FRANKLIN

National Facility
Oceanographic Research Vessel

TROPICS97 (Leg 4)

CRUISE SUMMARY

ORV FRANKLIN

FR 07/97

Depart Madang	Monday 4 August 1997
Arrive Townsville	Friday 22 August 1997

Principal Investigator

Dr Denis Mackey
CSIRO Division of Marine Research

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RESEARCH SUMMARY

CRUISE FR07/97

Sailed Madang 0800 Monday 4 August 1997
Arrived Townsville 1330 Friday 22 August 1997

Principal Investigators

Dr Denis Mackey
Mr Brian Griffiths

CSIRO Division of Marine Research

Dr David Smith

University of Melbourne

Dr Kathy Burns

Australian Institute of Marine Science

TROPICS - Leg 4

Cruise Summary
R. V. Franklin
FR07/97

Project Title

TROPICS (Leg 4)

Objectives of the Cruise

To investigate the supply of nutrients, organics and trace metals to the equatorial region from the Sepik River (this is part of an integrated TROPICS program involving considerable interaction with other research groups).

Stations were occupied from: (i) four N-S transects from the coast to 1.5 degrees northwards and over 2 degrees of longitude, (ii) the canyon at the mouth of the Sepik, (iii) the Sepik, (iv) along a continuation of the fourth N-S transect to 2 ^{0}N, 143 ^{0}E and, (v) along the equator to 152 ^{0}E. Due to the wide range of parameters being measured, there were generally multiple casts (up to 7) at each location. The positions and cast numbers for the four transects are shown below as is an indication of whether casts were made to the bottom. The cruise track is shown in Figure 1.

Transect	Longitude	Latitude	Cast	Bottom
1	145:00	4:18	2 (1-2)	Y
		3:47	5 (3-5)	Y
		3:18	6	Y
		2:48	10 (8-12)	Y
2	144:30	3:45	16 (16-17)	Y
		3:15	19 (18-20)	N
		2:45	22 (21-22)	Y
		2:15	24 (23-26)	Y
3	144:00	3:38	29 (28-29)	Y
		3:09	30 (30-32)	N
		2:39	33	Y
		2:09	37 (34-40)	Y
4	143:00	3:19	42 (41-42)	Y
		2:50	45 (43-47)	Y
		2:20	49 (48-49)	Y
		1:50	51 (50-53)	Y

