National Facility Research Vessel

RV FRANKLIN

VOYAGE DOCUMENTS

RV SOUTHERN SURVEYOR

CSIRO AUSTRALIA

CSIRO MARINE AND ATMOSPHERIC RESEARCH

Voyage Plans and Summaries

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Franklin Voyage Summary No. FR07/99

Title

Acoustic Thermometry of the Indian Ocean

Itinerary

Departed Singapore 1100 hrs, Wednesday 29 September, 1999
Arrived Darwin 0800 hrs, Tuesday 19 October, 1999

Principal Investigator(s)

Dr. Andrew Forbes (Chief Scientist)
CSIRO Marine Research
GPO Box 1538, Hobart, Tasmania 7001, Australia

Dr. Bruce Howe
Applied Physics Laboratory, University of Washington
Seattle, Washington, USA

Dr. Peter Worcester (Could not participate in cruise)
Scripps Institution of Oceanography
La Jolla, California, USA

Scientific Objectives

- The long-term objective of the project is to measure climate scale temperature change in the Indian Ocean.

Cruise Objectives

The science objective involves the following more immediate objectives, all aimed at preparing for a future installation of an acoustic source on the seabed.

- Map the sound speed structure to find the axial depth of the SOFAR channel in the vicinity of Cocos Is.
- Conduct a detailed bathymetric survey of the acoustic source site
- Conduct a detailed bathymetric survey of the proposed cable route to shore

Ancillary Cruise Objectives

- A preliminary assessment of Muirfield Seamount's geomorphology, epibenthic and benthic fauna.
- Deployment of a pilot array of four PALACE floats in the Indian Ocean region between Indonesia and the north coast of Australia

Cruise Track

Figure 1 illustrates the cruise track from Singapore to Cocos (Keeling) Islands, Muirfield Seamount and Darwin.

Results

Two CTD casts were made in the vicinity of Cocos (Keeling) Islands; one to the north, and one to the west, in 2500 m water depth (Figure 2). Sound speed was calculated according to Chen & Millero's formula. The axis of the sound channel was found to be at 1000 m depth.

Digitised soundings were acquired along all the ship tracks shown in Figure 3, which were then objectively gridded and contoured. The resulting map, Figure 4, shows the general form and major features of the western and southwestern margins of West Island. Echo-sounder beamwidth across track is typically 200 metres (at 1000 m depth), so features smaller than 200 m are poorly resolved. Track spacing was 600m, leaving 400m gaps between tracklines. The computer-drawn contours bridge those gaps but are likely to appear smoother than in reality.

As expected, the transition from lagoon and reef edge to deeper water is abrupt and steep, some slopes locally exceeding 60° between 80 to 180 m depth, decreasing to 33° beyond 180 m, with an average slope of 29° between depths of 300 and 1000 m. Between 1000 and 2000 m depths, the slopes ease to 13° . There do not appear to be any local obstacles that would interfere with acoustic transmissions, within the survey area.

Six sediment samples were obtained; one at the proposed source site, and four along the two proposed cable routes. Sediment cover was variable (a few

cm to more than 30cm), but typically composed of calcareous sand, ranging from fine to medium texture. The deep towed video camera showed large areas of sandy bottom, interspersed with rocky ledges and slabs.

A site suitable for an acoustic source, located at 12.214 S, 96.797 E, is indicated on Figure 3, off the southwestern side of West Island at 950 m depth. Two possible cable routes to shore are also shown.

A contoured bathymetric map of Muirfield Seamount, based on a star-like pattern of echo-sounding transects, is shown in Figure 5. The ship's survey track is superimposed on the bathymetry. Two major deep towed video camera transects, one from NE to SW, and one from NW to SE, were conducted which will be analysed in detail in a separately commissioned report for Environment Australia. A number of benthic samples were obtained from targeted depth strata, which will also contribute to the report.

Four PALACE floats were deployed successfully at the following locations:

Float No/ID	Date	Time-GMT	Latitude (S)	Longitude (E)	Depth (m)
1 / 54	12.10.99	0005	12° 06.23'	106° 54.97'	5018
2 / 55	13.10.99	0816	12° 16.18'	111° 55.66'	3083
3 / 56	14.10.99	1014	13° 15.29'	116° 04.48'	5613
4 / 57	15.10.99	1549	12° 56.98'	120° 21.37'	2512

A CTD cast was made to 2500 m at each float deployment position.

Cruise Narrative

Cocos (Keeling) Islands are four days by ship from Singapore, so there was adequate time on the way for equipment assembly, testing and trials. This was particularly valuable for integrating the sidescan sonar and Omnistar Differential GPS (DGPS), which were hired in Singapore, into Franklin's winch system and normal suite of instruments.

Once the ship reached Cocos, two CSIRO Marine Research personnel and two Parks Australia staff (representing Environment Australia) were embarked, and the site survey commenced.

