

FRANKLIN

National Facility
Oceanographic Research Vessel

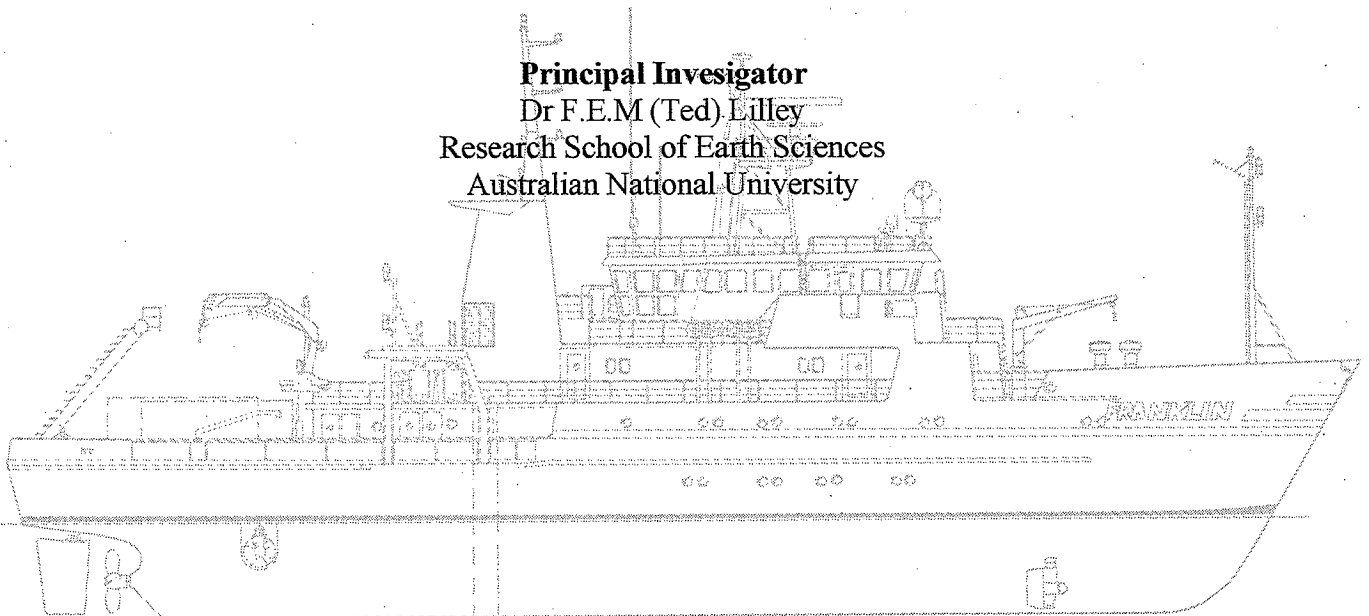
CRUISE SUMMARY

R/V FRANKLIN

Fr08/97

Depart:	Townsville	1000hr Thur 24 Sept 1997
Depart:	Sydney, NSW,	1500 hr Sun 28 Sept 97
Arrive:	Sydney, NSW,	0700 hr Tues 7 Oct 97
Arrive	Brisbane	1000hr Thur 9 Oct 1997

Principal Investigator
Dr F.E.M (Ted) Lilley
Research School of Earth Sciences
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Cruise Summary, RV *Franklin*, Fr08/97, Sep 24 - Oct 9, 1997.

Itinerary

Depart:	Townsville, Qld, Wed 24 Sept 97	1000 hr
	Sydney, NSW, Sun 28 Sept 97	1500 hr
Arrive:	Sydney, NSW, Tues 7 Oct 97	0700 hr
	Brisbane, Qld, Thur 9 Oct 97	1300 hr

Title: Study of Oceanic Dynamo Action (SODA)

Scientific Programs

The main scientific program of the cruise had the objective of obtaining a description of the motional electromagnetic induction taking place in the East Australian Current (EAC). Such a description involved measuring magnetic signals on the seafloor, electric signals on the seafloor, magnetic signals at the sea-surface, and magnetic profiles vertically down through the ocean column. As much of the magnetometer equipment for this purpose is still under development, an important objective of the cruise was to test and possibly further develop the equipment under ocean conditions.

It was expected that the measurement of the magnetic fields generated by ocean movement would, in turn, contribute knowledge of the volume transport of the EAC, and obtain measures of how the velocity of the EAC varies with depth. In particular: the following instrument deployments were made:

- One seafloor magnetometer at depth 500m

- Three seafloor magnetometers at depths 5000m approx

- Two combined electric and magnetic instrument deployments at 5000 m approx

- A magnetic profiler lowered from the ship: six events (each of a profile down then a profile up)

- The profiler operated in "free-fall" mode: two events (each of a profile down then a profile up)

- A floater magnetometer operated tethered to the ship: some five events

- A floater magnetometer operated floating free from the ship: some three events.

