOLOGY	VOL	INTERVAL (m or No.)
Mineralogical char of clays (Setti et al.) ***	*Mudstone*	10 cc	25

Clay fraction (<2 microns) analysed by XRD, XRF, SEM & EDS, Hg Porosimeter. Crystallite size and microstrain analysis by Warren-Averbach method. Ordering in interstratified minerals by Srondon method. Provides higher resolution mineralogical data to link with Ehrmann's close-spaced stratigraphic survey. For Research Report.

Source char. by min chem (Messiga et al.) ***	*Sandstone*	10 cc	25

Major and trace element distribution within mineral grains using EDS-WDS microprobe. High resolution mineralogical data to link with Ehrmann's close-spaced stratigraphic survey. For Research Report.

Hydrocarbon composition (Kettler) +	*All*	10 cc	5 m

To determine Total Carbon, CHNS-O, gas chromatograhy of solvent fraction, $\delta^{13}C$ of kerogen for oil-source rock correlation and marine productivity during mass extinction events. For Initial Report.

Sm/Nd isotopes (Lavelle) ***	*All*	10 cc	20 m

To obtain isotopic signatures and ages of the source terrane for each major sequence for Research Report. Analyses to be carried out on <2 micron clays and >10 micron silts

Sr isotopes (Lavelle) ***	*Shell*	1 cc	where possible

To obtain $^{87}Sr/^{86}Sr$ isotopic ratio for estimate depositional age from shell material for Research Report.

C/O isotopes (Kennett) ***	*Mudstones*	5 cc	40

To test suitability of calcareous microfossils for isotopic studies of C and O for Research Report.

+ sampled by requestor
* sampled by Fielding/Bryce
*** sampled by Howe

Notes:

1. Investigators may ask to use the residues for other studies. They may also be asked to return residues so that they may be used by others.
2. Arrangements for curation of macrofossils, microfossil slides and thin sections to be decided by ISC.
3. Further sampling may be requested either by ISC members by circulating a proposal noting purpose, amount, number or frequency of sampling and CV of investigator. During drilling the Chief Scientist may approve modest non-routine sampling requests after consulting relevant senior scientists in the project.

SECTION 9
REPORTING AND PUBLICATION

The information policy for CRP is based in some aspects on that of the Ocean Drilling Program (JOIDES JOURNAL, 20 (2), 47-49) and in others on the smaller land-based drilling programmes in the Ross Sea. It involves documents that can been separated into four distinct categories.

9.1 Working Documents

The project is founded on a Record of Understanding developed in September 1993 at a meeting at Xerox Document University, near Washington DC. This established an International Steering Committee responsible for the scientific aspects of the project and an Operations/Management Group (OMG) responsible for logistic and drilling operations. These two groups subsequently have met together and separately in Rome in August-September 1994, OMG in Santiago, Chile, in July 1995, and ISC in Siena, Italy in September, 1995. The discussions and decisions of these groups are recorded in the preparatory papers, discussion papers and minutes of these meetings.

9.2 Planning Documents

These include:

- the Operations Plan, which details all operational aspects of the project. This is prepared by the Project Manager - Jim Cowie, Antarctica NZ, Christchurch.

- the Science Plan (this document), which contains a synopsis of the project, and outlines science tasks and schedules from core recovery to publication.

- short science proposals and subsequent updates received in response to EOS request of 1/94, along with 1 page CVs and subsequent updates received in response to ISC request of 9/94

- responses to letters of invitation for on site participation and home lab research

Copies of these documents are held by ISC members, and project offices in Wellington and Christchurch.

9.3 Public Information Documents

These provide information about the project to different readerships. They include:

- the January 1994 article in EOS announcing the project and calling for one-page proposals. Prepared by ISC.

- the Cape Roberts News, a 4 page occasional newsletter backgrounding the project and providing information on its progress (aimed primarily at scientist participants) No 1 was distributed in July 1994, No 2 in March 1995, No 3 in March 1996 and No 4 in September 1996. Produced by PSC.

- colour pamphlet on the project, one double-sided A4 page, aimed at the public, schools etc. Produced by PSC.

- press releases. Releases on progress of the project to date have been issued by the Information Officer, Antarctica NZ. Reports of scientific results during and after the drilling phase will be prepared by the Chief Scientist, and issued through the Information Officer or his representative, who will be representing to the project to the media. Press releases relating to scientific work of the project will be distributed to international partners for release at the same time in the various countries. Press releases from Antarctica NZ on operational aspects of the project will also be distributed to partners.

- articles after each drilling season in [New Scientist, EOS]. Prepared by the Chief Scientist and senior scientists.

Copies of Cape Roberts News and the colour pamphlet are available from the Information Officer, Antarctica NZ, or Antarctic Research Centre, Victoria University of Wellington.

9.4 Scientific Publications

These now include:

- the 1992 Cape Roberts Workshop Report published by the Royal Society of NZ, which outlined the reasons for the project and how it could be carried out to both scientists and managers.