The primary tool for acquiring bathymetric data was a Simrad EA500 (12 kHz)

single beam echo sounder. It has a beamwidth of 15° , which at 1000 m water depth results in a footprint of 200 metres. Features smaller than this are not resolvable. A towed Deep Video System (DVS) allowed direct viewing of the seabed with "snapshots" returned to the ship every ten seconds, and a continuous record was available upon recovery. Sediments were sampled using a Smith-MacIntyre grab lowered on a hydrographic wire. A sidescan sonar planned for examining proposed cable routes was unable to be deployed due to the loss of its conducting wire during unrelated surveys of Muirfield Seamount. These instruments were deployed from CSIRO's Oceanographic Research Vessel R/V *Franklin*. DGPS was used for navigation, with an accuracy of 5 m.

A shallow water survey was carried out on October 9 using a Simrad EY500 (120 kHz) echo-sounder mounted on the (Cocos) Parks Australia vessel, positioned with DGPS.

The general approach was to conduct a systematic grid-like pattern of echo-sounding transects N-S and E-W, spaced 0.3 nautical miles (600m) apart that would provide complete coverage of the western and southwestern margins of West Island. The resulting cruise track is shown in Figure 3. More closely spaced line transects were occupied in areas of special interest, specifically the source site and cable routes. Once a likely candidate site was identified, a DVS video transect was run to examine the seafloor in detail. Finally, the Smith-MacIntyre grab was deployed to obtain samples of the seabed at the likely source site and at selected positions along the proposed cable routes.

After two days of intensively surveying the western margin of Cocos (Keeling) Islands, the weather was suitable for heading south to Muirfield Seamount, so we made the six hour trip south and commenced a bathymetric, video and grab sampling program. This went well until at the deep end of the second deep towed video system (DVS) transect. At this point, with nearly all the wire deployed (2000 m), the DVS clump weight apparently became lodged under a rocky obstruction in rapidly rising terrain, and the wire parted. The entire DVS and wire were lost. Fortunately the Seamount survey was virtually complete, but the loss of the wire did impact on the Cocos site survey. It meant that the sidescan sonar, which required the DVS cable, could not be deployed.

Several more days of meticulous survey work, including taking sediment grab samples at the likely source site and along the proposed cable routes, completed the main tasks. On October 8, a brief visit was made ashore to meet the Cocos (Keeling) Islands Administrator. The results of the survey were discussed and the approval process for an acoustic source to be installed offshore as part of the Indian Ocean Acoustic Thermometry of Ocean Climate project was explored.

During the passage from Cocos to Darwin, four autonomous profiling floats were deployed as pilot array for the Cooperative Ocean Observing Experiment (COOE), accompanied by a CTD cast in each case. Since these are new technology for CMR, many tests were performed to ensure their complete

functionality before launching. The first float was observed carefully for the last half an hour of its six hour surface period, to confirm that it descended automatically as programmed.

The weather was extraordinarily benign for the entire cruise. A brisk SE Tradewind blew at 15-20 kt for most of the time.

Summary

All the cruise objectives were met. The ship's crew maintained their usual professional, helpful attitude throughout. The science team performed exceptionally well.

Personnel

Scientific

Andrew Forbes, CMR, Chief Scientist
Bruce Howe, APL/UW, Co-PI
Ron Plaschke, CMR, Cruise Manager
Phil Adams, CMR, Electronics
Daniel Conwell, CMR, Electronics
Bernadette Heaney, CMR, Computing
Pamela Brodie, CMR, Computing (Cocos-Darwin)
Dave Terhell, CMR, Hydrochemistry
Kevin Miller, CMR, Ocean Engineering
Matt Sherlock, CMR, Electronics (Cocos/Muirfield)
Mark Lewis, CMR, Marine Biology (Cocos/Muirfield)
Robert Thorne, Parks Aust., Marine Biology (Cocos/Muirfield)
Ismael MacRae, Parks Aust., Marine Biology (Cocos/Muirfield)

Crew

Neil Cheshire, Master
Arthur Staron, 1st Mate
Paul Ware, 2nd Mate
John Morton, Chief Engineer
Dave Jonker, 1st Engineer
Hugh McCormick, Electrical Engineer
Bill Hughes, Bosun
Terry Ganim, AB
Graham McDougal, AB
Tony Hearne, AB
Phil French, Greaser
Gary Hall, Chief Cook
Ian Lock, 2nd Cook
Ron Culliney, Chief Steward

Acknowledgments

I would like to thank Neil Cheshire and his entire crew for turning a complex cruise into something manageable. Their willingness to accommodate unusual requests greatly helped achieve the scientific objectives.

I would also like to thank my whole science team for taking the cruise preparation and technical burdens entirely on their shoulders, so that I could concentrate on planning, analysis and interpretation. It was enormously helpful to have Bruce Howe from APL/UW on board. His experience with site surveys for acoustic thermometry installations proved extremely valuable.

Andrew Forbes
Chief Scientist

Updated: 31/01/03