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### Voyage Plans and Summaries

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#### Franklin Voyage Summary No. FR05/00

##### Title

Seismic structure and sedimentary history of coral reef systems of the Northwest Shelf: Rowley Shoals, Scott and Seringapatam Reefs: implications for global sea level and climate change during the Quaternary.

##### Itinerary

Departed Darwin 1100 hours Wednesday 12 July  
Arrived Broome 1600 hours Monday 31 July, 2000.

##### Principal Investigator

Dr Lindsay Collins  
Department of Applied Geology  
Curtin University of Technology  
Perth WA  
Tel: (08) 9266 7968 Fax: (08) 9266 3153  
email: [head@lithos.curtin.edu.au](mailto:head@lithos.curtin.edu.au)

##### Scientific Objectives

Little is known of the geological history and sedimentary setting of shelf-edge reefs on Australia's western margin. These reefs which are centres of biodiversity face increasing pressures from human activities and environmental change (eg. fishing, tourism, resource development projects, coral bleaching events) and are in need of more detailed scientific understanding to assist planning and management. This study will investigate the continental shelf substrate from which the reefs arise, and the sea level change and growth history of the reef platforms, within the limits of available access.

In a separate study, sediments will be surveyed near Broome and Roebuck

Bay, where large migratory bird populations, pearl farming and tourism depend on the bay and its ecosystems. This research will be specifically focused on the microfaunal components of the onshore and offshore sediments in Roebuck Bay.

An AGSO piggy-back study will investigate the Penguin Deep.

### **Cruise Objectives**

#### **Scott Reef and Rowley Shoals**

1. Determine the sedimentary and structural setting of reef systems of the Northwest Shelf;
2. assess the Quaternary (=last 2 million years) morphology, growth history and structure of the reef systems;
3. assess the feasibility of obtaining "long" Holocene (=last 10,000 years) stratigraphic, sea level and palaeoclimatic records from the reef systems.

#### **Broome/Roebuck Bay**

1. Determine sediment types and thicknesses in the area seaward of present day tidal flats;
2. assess sediment sources and production using the microfauna as a productivity index.

#### **Penguin Deep (AGSO Project)**

1. Determine the composition and nature of the modern sediments of the Penguin Deep;
2. acquire seismic data to map the down-channel distribution of the Penguin fan system.

A combination of shipboard data collection and observations and seismic data obtained from a small Curtin research vessel deployed for shallow water reef traverses was used, including

1. Bottom samples at specific sites, using Smith-Macintyre Grab, epibenthic sled, gravity corer and rock dredge to obtain sediments, biota and cores;
2. PDR profiles and seismic profiles to confirm seabed morphology and subsurface reef structure, pick lowstand shorelines and define

sedimentary systems;

3. temperature and salinity profiles at most sites to obtain a snapshot of bottom conditions and regional oceanography;
4. bottom photographs and videos of specific sites to obtain substrate information;
5. small vessel traverses of reef platforms for seismic profiling and sediment sampling.

### **Cruise Track**

Following travel from Darwin the ship operated on the Northwest Shelf from latitudes 13° S (Penguin Deep), 14° S (Scott Reef) and 17-18° S (Rowley Shoals), thence eastward to nearshore Broome, with the cruise terminating at Broome (see Fig 1).

### **Results**

The program consisted of the following components in order of execution:

1. AGSO piggy-back study: Penguin Deep sedimentation and hydrocarbon seeps (4 days)
2. Curtin Scott Reef Study: Quaternary seismic structure of Scott Reef , and sediments of the platform and surrounding shelf (6 days)
3. Curtin Rowley Shoals Study: Quaternary seismic structure of Mermaid, Clerke and Imperieuse Reefs, and sediments of the reef platforms and surrounding shelf (6 days)
4. Curtin Broome nearshore sedimentation study (2 days).

#### **1. AGSO Penguin Deep Study**

The Penguin Deep is a poorly understood palaeo-drainage system that forms a major east — west orientated channel across part of Australia's Northwest Shelf. This channel system terminates north of the Yampi Shelf forming a submarine delta fan that is over 130 km long and 60 km wide and is presently in 120—300 meters of water.