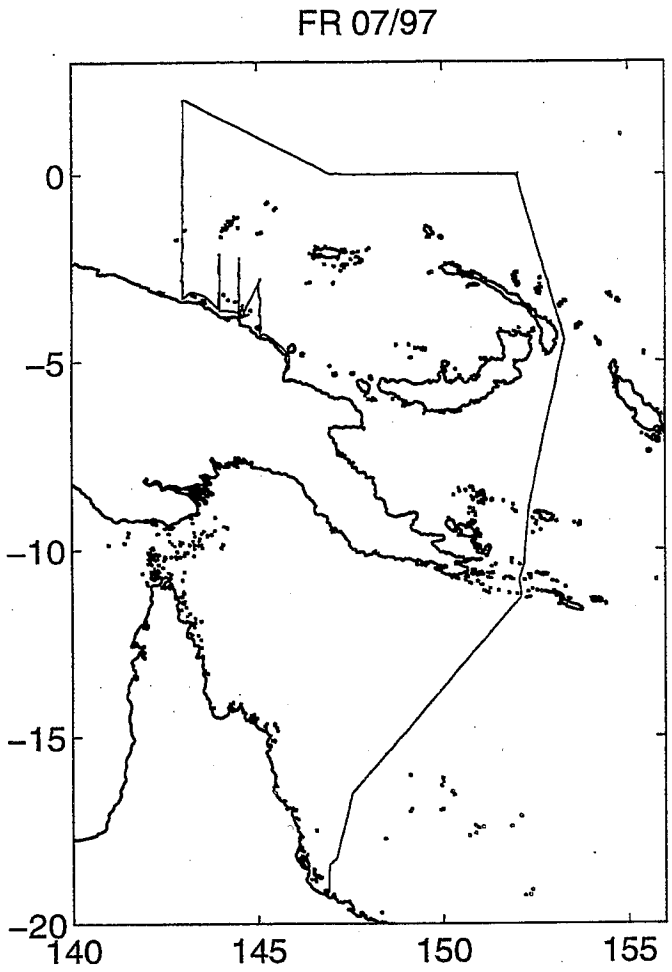

Figure 1. Cruise track for FR07/97

Samples were collected for the determination of a wide range of parameters including oxygen, salinity, nitrate+nitrite, phosphate, silicate, ammonia, ^{14}C productivity (including PvsI and grazing dilution experiments), chlorophyll and carotenoid pigments, dissolved organic carbon, particulate organic carbon, suspended solids, UV fluorescence, alkalinity, dissolved inorganic carbon, radionucleides (^{210}Pb, ^{210}Po), trace metals (Cu, Cd, Mn, Ni, Fe and Hg), rare earth elements (REE), spectral absorbance, phytoplankton (preserved, air-dried and flow cytometry) and organic ^{15}N and ^{13}C. Trace metals and rare earth elements were collected using Helmond-Bryne bottles mounted on a Kevlar hydroline.

In addition, a wide range of *in situ* measurements were made using autonomous instruments (PAR and fast repetition rate fluorometry) or instruments attached to the CTD (fluorescence, photosynthetically active radiation, transmissivity, optical back-scattering and free iron and copper using ion selective electrodes) or mounted on the Aquashuttle (fluorescence). The deployments of the Aquashuttle in the region of the Sepik are shown as dark lines in Figure 2.

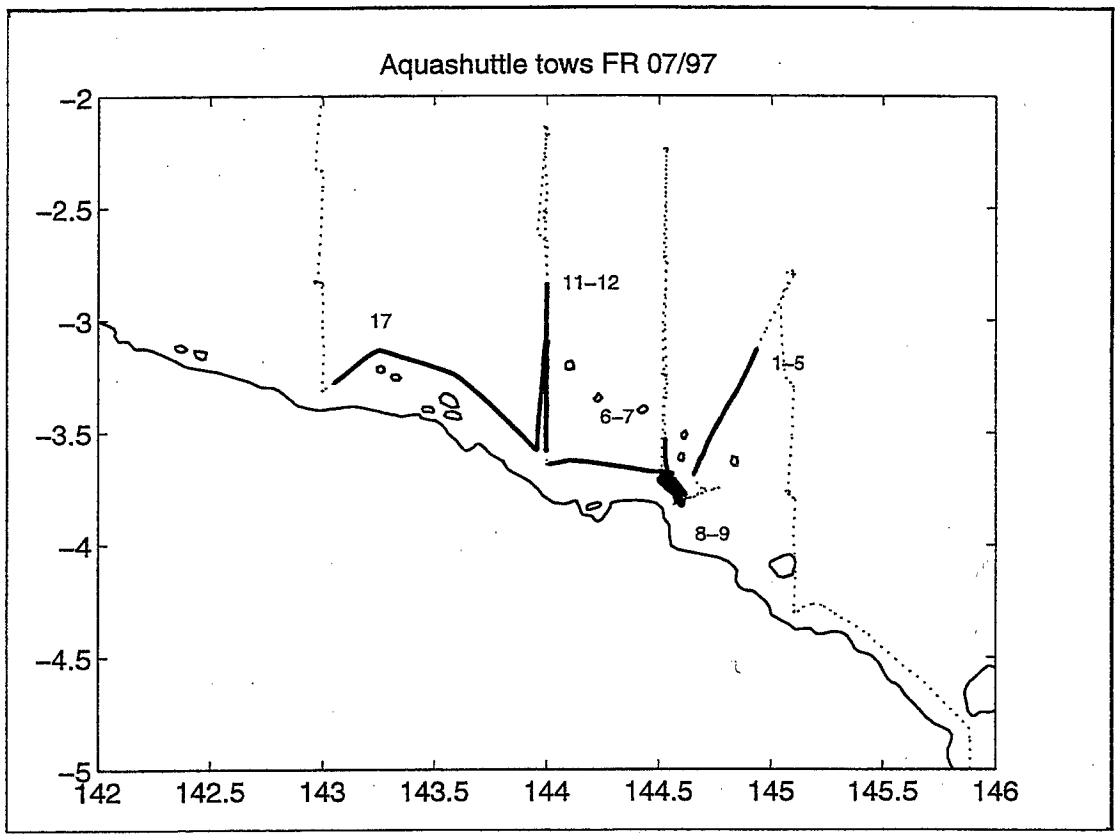

Figure 2. Cruise track (•••••) and Aquashuttle deployments (——) on FR07/97.

