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. FR02/00

Title

Tropical River Ocean Processes in Coastal Settings (TROPICS Leg 10) - Biogeochemistry, Benthos, & Sedimentation in the Gulf of Papua.

Itinerary

Leg 1
Departed Rabaul 0940hrs, Friday 4 February, 2000.
Arrived Port Moresby 0740hrs, Sunday 13 February, 2000.

Leg 2
Departed Port Moresby 1010hrs, Sunday 13 February, 2000.
Arrived Cairns 0700hrs, Tuesday 22 February, 2000.

Principal Investigators

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Scientific Objectives

Project TROPICS research began in 1996 to describe and model the mechanisms of globally significant wet tropical river delivery of dissolved and suspended materials to the continental shelf and the Pacific Ocean.

Cruise Objectives

Drs. Sternberg & Ogston to obtain near-bottom profiles of current speed & turbidity, to estimate sediment resuspension & movement as a function of tidal energy.

Dr. Nittrouer and Ph.D. student J. P. Walsh to obtain Kasten cores and box cores of inshore sediments to estimate mass accumulation rate and sediment mixing depth.

Dr. Robert Aller & assistants to obtain Kasten and box cores for shipboard sampling benthic fauna, and for shipboard measurements of organic matter decomposition reactions.

Dr. Brunskill & assistants to measure (shipboard) 2 of the four natural isotopes of radium in large volume samples of surface water to estimate the residence time of shelf water. They also wish to measure oxygen consumption respiration and obtain grab samples and Kasten cores for geochemical mass balance research on trace elements and the biological elements in the Gulf of Papua.

Dr. Milliman and assistants wish to map Holocene sediment thickness with high resolution seismic equipment, to determine the volume and mass of clinoform delta front sediments trapped on the inner shelf over the last 6000 years.

Cruise Track

During 4-13 February our time was spent obtaining CTD and seabottom profiling tripod (Gafanhoto) profiles, benthic lander deployments, grab samples, box and Kasten cores of the inner shelf sediments of the nearshore

clinoform sediments. After a scientific crew change in Port Moresby, the ship was used for high resolution shallow seismic transects of the inner shelf, with some coring and water sampling at the beginning and end of these long shore normal & parallel transects (Figs. 1a & 1b).

Results

The weather was calm, all equipment worked well and the ship & scientific crew performed all tasks better than anticipated.

The seabottom profiling tripod (Gafanhoto) performed well in obtaining water column and seafloor measurements of salinity, temperature, pressure, turbidity, suspended sediment samples and seafloor current speed and direction. Turbid layers of sediment rich water of 20-100 cm thickness were moving back & forth across the inner shelf, in accordance with the tide. A benthic lander tripod was successfully moored & recovered for two separate week periods in two locations to monitor surface sediment boundary layer motion and processes on the inner shelf.

In the sediment sampling operations, 40 Kasten cores, 35 box cores and 52 grab samples were obtained from water depths of 15-80 m, where maximum sediment accumulation rates occur. Many of these cores were subsampled on the aft deck for shipboard pore water chemical measurements, sedimentary pigments, X-radiographs, incubations for decomposition reactions and were prepared for more complex measurements back in our home laboratories.

Large volume (>2000 L) water samples were obtained at 5 stations for radium isotopic extraction and measurements. Short-lived ^{223}Ra and ^{224}Ra were found in high activity in shallow locations and were nearly undetectable beyond the 60 m water depth contour, indicating limited mixing of inshore tidal mangrove water with offshore clear water masses. Measurements of oxygen consumption rates of offshore surface waters over 12 hour incubation periods indicated large respiration rates, similar to previously measured inshore respiration rates.

