FRANKLIN

National Facility
Oceanographic Research Vessel

TROPICS97

CRUISE PLAN

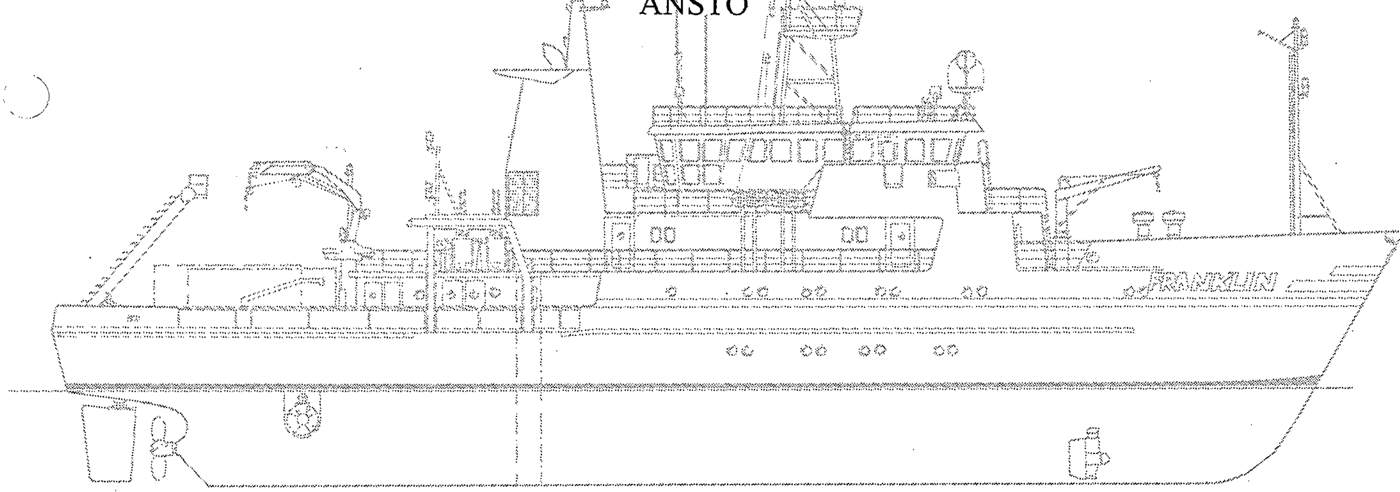
R/VFRANKLIN

Fr06/97

Depart:	Townsville	1000 hrs 17 July 1997
Arrive	Madang	1000 hrs 3 August 1997

Project Coordinator
G.J. Brunskill
Australian Institute of Marine Science

Principal Invesigator
Mr Ron Szymczak
ANSTO



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TROPICAL RIVER/OCEAN PROCESSES IN COASTAL SETTINGS (TROPICS) PROJECT

RV Franklin Cruise Plan : FR 06/97

TROPICS Leg 3 : Gulf of Papua / Bismarck Sea
Chemical and Biological Oceanography

Itinerary	Depart	Townsville	1000 hrs 17 July 1997
	Arrive	Madang	1000 hrs 3 August 1997

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Background

This cruise constitutes Leg 3 of a series of multidisciplinary cruises proposed by the TROPICS Project for which the background and objectives are detailed in the TROPICS Project Franklin proposal, a summary of which is given below.

The TROPICS Project objectives are to understand mechanisms and establish models of coastal ocean trapping, bypassing and cycling of solutes and sediments from wet tropical rivers draining the high relief areas of PNG into different coastal shelves. We seek to determine the processes that control the dispersal of wet tropical riverine dissolved and particulate material into the coastal ocean, and how these processes affect estuarine, deltaic, coastal, shelf and slope productivity. The Fly & Purari Rivers draining onto the broad continental shelf of the Gulf of Papua, and Sepik River draining into the Bismarck Sea with no appreciable shelf region have been selected as study sites. Studies onboard RV Franklin will be coordinated with vessels from AIMS and collaborating US institutions so that the sites will be studied over several climatic seasons in 1997 and 1999.

The south coast of PNG has a broad shelf that contains much of the riverine sediments from the Fly & Purari Rivers outflow (Brunskill et al., 1995; Bird et al., 1995). The estuarine mangrove regions are large and important sources and sinks for riverine organic matter and sediments (Robertson et al., 1993; Alongi, 1994). Water and sediments are likely transported and retained on the inner shelf by a variety of physical forces (currents, tides) that act to restrict the shelf-wide dispersal of these new riverine inputs (Wolanski et al., 1988; Harris et al., 1993). Chemical transformations (phase transitions, redox reactions, de/sorption, speciation & complexation) also affect the fate of several riverine elements entering the coastal shelf zone (Waite and Szymczak, 1991; Szymczak, 1992).