Identify organic biomarkers and isotopic signatures that can be used to trace sediment transport from riverine to oceanic regimes.

The amounts of ^{13}C and ^{15}N are different in marine and terrestrial organisms and hence the measurements of these isotopes in organic matter from the Sepik River should enable us to determine whether we can trace such waters as far as the New Guinea Coastal Undercurrent and the Equatorial Undercurrent. In addition, preliminary experiments have suggested that the freshwaters flowing from New Guinea have very different ratios of rare earth elements from the waters of the equatorial Pacific. The behaviour of REE in natural waters has close parallels to that of iron and hence measurements of REE and dissolved and particulate iron should provide valuable information on whether the Sepik River has any effect on the supply of iron to the equatorial Pacific.

Assessment of the relative importance of nutrients (including micronutrients such as iron), light and grazing to the biological productivity and phytoplankton biomass of the region.

Measurements of ^{14}C productivity, as a function of light intensity, were made at a range of locations along with measurements of nutrients, trace metals (including iron), *in situ* fluorescence, spectral absorbance and photosynthetic and carotenoid pigments. Algal class abundances will be calculated from the pigment samples and, in conjunction with flow cytometry data, we will have good data on the factors controlling both the total productivity and community structure. Actinide

measurements will enable us to estimate the particulate fluxes out of the euphotic zone while the grazing dilution studies will provide information on the importance of grazing by microzooplankton.

Cruise Narrative

Getting to Madang proved more interesting than anticipated. Air Niugini was having major maintenance problems and were cancelling many flights. Val was due to fly from Port Moresby on Tuesday afternoon but left at 0530 on Thursday, while Denis, Brian, Don, Ros, Lindsay and Bec were due to fly out on Friday afternoon but did not leave until Saturday morning, also at 0530. We looked on the bright side of things since were put up in Port Moresby at the airlines' expense and so saved DMR some money. Meanwhile, the second mates' luggage was in Port Moresby when we sailed from Madang.

The heavy seas that were a feature of FR06/97 had not completely abated by last Saturday (August 2) and the dining room at Smugglers Inn had all the shutters drawn to keep out the waves that were breaking over the sea wall. It was not entirely successful. On some parts of the coast spray was reaching a height of about 10 m or so.

Despite the heavy seas on FR06/97, the loss of liquid nitrogen from our Dewars was far less than we had anticipated on the basis of data from the suppliers of the Dewars and we had more than enough for our needs.

The fast repetition rate fluorometer (FRRF) arrived in Hobart the day before we left for Madang and we just had time to have some brackets made so that Brian could take it as extra luggage, all 75 kg of it!

We left Madang on schedule on Monday August 4 and slowly steamed to the start of our first transect out from the coast of PNG. Everyone was beavering away getting equipment in order for the first station at 0600 on Tuesday August 5. We had many additional instruments to attach to the CTD - two copper ion selective electrodes (ISE), an iron ISE, a Seatech fluorometer, a transmissometer, an optical back scatterometer, a light meter and the FRRF. Since these have depth ranges varying from 200 m to 6000 m, and we have three different types of bottles to attach to the rosette, working out the various casts was like trying to solve a 3-dimensional Chinese jigsaw puzzle. After the first 2 stations, we thought we had a reasonable schedule worked out for each of the 4 stations on the 4 transects out from the coast. During this time we passed within a few kilometers on the active volcano, Manam Island, which rises to 1800 m. It seemed as if there was steam and smoke issuing from the summit but it may have been low clouds. Lava flows down the eastern slope were clearly visible.