The Franklin survey obtained sediment samples along and across the channel system and delta sequence that will identify the level of terrestrial inputs in relation to relative sea level rise over the past 15 thousand years. The seismic program enhances this by providing a spatial context for the data.

## **2. Curtin Scott Reef Study: Quaternary seismic structure of Scott Reef , and sediments of the reef platform and surrounding shelf**

Scott Reef is a carbonate platform and a major oil and gas reservoir. The sedimentary foundations rise 500m above the shelf surface, and the reef consists of the nearly closed North Reef and the boomerang shaped South Reef (open to the north) separated by a 400m deep intervening trench. The 45m deep lagoon of South Reef has healthy coral cover and hard substrate sponge-algal-coral communities, but is starved of bottom sediment. Strong tidal flushing (tidal range is 4m, and greater than most tropical reefs) and the open nature of the lagoon are important controls. Lagoon sediments are swept northward across the open lagoon edge and deposited in the deep trench between North and South Reefs. Seismic profiles reveal two distinct periods of reef growth, which are still to undergo detailed U-series dating. An earlier stage of growth occurred 125,000 years ago (based on dated growth records elsewhere), when reefs reached 30m below present sea level and the lagoon floor was 50m below S.L. This indicates that up to 50m of subsidence may have occurred in the last 125,000 years. The older reef system was colonised by younger reefs about 10,000 years ago, which probably grew to SL by 5,000 years ago and comprise the modern "double" reef crest which encloses the lagoon. This reef is up to 35m thick, and indicates an active and healthy tropical reef system.

## **3. Curtin Rowley Shoals Study: Quaternary seismic structure of Mermaid, Clerke and Imperieuse Reefs, and sediments of the reef platforms and surrounding shelf.**

These 3 reefs comprise one of the most perfect morphological series of reefs known. An important contribution of the study was to check the "ground truth" of aerial photograph and landsat images available, so that more detailed maps of the reefs will be produced. Seismic profiles have revised the tentative growth pattern and history of the reefs found in earlier work. A similar reef growth history to that obtained for Scott Reef applies to the Rowley Shoals (subject to confirmation of coral ages by U-series dates) , which also carries the implication of regional subsidence by up to 30m since 125,000 years ago, and indicates healthy reef growth over the last 10,000 years. This information will be of use in developing management plans for the reefs.

## **4. Curtin Broome nearshore sedimentation study**

This research project is being carried out in conjunction with other studies to determine the makeup and origin of the sediments in Roebuck Bay. These studies are necessary because of the large bird populations, pearl farming and tourism depending on the bay. This research will be specifically focused on the microfaunal components of the onshore and offshore sediments in Roebuck Bay, which will indicate amounts of terrestrial sediment input and local marine production rates, which are essential for establishing the sediment budget for the area, and for measuring environmental impacts.

## Cruise Narrative

The ship departed Darwin Harbour 4 hours late after testing newly installed positioning equipment in the harbour. During the first 2 weeks of the cruise the almost perfect weather experienced allowed Projects 1 (Penguin Deep: sediment sampling, coring and seismic profiling of a fan and fan-valley system) and 2 (Scott Reef: sediment sampling, seismic profiling, coring, CTD's, both on the surrounding shelf and the Scott Reef platform, the latter partly by deployment of the 5 m Curtin vessel carried on board) to be completed in a timely and efficient manner. After 2 days work at Rowley Shoals (Mermaid Reef), at 2300 hours on Tuesday 25 July, wind exceeding 30 knots from the ESE and rough seas forced suspension of the program. The ship was on standby for 59 hours in the lee of Imperieuse Reef until shelf sampling resumed on Friday 28 July at 1015 hours. Small vessel sampling and seismic traverses of Imperieuse Reef were resumed on Saturday 29 July at 0700 and completed by 0100. The Rowley Shoals reef platform work was not completed due to bad weather, and Clerke Reef was not visited.

Operations on Project 4 near Broome (sediment sampling, coring, seismic profiling) were completed satisfactorily during July 30-31 and the ship berthed at Broome on schedule.

Apart from 1 day when 6 whales were sighted, the area of ocean traversed was relatively poor in sightings of birds and fish, both in the open ocean and at the reef systems.