Iron is an essential element for primary producers, necessary for the manufacture of chlorophyll by phytoplankton and photosynthetic cyanobacteria. The fast oxidation kinetics of riverine iron supplied to the ocean rapidly reduces its bioavailability, forms scavenging particles which deposit to the sediment and limit long range transport. Iron and manganese are the major scavenging elements in the ocean, thus influence the biogeochemical cycling of several other trace constituents (heavy metals, radionuclides, organics). With high levels of light and dissolved organic matter, tropical coastal regions typically experience intense photochemical activity which subsequently influences the chemical reactivity of these elements (Szymczak and Waite, 1992). In the case of iron and manganese, these transformations result in redox changes and phase transitions between dissolved and particulate pools which influence overall rates of particle formation, aggregation and sedimentation (Waite & Szymczak, 1993a; 1993b; 1994), as well as availability to the biota (Szymczak, 1992; Waite et al., 1995).

Sulfur also has an active seawater cycle (Jones et al., 1994), although little is presently known regarding the degree of chemical and biological mediation in tropical coastal shelf zones. Dimethylsulfoxide (DMS), a metabolite of marine algae, has been identified as the compound responsible for the major biogenic flux of sulfur from the oceans to the atmosphere. It has been proposed that this mechanism is a possible regulator of climate through provision of cloud condensation nuclei and alteration of the albedo of clouds (Liss et al., 1993). DMS can be lost from the water column by air-sea exchange, microbial consumption and photo-oxidation.

By these mechanisms, we think that much of the input from the Fly & Purari Rivers is retained on the inner shelf, and only a small proportion of this large riverine input will enter oceanic circulation. It also likely that this retention of riverine inputs on the south coast of PNG fertilise a shelf benthic community that, subsequently, supports a rich prawn harvest. This is partly because of the high supply rate of nutrients, sediment resuspension and decomposition of organic matter, in the presence of shallow, warm and productive water column (Robertson et al., 1993). Due to the extremely short shelf region adjacent to the Sepik River outflow, river derived material transported seaward soon overlies extremely deep water and has the opportunity to enter deep ocean circulation. Contrary to the south coast prawn harvest, the north coasts supports an extremely rich pelagic skipjack tuna fishery. The waters north of PNG are also the source region for the

Equatorial Undercurrent which travels east at depth and upwells to support regions of high productivity in the central Equatorial Pacific. The supply of the bioessential elements such as iron to this current is of particular interest to studies of oceanic productivity and ocean-atmosphere exchange(JGOFS).

Cruise Objectives

The objectives of this cruise are to determine the fate of riverine material entering the Gulf of Papua from the Fly & Purari Rivers and to the Bismarck Sea from the Sepik River. That is, to determine to what extent this material (a) is trapped on the inner-shelf via elemental scavenging processes in the water column, (b) chemically transformed via chemical and/or biological mediation, and/or (c) bypasses the shelf and enters the coastal ocean. The study will include both dissolved and particulate forms of nutrient elements (N, P, Si), trace elements (heavy metals, radionuclides, rare earths, noble metals) and organic matter (hydrocarbons, PAH's). Special emphasis will be placed on several specific components (iron, manganese, carbon, sulfur, hydrocarbons) known to undergo dynamic chemical transformations in the transition from a freshwater to marine environment. To achieve these objectives, studies will be performed in the estuarine, inner and outer shelf zones of the Fly/Purari and Sepik Rivers outflow regions. We will;

1. Contribute to quantifying the export of riverine material from the Fly and Sepik Rivers.

2. Investigate and quantify the rates of particle formation and aggregation processes through salinity, particulate load and dissolved organic gradients.

3. Measure water column inventories for several natural radionuclides (^{238}U, ^{234}Th, ^{210}Pb, ^{7}Be) to determine the removal rates and vertical flux of particles (and associated chemicals) in the water columns of the estuarine, inner and outer shelf zones.

4. Investigate the influence of chemical and biological oceanographic processes that control the rates of particle scavenging; in particular, the changes in distribution and nature of riverine and planktonic sourced TOC/DOC through the salinity gradient.

5. Determine the dynamics of planktonic productivity in the estuarine, inner and outer shelf zones, and the extent of enhancement due to entrainment of nutrient rich sub-surface waters into the river plume.

6. Determine the composition of planktonic communities in the inner and outer shelf zones

7. Investigate the presence and utility of biochemical, geochemical and radiochemical tracers for identification and chronology of terrestrial/oceanic sourced water masses.

8. Determine the nature and extent of photochemical activity in the water column.

9. Investigate the photo-redox chemistry (bioavailability) of iron.

10. Measure the flux of dissolved inorganic carbon

11. Investigate the water column chemistry and atmospheric flux of DMS in relation to photochemical activity, primary productivity, nutrient supply, mixed layer depth and meteorological phenomena.