The FRRF was to give us additional information on the productivity of the waters and we planned to use it to interpolate between the stations where we were measuring productivity by ^{14}C incubations. Then the FRRF died. The main 9-pin connector for communicating with the instrument broke and there were ominous rattles from inside. After much difficulty in opening the instrument we found that virtually all the screws inside were loose, including one that had to be partially sheared before the insides

could be removed from the pressure casing, one nut was missing, and the two supports holding the electronics in place had unscrewed. Dave is now using string, rubber bands, Araldite and offerings to numerous pagan gods in the hope of resurrecting the instrument.

Wednesday August 6 saw us completing the first transect and everyone wanted water samples. We did five CTD casts to various depths with various instruments and one hydrocast for trace metals and rare earth elements using the Helmond-Byrne bottles and a kevlar line attached to the hydrowinch. Initially the kevlar line was wound onto the hydrowinch in the opposite direction to the steel wire since that was the only way that the line would clear the railing on the forecastle deck. However this meant that the controls on the hydrowinch would have to be operated in the opposite direction. This seemed to be an accident waiting to happen so we took the kevlar line off, rewound it in the normal direction and used the spare trace metal block to direct the line over the railing. We had to use a pair of binoculars to read the meter block and stuck coloured tape to the line to mark the bottle positions for future casts. This was Ros' first hydrocast and my first in about 14 years and it worked well.

Thursday August 7 was spent off the mouth of the Sepik with two trips up the river in the rubber ducky to collect freshwater samples so that we can get information on the amounts of metals, organics, nutrients, suspended matter and actinides that are supplied by the river to the Bismarck Sea. The plume of the Sepik seems more marked than on previous TROPICS cruises and we have surface salinities of about 20 with very sharp fronts on the southeast side. It is quite a picture with deep brown water around the ship, clear blue water a bit further offshore and the perfectly symmetric cone of the volcano, Bam Island, rising to 700 m in the distance.

Inshore, the main pycnocline was at about 140 m although there were a few weaker ones at about 50 m and 90 m. Chlorophyll fluorescence was fairly low but was almost constant down to about 140 m. At the next station, 30 km offshore, the main pycnocline was at about 120 m but the profile of chlorophyll fluorescence showed a broad maximum centred at about 70 m with surface values approaching zero. At stations 3 and 4, 60 and 90 km ofshore, the main pynocline had shallowed to about 80 m and coincided with a pronounced maximum in the chlorophyll fluorescence. The high salinity waters of the New Guinea Coastal Undercurrent were prominent at about 200 m.

The weather remained kind and we had some impressive views of the many active and extinct volcanoes that appear as islands off the north coast of PNG. The preliminary data from the ADCP from the first transect showed that there were currents greater than 80 cm/sec in the top 100 m over virtually the whole transect. Peak currents were over 1.2 m/sec. The New Guinea Coastal Undercurrent was alive and well.

After the first transect was completed we steamed back to the mouth of the Sepik and waited offshore while the 'rubber ducky' was used to take two groups into the Sepik to collect freshwater samples. The following day we headed off to start the next transect. The ADCP data were very similar with typical velocities in the top 100 m of 80 cm/sec and peak velocities again reaching 1.2 m/sec. A deeper current, at about 200 m, was found about 100 km offshore with a velocity of about 80 cm/sec to the

northeast. At the offshore stations we are doing 5 CTD casts and a hydrocast for trace metals while at midday we are also doing a spectroradiometer cast from the HIAB. We were glad that we were only doing 4 transects since it would have been difficult to keep this pace up much longer. Many of us were working much longer than 12 hours a day.

Dave's rubber bands, bits of string, sticky tape and various incantations (some unprintable) enabled us to get the Fast Repetition Rate Fluorometer functional again although it threw an occasional wobbly.

After the second transect was completed we steamed back to the mouth of the Sepik and flew the Aquashuttle along a series of gridlines to map the plume. The plume was more extensive and deeper than on earlier cruises. However it was still generally less than 5 m and we had surface Niskin bottles with salinities 10 lower than the CTD which samples about 30 cm lower in the water column. We could readily track the plume with the Aquashuttle although it never saw the very low salinity water, even at 1 m, since it was in the wake of the Franklin which caused a great deal of mixing at shallow depth. Low salinity water (< 34 at 5 m) extended more than 25 km along the coast. We tried one CTD cast in the canyon of the Sepik and saw some evidence of a turbid outflow. It was an interesting exercise since the altimeter read >15 m even though the CTD reading was up to 20 m greater than the depth sounding.