## Summary

The cruise was successful in meeting most of its scientific objectives. Weather downtime impacted adversely on achievement of the Rowley Shoals objectives, and the program was significantly reduced. Geoscientific sampling was supported by, in addition to on-board equipment, the Curtin and AGSO equipment base, which included a corer, seismic equipment, and rock dredges. The Franklin's equipment functioned well, apart from failure of a colour printer which prevented ready availability of CTD hard copies. Smith-MacIntyre Grab was preferred over epibenthic sled for sediment sampling, which was normally in depths of 300-500 m. The refurbished CSIRO corer was tested satisfactorily, but penetration was generally low; this could be improved by significantly increasing lead weights on the core barrel. Techniques for deployment and recovery of the small (5.25m) aluminium workboat supplied by Curtin for shallow island work were developed and executed well, at times under difficult conditions.

## Personnel

### Scientific Participants

### CSIRO Marine Research

Don McKenzie	Cruise Manager
Bernadette Heaney	Computing
Mark Underwood	Electronics
Val Latham	Hydrochemist
<b>Curtin University: Department of Applied Geology</b>	
Lindsay Collins	Chief Scientist
Jason McMullan	Sedimentologist
James Tyrell	Sedimentologist
Rosalyn Wallace	Sedimentologist
<b>WA Museum</b>	
Chris Brimmel	Biologist
<b>AGSO: Petroleum and Marine Division</b>	
Kriton Glenn	Scientist
Stephen Thomas	Seismic Specialist
Lyndon O'Grady	Coring Specialist
<b>Crew Members</b>	
Ian Taylor	Master
Arthur Staron	Chief Officer
John Boyes	2 <sup>nd</sup> Officer
Ian Murray	Chief Engineer
Robert Cave	1 <sup>st</sup> Engineer
Hugh McCormick	2 <sup>nd</sup> Engineer
Bill Hughes	Bosun
Norman Irvine	I.R.
Terry Ganim	I.R.
Tony Hearne	I.R.
Phillip French	Greaser
Ron Culliney	Chief Steward
Gary Hall	Chief Cook
Wayne Hatton	2 <sup>nd</sup> Cook

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Dr Lindsay B Collins  
Chief Scientist

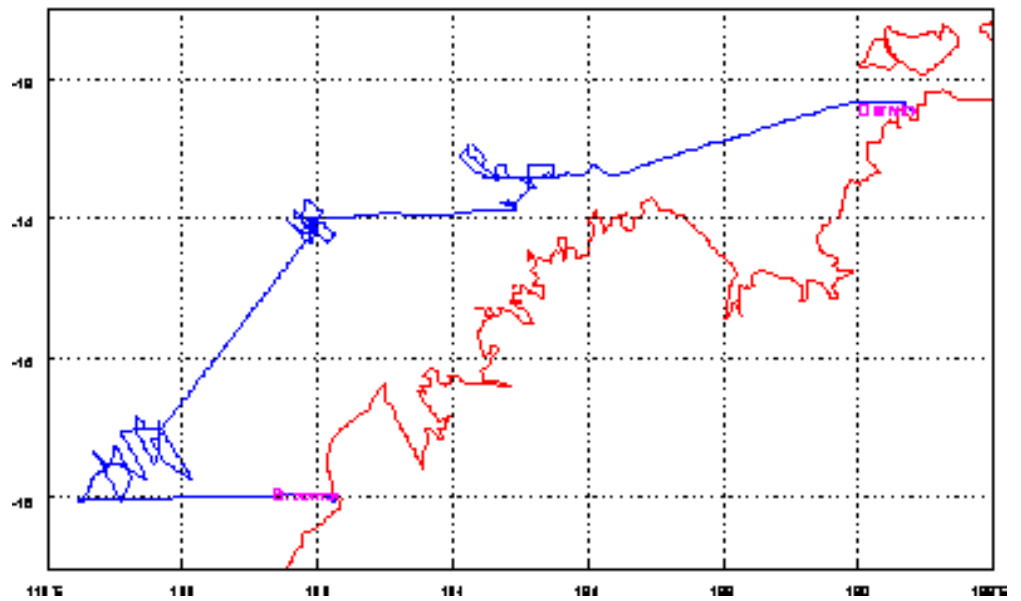


Figure 1. Cruise track, FR05/2000.

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