- abstracts of tasks or posters presented at meetings e.g:

  Barrett et al., 1994. Coring for Antarctic tectonic and climatic history, Cape Roberts Project, ANTOSTRAT Symposium, Siena, Italy, Aug 24-26, 1994. *Terra Antartica*, 2 (1)

  Webb et al., 1995. Coring for Antarctic tectonic and climatic history, Cape Roberts Project, International Conference for Coring for Global Change, Kiel, Germany, 28-30 June 1995.

  Barrett, P J, Henrys, S A, et al., 1995. Geology of the margin of the Victoria Land Basin off Cape Roberts, Southwest Ross Sea, Antarctic Research Series, AGU Washington DC.

Future publications will include:

- Short article for <u>Science</u> or <u>Nature</u> on results of drilling season. Authorship by Cape Roberts science team.

- Initial Reports of the Cape Roberts Project (2 planned)
contains logs, core descriptions and immediate results and is prepared immediately after drilling is concluded for each season (deadline December 15 publication by end of March). Authorship by Cape Roberts science team. Internal review only. Discussed further in 9.5 below.

- Scientific Reports of the Cape Roberts Project (2 planned)
contains results of laboratory work on core samples (sedimentology, palaeontology, petrology, geochemistry, palaeomagnetism, geochronology carried out in the months following the drilling (deadline August 15, publication by end of November). Separately authored articles with authorship agreed by consensus of all contributors to the report. Articles will undergo review.

The Initial and Scientific Reports are aimed at relatively rapid characterization of the cored sequence, and fast publication of the results. The core will be available for further sampling at a later date.

Articles reviewing the results of the project will be solicited by the International Steering Committee for presentation at the VIIIth Antarctic Earth Science Symposium to be held in Wellington, New Zealand, from July 5-9 in 1999, and for publication in international journals.

Articles may be prepared by individuals or groups of scientists for international journals, but must be approved at an early stage by the International Steering Committee before a manuscript is submitted to ensure appropriate cross-referencing to related work in progress and to reduce duplication of effort..

All scientific articles based on material from the project are to carry an acknowledgement of the project in the following or similar words: *The Cape Roberts Project has been made possible by the resources and close collaboration of the Antarctic Programmes of Italy, New Zealand, the United States of America, Germany, Australia and Great Britain with field operations organised by the NZ Antarctic Programme. We wish to thank those involved in the field phase of the project for their efforts in recovering the core and related data, and the International Steering Committee for access to the core material.*

9.5 Organisation of the Initial Report

The first results of the Project will be prepared by the on-ice scientists before leaving the ice for publication as a special issue of *Terra Antartica*. Table 9.1 below indicates the likely structure of the report and the names of those expected to contribute. Also several senior scientists will help with coordinating contributions from each of the main areas of the project. The size of the report has been set at 300 pages, and the Table 9.1 gives an indication of the space available for each part of the report.

Each section of the report should include an outline of procedures, a summary of data obtained and typical sets of data in the form of tables and graphs, along with a brief explanation of its significance. We expect large numerical and biostratigraphic data sets, which should be lodged in the SEPAN database through Dr Niessen while in Antarctica or Dr Grobe (hgrobe@awi-bremerhaven.de) after this. Eighty pages have been set aside in the report for publishing data, though this may be insufficient. The balance between the narrative and data sections of the report will be reviewed in consultation with the science team after drilling has been completed.

The editorial style will be that of *Terra Antartica*, which is set out in Table 9.2. Although material for this report will not be formally reviewed, all contributors should ensure that their material has been read both for scientific good sense and consistent style, grammar and spelling by at least two other colleagues, before submission to the editorial office at Crary Lab.

Table 9.1 List of tasks and scientists reporting on the drilling phase of the project in 1997 for the Initial Report. Those responsible for collating material from the various sections are marked with an asterisk (*). Numbers in parentheses are indications of the number of published pages (text, figures, tables and references) for each section.

BACKGROUND (5)	P Barrett	
REGIONAL SURVEYS (10)		
Seismic & magnetic surveys	*F Davey	G Brancolini
		S Henrys
DRILL SITE (30)		
Core stats/sea ice obs (6)	A R Pyne	
Core fracture study (6)	T Wilson	
Core physical properties(6)	F Niessen	
Downhole logging (12)	*R Jarrard	T Wonik
	S Bannister - from NZ	P Montone -from Italy
CAPE ROBERTS LAB		
Stratigraphy (4 m/page logs) determined by core recovery	K Woolfe (Hole 1)	R Powell (Hole 2)
CRARY LABORATORY		
PAL & BIOSTRAT (60)		
Diatoms (10)	D Harwood	
Foraminifera (10)	*P Webb	P Strong
Macrofossils (10)	M Taviani	
Nannofossils (10)	S Wise	G Villa
Palynology (15)	M Hannah/J Wrenn	I Raine
Biostrat synthesis (5)	*Wise/Webb	
PETROLOGY (20)	*J Smellie	P Armienti
	F Talarico	
PALEOMAGNETISM (20)	A Roberts	L Sagnotti
	*K Verosub	F Florindo
	G Wilson	
SEDIMENTOLOGY (60)		
Clay mineralogy (5)	W Erhmann	
Clast shape & fabric (5)	C Atkins	
Cyclostratigraphy (5)	M Claps	
Lamination in mar. seds (5)	J Howe	
Lamination in glac. seds (5)	R Powell	
Organic geochemistry (5)	R Kettler	
100m/page log/interp (20)	M Hambrey (Hole 1)	L Krissek (Hole 2)
Sedimentary synthesis (10)	*C Fielding/ Hambrey/ Krissek	
CORE MANAGEMENT (5)	M Curren	
CONCLUSIONS (10)	Barrett and others	
APPENDICES (80)		