The third transect was started on the morning of Sunday 10 and provided some interesting moments as a seamount rose out of nowhere to less than 100 m. We were about to take evasive action and stop Aquashuttle from going deep when the depth rapidly increased again. The master sent its position off to the powers that be. We completed the fourth station on the third transect on the morning of Monday 11 August.

The fourth transect was completed by early on the afternoon of Wednesday 13 August, and it would have been great if we could have had all the data from the transects before we started doing them! The NGCU was much closer inshore than we had anticipated from the WEPOCS data of Eric Lindstrom. Peak currents (uncalibrated as yet) were close to 1 m/sec and were centred at 50-100 km offshore rather than 150 km. The current was also shallower with typical depths being 100 m. However, the main feature to emerge from the ADCP was that most of the water column over the top 300 m was moving to the northwest under the influence of the NGCU and local forcing by the SE tradewinds.

We made frequent use of the Aquashuttle and found that the productivity of the waters was quite patchy and there was evidence of localised upwellings of cold, salty and higher fluorescence waters. The 'seamount' that gave us a bit of a scare on transect 3, was found to extend at least 3 km to the west since we observed it again when we were towing Aquashuttle back towards the coast prior to beginning transect 4. The 'seamount' was obviously a 'ridge' of unknown extent. The seas around the ridge were disturbed and Aquashuttle observed upwelling and high fluorescence associated with the feature.

We continued northwards to 2 N and found that the currents along the equator were similar to those observed on FR05/92 during the El Nino. The South Equatorial

Current was weak or absent and the currents over the top 300 m were largely to the east.

With the varied requirements of the people on board we had been doing up to 8 casts at some locations and I am sure we had a significant impact on sea-level with the amount of water that has been filtered. The temporary repairs to the FRRF enabled it to keep operating and the data looks good. The electronics in the rosette packed up at 2 N, 143 E but were repaired in time for the next station. The transmissometer leaked and ceased to be operational and we had to redo the connections to the Aquashuttle. Also, the Clean Container was wired wrongly so that, for the first few days, it was at negative pressure rather than positive pressure. Time will tell whether this lead to contamination of the trace metal samples from the first transect. Over all, none of the malfunctions seriously impacted on the cruise.

We did not have time to get to 155 E so did stations on the equator at 143 E, 147 E, 149 E and 152 E. We left the equator about 1400 on Sunday 17 August and headed for the southeast tip of New Ireland. we needed to average better than 11 kt to arrive in Townsville on schedule but struck rough seas, headwinds of 35 kt and adverse currents of 1 - 3 kt, so that at times we were making less than 9 kt 'over the ground'. After we passed through Jomard Strait, the weather improved (temporarily) before we again encountered rough seas and winds gusting to 30 kt. These were now broadside which made for an uncomfortable ride. Nevertheless, we made good time and arrived in Townsville only a few hours late.

Personnel

Ship's Crew		**Scientific Staff**
Master	Neil Cheshire	Denis Mackey (DMR) - Chief Scientist
Mate	Arthur Staron	Brian Griffiths (DMR)
2nd Mate	Wendy Doran	Harry Higgins (DMR)
Chief Eng.	Mike Culpeper	Roslyn Watson (DMR)
2nd Eng.	Greg Pearce	Don McKenzie (DMR)
Elec. Eng.	Don Roberts	Dave Edwards (ORV) - Electronics
Bosun	Jannik Hansen	Lindsay Pender (ORV) - Computing
AB	Gerry O'Halloran	Rebecca Deed (ORV) - Hydrology
AB	Peter Genge	Val Latham (ORV) - Hydrology
AB	Wayne Browning	Kathy Burns (AIMS)
Greaser	Phil French	David Smith (U. Melbourne)
Steward	Dianne Kelly	Gillian Peck (U. Melbourne)
Chief Cook	Gary Hall	

2nd Cook Peter Dux

Acknowledgements

The success of the cruise depended in no small way on the willing support provided by the master and crew of the *Franklin*. This was especially appreciated given that the cruise was the second of two back-to-back cruises and occurred at a time when the management of the ship was changed. I trust that the scientific staff on future cruises continue to be as well served.