

## THE CAPE ROBERTS PROJECT

The Cape Roberts Project was an international collaborative effort of seven countries - Australia, Germany, Italy, the Netherlands, New Zealand, the United Kingdom and the United States. The Project was managed by Antarctica New Zealand and led scientifically by Prof. Peter Barrett from Victoria University of Wellington. The project finished coring during the summer of 1999/2000, a small team completing the final clean-up of the site in 2001.

The objective of the project was to investigate and better understand the climatic and tectonic history of the region. Three sites were drilled over three field seasons, providing continuous core (with 95% recovery) of 1500 metres. This core represents an age of 16 million years ago, from the upper section of CRP-1, to approximately 350 million years ago, from the bottom of CRP-3.

The earth core was being studied for three major reasons:

- To gain further knowledge of the paleoclimate of the earth
- To better understand the glacial history of the East Antarctic Ice Sheet
- To date the rifting of the Western Antarctic system



Beside Cape Roberts drill rig

### Location

Cape Roberts is situated 125km north - northwest of Scott Base on the coast of the Antarctic continent. The first drill site was 15kms off the Cape Roberts shore. The second site was 14kms from the Cape and the third drill site was 11.5kms off shore. Geologically, the drill sites were selected to fully interrogate the historical record of the region using three different locations each studying a different time frame in history with age overlap to link the sites.



Aerial view Cape Roberts site

### Science results

#### Cape Roberts 1997/98 season highlights

The 1997/98 drilling season was cut short by an early break-up in the sea ice but despite only 150 metres of core being recovered a number of significant scientific findings were made including:

- Documentation of a period (20-22 million years ago) not before recorded from the Victoria Land Basin
- The discovery that strata was nearly 8 million years younger than expected indicates the need for a major review of the Victoria Land Basin stratigraphy interpreted from seismic surveys

- A characterisation of variations in glacial and glacial marine environments in the early Miocene and Quaternary. Two different approaches indicate around 10 major variations in ice extent and relative sea level through the cored interval
- An identification of a significant, relatively warm-climate facies in the early Quaternary with a rich and varied calcareous and siliceous biota
- A documentation of new fossil biotas from the Antarctic region and development of a biostratigraphic database

### **Cape Roberts 1998/99 season highlights**

In this season 624 metres of continuous core (with 95% recovery) was pulled out of the sediment basin near Cape Roberts. Some of the scientific discoveries made from the core were unexpected and extremely important to our understanding of Antarctica's past climates. The core represents strata deposited on the sea floor at the western margin of the Victoria Land Basin. The sedimentary features in the core are glacial deposits, which record the changes in the ice sheets.

There were a number of scientific findings from the core studied including:

- Volcanic ash layer 1.2 metres thick from a depth of 112 metres dated at 21.4 million years. The thickness of the layer and size of the large stones suggests a very large volume eruption in close proximity to the drill site (50- 100 km) that generated an ash cloud reaching 50 to 70 km into the stratosphere
- A large number of microfossils found in the core. The fossils are used to date the strata and provide data on the environment of deposition. The dating throughout the core is very high resolution because fossils have been found at all depths. Many new forms of microfossils are also being found increasing the number of species known to have existed in the past
- The oldest portion of the core dated at 33 million years. Despite evidence of warmer times, stones were found throughout the core, and show that ice persisted in this region throughout the time represented by the cored strata. Much of the value of the core recovered comes from the opportunities for dating to <0.1 million years using the microfossils, volcanic ash layers, isotope chemistry of shells and reversals of the earth's magnetic field



Cape Roberts drill rig  
Nov 98

### **Cape Roberts 1999/00 season highlights**

In this season 939.4 metres of continuous sediment core (5,147 kgs) was recovered near Cape Roberts. The results show that ice sheet cycles 20 million years ago in the Southern Hemisphere were similar in frequency to those in the Northern Hemisphere over the last million years. Scientists have also seen that the coastal Transantarctic mountains, which are currently bare of vegetation, were covered in cold climate vegetation around 25 to 34 million years ago.



Cape Roberts drill site

The final goal of the Cape Roberts Project has been achieved by coring into the floor of the Victoria Land basin, into 350 million year old Beacon sandstone. The age of the oldest sediment was thought to have been 50 to 100 million years old. The core shows it to be around 34 million years old. This will change much of the theories regarding the history and processes along the margin of one of the largest rifts in the world.

## **Summary of results**

The three cores, provide a continuous and detailed sedimentary record for some intervals but with a number of significant time breaks for others due to erosion and non-deposition. The oldest Cenozoic sediments cored show that the Ross Sea coast of East Antarctica had a cool temperature climate with a low woodland vegetation from 34 to 25 million years ago. These imply coastal summer monthly temperatures of around 12°C. Nevertheless the oldest cores still include occasional boulders and striated stones that record glacial activity and ice-rafting at this time.

The younger core representing the period from 25 to 17 million years ago, records a low-growing, sparse tundra on the adjacent mountains, along with periods in which the ice sheet margin reached offshore beyond the drill site. In this case coastal summer temperatures were significantly lower, around 5°C.

One significant outcome from studying the sediment characteristics is that the core shows cycles of advance and retreat of the ice margin. These coincide with falls and rises in sea level recognised from other core features, and presumed to be linked through changes in ice sheet volume. Over 50 of these cycles are recognised in the Cape Roberts core, though many more must be missing through erosion. Three of the thicker cycles deposited around 24 million years are of particular interest because a lucky combination of age data from volcanic ash, fossils and magnetic measurements has shown them to have been deposited within a time period of no more than 400,000 years and most likely with 120,000 years. Although the most recent ice ages are characterised by a 100,000 year cyclicity, the deep-sea record suggests that those prior to 800,000 years ago are characterised by 40,000 year cyclicity. The Cape Roberts record is the first physical confirmation of cyclicity on these time scales for ancient ice sheets, indicating that the Antarctic ice sheet in the distant past was being modulated at Milankovitch frequencies like the more recent Northern Hemisphere ice sheets.

## **Drilling operations**



Cape Roberts Camp – Nov 98

Drilling off Cape Roberts took place in the early spring (October-November). The sea ice needed to be at least 1.5 metres thick to support the 50 tonne drill rig. The sea depth under the rig varied between the three sites from 150 to 400 metres. A total of over 1500 metres of sediment core were pulled from the three sites. This is equivalent to over 8000 kgs of core. After pulling the core up from the ocean floor, the core was split into two halves. One section was archived in a core storage facility at Florida State University in the United States, and the other section was sent to the Alfred Wegener Institute in Germany to be available for analysis by researchers around the world.

## **Environmental impact**

Antarctica New Zealand co-ordinated the environmental management of the project, which included completion of a Comprehensive Environmental Evaluation (CEE). This is the most detailed level of environmental impact assessment required by the Protocol on Environmental Protection to the Antarctic Treaty, and was the first of its kind undertaken.

In 1998 New Zealand invited an independent review of the project's activities against its CEE. The Australian Antarctic Division Environmental Manager visited the drill site and the camp and found the activity he assessed to be in accordance with the CEE and within the limits of the environmental monitoring programmes in place. He noted that commitment to environmental protection was a part of the CRP organisational culture, with staff familiar with the environmental issues. The overall conclusion was that the project's activity resulted in negligible environmental impact.

## **Management**

Antarctica New Zealand was responsible for implementing the Cape Roberts Project. The scientific direction of the project came from an International Steering Committee (ISC). The logistics were co-ordinated separately through an Operational/Logistics Management group (OMG).