Preliminary results indicate a wide range of bottom sediment reactivity closely related to depositional environment. The mobile inner shelf and upper foreset muds are characterized by rapid oxygen uptake (penetration depths 1.5 — 2 mm) and metal reduction in a surface zone of 30 — 70 cm thickness. Although surface deposits are apparently highly mobile, macrobenthic organisms are present and bioturbation (biological mixing) is a significant component of transport processes in the upper ~10 cm (this was quantitatively checked using Br^- tracer experiments run on board ship). Erosional topset regions lying between inner shelf topset and foreset net depositional areas are characterized by relatively deep penetration of oxygen (> 5 mm) and appear to be unreactive, implying re-exposure of once deeply buried material that has already been through significant decomposition. These relict deposits are firm and typically extensively burrowed by crustaceans. Relict areas clearly exchange solutes with overlying water, although fresh organic matter is

apparently not being incorporated into them to any significant degree. The outer foreset beds (> 60 m water depth) are highly reactive, but metal reduction (iron mobilization) appears less obviously important than in the frequently reworked muds of the topset and upper foreset regions. At some stations, pore water S CO_2 reached concentrations over 20 mM in the upper few decimeters or just below the reworked zone, indicating the presence of highly reactive organic material. In contrast, at relict mud sites, pore water components derived from decomposition were extremely low, implying old reworked material lacking recent inputs of fresh organic matter and having extensive solute exchange (biogenic) with overlying water. All measurements and qualitative observations indicate a dynamic sedimentary environment highly interactive with the water column and having both similarities and distinct differences with previously studied tropical deltaic regions.

Seismic data were obtained with a multi-electrode sparker, with 540 joules firing at a 3-second interval. Total time for seismic operations was 101 hours, amounting to approximately 800 km of data; in these 101 hours, more than 120,000 low-power, high-resolution seismic shots were fired. Of the 12 seismic profiles obtained during the cruise, three were shoreline-parallel, and nine were short normal. Water depths ranged from approximately 90-100 m offshore to as shallow as 18 m landward. Sesimic penetration locally exceeded 150 msec, or approximately 120 m beneath the sea floor.

The inner and mid shelf off the Kikori River is characterized by a number of prominent faults; otherwise the study area appears relatively free from recent tectonic activity. We were able to distinquish several prominent surface and subsurface features that represent former low stands of sea level. Mesa-like features (a term coined by Peter Harris in 1996) apparently represent paleo-river banks of Kikori, Purari, and Fly rivers formed during the early Holocene sea-level transgression. In the nearshore clinoform regions of the study area, these mesas are overlain by 10 to 40 m of modern mud. On top of several these relict features, we found sediments (oolitic sands) indicative of past intertidal deposition. Radiometric C-14 dating of these oolitic sediments therefore should indicate the exact timing of the rise of sea level in this area.

Cruise Narrative

The Chief Scientist boarded the *RV Franklin* in Rabaul at 1000 hrs on 3 February and by 1300 we were bringing our coring equipment out of the hold and bolting the heavy gear on the aft deck.. The General Purpose Lab was converted into a sediment chemistry work area, an X-ray facility, and a incubation tank for respiration rate measurements. The Chemlab was converted into a pore water extraction and radium counting area and the Wetlab was used to assemble and test the "Gafanhoto" (a specially designed CTD and turbidity sensor/sampler on a tripod designed to sit on the bottom after profiling the water column).

During our transit (Fig. 1a) across the Solomon Sea 4-7 February under flat

calm conditions, we did some sounding and ADCP work for George Cresswell and Ray Binns, including a CTD-Transmissometer profile to 2300 m water depth. The second work area for Ray Binns was abandoned, as we experienced a computer network crash at this time. The scientific crew held work plan meetings and prepared the aft deck and labs and gave presentations to the ship crew on the objectives of the research.

During 7-13 February, the ship research team moved from shore perpendicular survey line A to K (Fig. 1b), typically running the ship slow to landward for a good 12.5 kHz sonar signal of the sediment wedge along the inner shelf. After seeing the sonar record, we selected sampling sites along this clinoform and typically would take box cores, grab samples, kasten cores and CTD/Gafanhoto profiles at 15, 25 and 40 meters water depth along each line. We deployed a fluid mud benthic lander on 8 February on the inner shelf to obtain a week duration record of near bottom current speed & direction, turbidity, back scatterance, and salinity. This lander was successfully retrieved on 12 February, downloaded and redeployed for another week's data gathering. On the afternoon of 12 February, we steamed for Port Moresby to change some of the scientific crew.