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	Neil White	Cruise Manager	CSIRO - ORV
	Phil Adams		CSIRO - ORV
	Ron Plaschke		CSIRO - ORV

Other Investigators - not onboard

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Summary

29 Stations, including 1 salinity transect (Sepik River)
12 Large volume water samplings (4 x deep water, 8 x surface water)

Operations

CTD - conductivity, salinity, temperature, depth, DO, light,
Acoustic Doppler Current Profiler (ADCP) - current dynamics
Niskin casts - nutrients : NH_4, NO_x, DON, PON, DOP, PO_4, SiO_2, SS
- primary productivity, chlorophyll & carotinoid pigments
- organics (TOC, DOC, size fractions)
- noble metals
- inorganic carbon/alkalinity
- pH

GoFlo casts - trace elements (Ag,Al,Au,Ba,Ca,Cd,Cr,Cu,Fe,Hg,Mn,Ni,Pb,Si,U,Zn)
- rare earth elements
- particle dynamics (^{54}Mn, ^{59}Fe)
- iron photochemistry & hydrogen peroxide

On-line underway measurements - sulfur chemistry (DMS, DMSP)
Medium volume sampling - hydrocarbons
Large volume sampling - radiochemistry (^{234}Th, ^{7}Be, ^{210}Pb)
Plankton nets - phytoplankton (cyanobacteria) & zooplankton

Cruise Track

Leave Townsville and steam to Gulf of Papua (Station 1). Transect to Fly River mouth (Station 2-6). Stations 7-10, nearby Purari River outflow. Steam to Sepik River mouth, Station 11. Deploy tender vessel and enter Sepik River mouth to collect 0°/$_{oo}$ samples (Station 12). Definition of Sepik River plume using Aqua-Shuttle & salinity gradient transect along Sepik River plume Stations 12-29. Steam to Madang.

Station Locations

1.	10°53'S	146°00'E	1500m
2.	09°50'S	146°00'E	2300m
3.	09°11'S	145°14'E	1100m
4.	09°00'S	144°30'E	90m
5.	08°46'S	144°10'E	40m

6.	08^{O}24'S	143^{O}48'E	20m (near Umuda Island)
7.	08^{O}05'E	144^{O}24'E	30m
8.	07^{O}57'S	145^{O}07'E	70m
9.	08^{O}37'S	145^{O}49'E	923m
10.	08^{O}58'S	145^{O}49'E	1500m
11.	03°45'S	144°32'E	

12-29. Sepik River Estuary transect

Time Budget

Steaming time	150 hrs
Casts	54 hrs
Sediment trap recovery	6 hrs
Large volume sampling	72 hrs
Estuarine sampling	48 hrs
Contingency	20 hrs
Total	360 hrs

ORV Equipment Required

Deck Machinery:
- Clean Room laboratory van
- Isotope laboratory van
- Hydrowinch and CTD winch
- Running water on aft deck
- Flowing seawater
- Zodiac for sampling

Scientific Equipment:
- HB Trace element water samplers
- CTD and rosette sampler
- Clean cabinet in GP Lab
- nutrient auto-analyser
- in-situ fluorometer
- U/W light sensor
- Acoustic Doppler Current Profiler (ADCP)
- Navigational and meteorological logger
- Scintillation counter
- Thermosalinograph
- UV/VIS Spectrophotometer

Note: (1) Request for all CTD data to be processed at 1 metre bin depth intervals
(2) Although nutrient analyses by autoanalyser are requested these will be a minimum of samples for intercalibration purposes. Nutrient samples will be collected and stored onboard for analysis at AIMS.

User Supplied Equipment

Infiltrex in-situ sampling pumps

Large volume in-situ sampling pumps
Flow injection Fe(II) and peroxide analyser
Plankton nets
Satellite reception & processing facilities
Onboard filtration equipment
Radioisotope workstation
γ-radiation detectors
Automatic air sampler (DMS)
Gas cylinders - G size
    High Purity Nitrogen gas
    Hydrogen gas

NB: We intend to use several artificial radionuclides for primary production (^{14}C, beta emitter) and particle formation experiments (^{54}Mn & ^{59}Fe, gamma emitters). These experiments will be performed in purpose-built workstations within the isotope van, at extremely low-levels with the appropriate licensing arrangements. Radiation detection will be performed underway (scintillation counter, NaI g-detectors). All wastes will be suitably stored and disposed of ashore. Samples will also be collected for naturally occurring radionuclides (^{234}Th, ^{7}Be, ^{210}Pb) using large volume in-situ sampling pumps, although, due to the extremely low-levels of natural radiation these samples are not considered "radioactive".

This cruise plan is in accordance with the directions of the National Facility Steering committee for the oceanographic research vessel *Franklin*.

C B Fandry
CSIRO Division of Marine Research

Prof. G W Paltridge
National Facility Steering
Committee

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