Instructions to the Contributors

Terra Antartica publishes several types of contributions:

1. **Articles**: 4 or more printed pages of *Terra Antartica* (equivalent to more than 20 000), abstract required (no more than 200 words), the text must be divided in sections and, if necessary, in subsections with headings
2. **Short notes**: 2 printed pages of *Terra Antartica* (equivalent to about 11 000 characters), no abstract, no more than 3 displays, the text must be divided in sections with headings
3. **Review papers** on relevant topics
4. **Summary reports** of meetings of Antarctic interest
5. **Special issues** devoted to specific topics and meetings may be published (a financial contribution will be required; contact the editor for more information).

Submission

Manuscripts (three original hardcopies of text and displays) should be submitted to *Terra Antartica*, Dip. Scienze della Terra, Università di Siena, Via delle Cerchia 3, 53100 Siena - Italy. We ask the contributors to send text and displays, where possible, also by **e-mail** or on **floppy disk** (3.5 inch). This allows us to carry out most the refereeing procedure by e-mail and therefore to save a lot of time. Contributions submitted before 31 January will possibly be published in the first issue and contributions submitted before 30 June in the second issue. The dates of receipt and acceptance of the contributions will be published.

Correspondence

The corresponding author and his complete address (including fax and/or e-mail) should be indicated.

Text

The first page should contain the title of the contribution, the name(s) of the author(s), their institutional address(s), and, if required, a concise and informative abstract (no more than 200 words).

The main text should follow and be subdivided into sections. Primary headings should be in centred capitals, secondary headings in lower-case adjacent to the left margin. Headings should not be preceeded by numerals or letters.

Acknowledgements should follow the main text.

An alphabetical list of all cited **references** should follow. Use upper and lower case for author names and pay attention to punctuation and format. Names of periodicals should be abbreviated according to the World List principles; if in doubt, give the full name of the journal. Examples:

Halls P., Free C., Aurora F., Magnum J.B., & Denver S., 1994. The New Scientific Pages of Macintosh. *European Journal of Page Structure*., **1**, 103-123.

France J.C., Hall U. & Member I.L., 1993. *The Preparation of Pages*. Oxford Publications, Cambridge, 134 p.

Page I.D. & Peiper O.S., 1992. The Form of Pages. In: George M.L. & Hall U.S. (eds.), *Recent Progress in Page Forms*, Page Publications, London, 211-220.

In the text, references should be cited in the form Page & Peiper (1992) or 'according to France et al. (1993) and Page & Peiper (1992). Papers 'in preparation' or 'submitted' are not valid references.

Displays are either figures or tables and should be referred to as Figure at the start of a sentence or figure within the text or as Fig. within brackets (e.g. see Fig. 3). Example of a figure caption:

Fig. 1 - Scheme of the possible ways for structuring pages.

Abbreviations and **acronyms** must be unambiguously defined in the text the first time they are used, e.g. Scientific Committee on Antarctic Research (SCAR).

Numbers should be written according to the following examples: 3 August 1994, 1988-1990, 0.07, 76 888 (and not 76.888 or 76,888), 78%, 25°34'98".

The text should be saved in a **Macintosh Word** or **MS DOS Winword** file and be submitted, together with the three hardcopies, either on diskette or by e-mail (as attachment file to be converted with BinHex).

Displays

Originals of **figures** and **tables** should be prepared at approximately twice the intended printed size (please only use good quality drawings or laser printing). The maximum size is one page of *Terra Antartica*. Displays should be prepared for either single (width: **8 cm**) or double (width: **16,5 cm**) column layout, with the minimum of excess space. Letters or numerals should not be less than 1 mm in height after reduction. **Photographs** should be sharp black and white glossy prints. **Colour photographs** and **colour drawings** may be acceptable on merit if the authors are prepared to pay for colour separations (contact the editor for more information).

All maps, field sketches and photographs should report a **metric** bar scale.

When quoting from published work, the author must ensure **copyright** is observed. Permission must be obtained from the copyright holder if the author wishes to print displays and the source must be acknowledged in the caption.

Authors' names and figure and table numbers must be indicated with pencil on the originals.

Displays should be saved in **graphic files, eps** or **tiff**, and submitted together with the text, either on diskette or by e-mail (as attachment file to be converted with BinHex).

Table 9.2 Instructions for authors for preparing material for the Initial Report.

9.6 Selected References

Anderson J.B. & Ashley G.M. (eds.)., 1991. Glacial marine sedimentation: paleoclimatic significance. Geological Society of America Special Paper 261, 232 p.

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