Science crew exhange in Port Moresby was done 0700-0930 on 13 February, and we were back at survey line B (Fig. 1b) by 2000 hrs with John Milliman's sparker seismic rig in operation. Between 13 and 20 February, the pattern of work was to run long seismic lines perpendicular and parallel to the shore, at 4.5 kts in silent mode and to take CTD, water and sediment samples near the beginning and end of each seismic line (Fig. 1b). A few large volume (2000 L) water samples were taken for radium isotopic analyses and for respiration rate measurements. The benthic lander was recovered after a second week's deployment on 19 February and multiple cores were taken at the deployment site, as it appeared to be a site of high productivity, chlorophyll and fluid mud movement. Mesa-like features (20-25 m high bluffs in 60 m water depth) on the seismic profiles were Kasten cored, to find oolitic and detrital carbonate sand and gravel.

At 1000 on 20 February we stopped the scientific sampling program and steamed for Cairns, arriving outside the port at 0630 on 22 February to meet the pilot, being ready for Customs Inspection at 0800. Total ship travel was 3,091.02 miles, Rabaul to Cairns. It took us till 1630 to transfer our equipment from the Franklin to a semi-trailer truck and a ute, for the haul to Townsville and the Australian Institute of Marine Science.

Summary

All scientific crew were very happy with the results of our sampling program. The weather helped us and there were few mechanical problems with our scientific equipment or the ship operations systems. The aft deck area and equipment worked well for our sampling program.

If the *RV Franklin* is to be used for geoscience research, then provision should

be made for handling of sediment samples and cores in the ship research laboratories. At present, the *RV Franklin* Users Guide indicates that no mud is to be taken into the ship laboratories. For this kind of shipboard research, it might be appropriate to remove the Autoanalyzer and other Chemlab bench equipment, so that this space can be used for sediment core processing and seismic equipment. This Chemlab was occupied with many empty crates and unused equipment. It would be convienent to use the aft door in the Chemlab to access the aft deck operations.

The gimbeled table in the Chemlab would be very useful for centrifuge work, if it could be upgraded and made ready for use.

We found a vial of ^{14}C standard in the General Purpose Lab drawer, probably for calibration of the liquid scintillation counter. We were trying to extract pore water samples for background and bomb fallout ^{14}C from our sediment cores and we require zero ^{14}C activity on the lab benches.

Intercommunication speakers and microphones should be installed in the General Purpose Lab, so that these workers can be quickly alerted to deck operations.

Personnel

Scientific Crew

Leg1: Rabaul - Port Moresby
Gregg Brunskill, Australian Institute of Marine Science (AIMS), Chief Scientist
Robert Aller, State University of New York, Biogeochemist
Angelos Hannides, State University of New York, Sedimentologist
Vanessa Madrid, State University of New York, Microbiologist
Charles Nittrouer, University of Washington, Marine Geologist
Andrea Ogston, United States Geological Survey, Sedimentologist
Richard Sternberg, University of Washington, Sedimentologist
John Pfitzner, AIMS, Radiochemist, Sediment Core Processing
John Walsh, University of Washington, Marine Geologist
Irena Zagorskis, AIMS, Sediment Core Processing, Oxygen Measurement
Bob Beattie, CSIRO Marine Research, Cruise Manager & Computing
Daniel Conwell, CSIRO Marine Research, Electronics

Leg 2: Port Moresby - Cairns
Gregg Brunskill, Australian Institute of Marine Science (AIMS), Chief Scientist
Robert Aller, State University of New York, Biogeochemist
Katherine Farnsworth, Virginia Institute of Marine Science, Seismic Geologist
Angelos Hannides, State University of New York, Sedimentologist
John Milliman, Virginia Institute of Marine Science, Seismic Geologist
David Mucciarone, Stanford University (California), Stable Isotope Chemist
Beth Mullenbach, University of Washington, Sedimentologist
John Pfitzner, AIMS, Radiochemist, Sediment Core Processing

John Walsh, University of Washington, Marine Geologist
Irena Zagorskis, AIMS, Sediment Core Processing, Oxygen Measurement
Bob Beattie, CSIRO Marine Research, Cruise Manager & Computing
Daniel Conwell, CSIRO Marine Research, Electronics

Ships Crew

Neil Cheshire, Master
Arthur Staron, 1st Officer
Roger Pepper, 2nd Officer
John Morton, Chief Engineer
Greg Pearce, 1st Engineer
Andrew McLagen, Electrical Engineer
Dan Davies, Greaser
Mal McDougal, Bosun
Tony Hearne, AB
Terry Ganim, AB
Graham McDougal, AB
Ron Culliney, Chief Steward
Gary Hall, Chief Cook
Mark Wheeler, 2nd Cook

Acknowledgements

We are all very grateful to Master Neil Cheshire and the entire crew of the *RV Franklin* for their excellent work in providing a good research platform for our work. Bob Beattie and Dan Conwell supported the scientific activities in every way. The Aft Deck crew made no mistakes with a lot of complicated sampling gadgets on the deck. The cooks were wonderful, as usual.

Gregg Brunskill
Chief Scientist

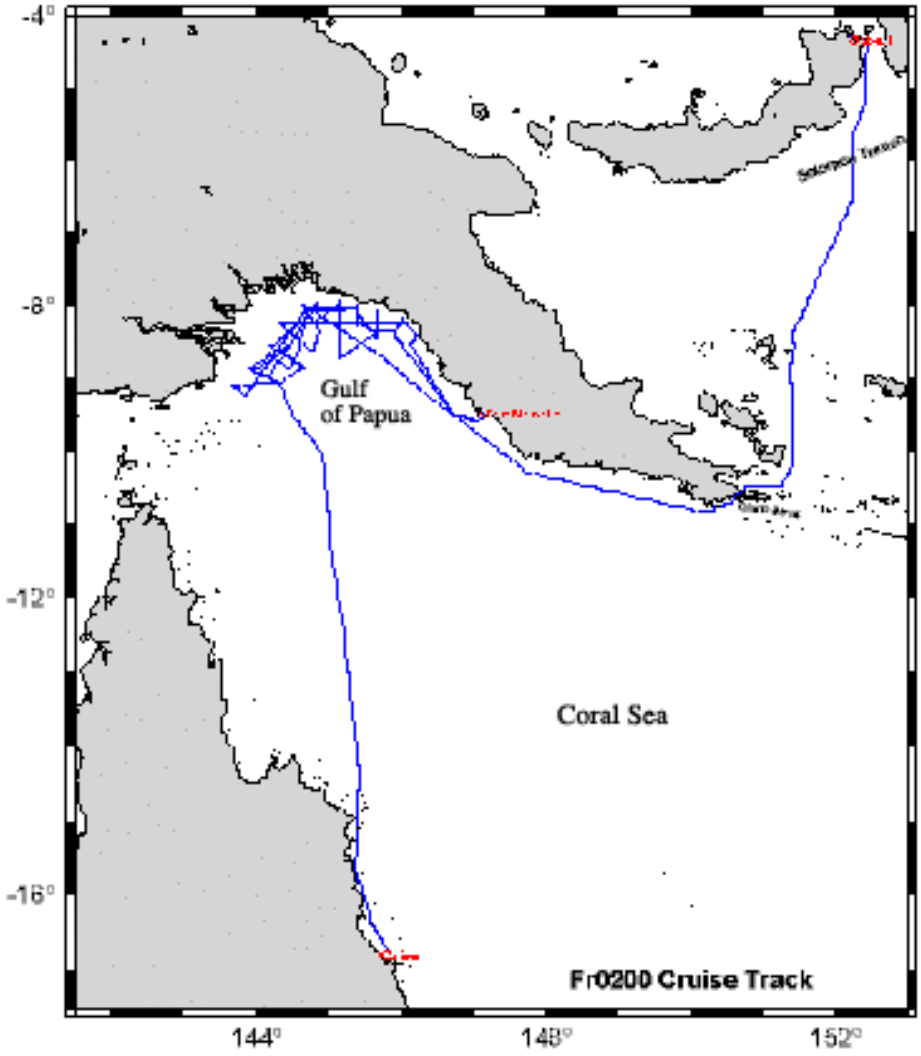

Figure 1a. FR02/00 (TROPICS Leg 10) cruise track 4-22 February 2000.

Figure 1b. FR02/00 (TROPICS Leg 10) cruise track for seismic lines A-K, 13-20 February 2000.

Updated: 31/01/03