In addition, eight magnetometers were operated on land, by the ANU and the Australian Geological Survey Organisation (AGSO), in a line reaching from Durras on the NSW coast to Barellan, 400 km inland.

During the cruise, the state of an ocean eddy being traversed was monitored by ADCP, CTD and XBT measurements, and daily advice was received from George Cresswell at CSIRO Marine Labs, Hobart, regarding the ocean current activity as evident in satellite images.

Put simply, the main objective of the cruise was to obtain a "snapshot" of the EAC as a dynamo, in as much detail as possible. A piggyback project during the cruise was the running of a radiometer and the release of ionosondes, to assess instrumentation for future use on merchant "ships-of-opportunity".

Cruise track

See Fig. 1.

Personnel List

SODA:

Lilley, F.E.M.(Ted)

ANU. Responsible for magnetometer casts at sea. Chief Scientist.

White, Antony

FlindersU. Responsible for deployment and retrieval of the seafloor magnetometers and electrometers.

<i>Heinson, Graham S</i>	FlindersU. Assist with deployment and retrieval of the seafloor instruments, and with the magnetometer casts.
<i>Perkins, Brenton</i>	FlindersU. Assist with deployment and retrieval of the seafloor instruments, and with the magnetometer casts.
<i>Kiss, Andrew</i>	ANU. Assist with CTD and XBT casts. Keep general scientific log of station positions and instrument activity. Liaise regarding hydrological data.
<i>Wong, Alan</i>	ANU. Assist with CTD and XBT casts. Keep general scientific log of station positions and instrument activity. Liaise regarding hydrological data.
<i>Robinson, David</i>	FlindersU. Assist with deployment and retrieval of seafloor magnetometers and electrometers, and with CTD and XBT casts.
<i>Jewell, Nathaniel</i>	FlindersU. Assist with deployment and retrieval of seafloor magnetometers and electrometers, and with CTD and XBT casts.

Piggyback (radiometry):

<i>Suber, Ken</i>	CSIRO Division of Marine Research. Radiometer operation and ionosonde releases.
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ORV Support:

<i>Vaudrey, David</i>	Cruise Manager and Computer Systems Manager.
<i>Adams, Phillip</i>	Electronics Support.
<i>Critchley, Gary</i>	Hydrology Support.

Ship's Officers and Crew:

<i>Dougal, Dick</i>	Master
<i>Staron, Arthur</i>	Chief Officer
<i>McCarthy, Allan</i>	2nd Mate
<i>Morton, John</i>	Chief Engineer
<i>Jonker, David</i>	1/Eng
<i>McLagan, Andrew</i>	Elec/Eng
<i>Hansen, Yannick</i>	Bosun
<i>O'Halloran, Gerry</i>	AB
<i>Marsh, Norm</i>	AB
<i>Browning, Wayne</i>	AB
<i>Clarke, Les</i>	Greaser
<i>Hall, Gary</i>	Chief Cook
<i>Dux, Peter</i>	2nd Cook
<i>Culliney, Ron</i>	Chief Steward

Cruise Narrative (times and dates in EST)

Introduction

The cruise can be simply described as heading from Sydney down the coast to intercept a warm-core eddy, and then going backwards and forwards across this eddy four times. The first leg across the eddy headed eastwards, laying seafloor magnetometers, and at the same time making XBT casts. The second leg headed back westwards, making CTD casts and magnetometer profiler casts at five equispaced sites. The third leg headed eastwards again, making "free-fall" magnetometer casts (in the event, the work of this leg was reduced due to bad weather). The fourth leg was westwards, retrieving the seafloor instruments.

Sunday 28 Sept

Having left Townsville on 24 Sept, the *Franklin* docked at No. 10 Darling Harbour, Sydney at 1000 hr on Sunday 28 Sept. The scientific party (five from Flinders University and three from

ANU) boarded the ship there, and loaded and stowed equipment. Welcoming briefings were carried out by the Cruise Manager at 1400 hr, and a tour of the vessel followed, before the vessel sailed at 1500 hr.

Outside Sydney Heads a strong southerly wind was blowing, and the ship headed south into this wind and weather overnight.

Monday 29 Sept

Magnetometer 1 was deployed in some 500 m of water at site "Solo" at 0600 hr, and its position on the seafloor was determined by acoustic triangulation. This procedure also allowed a first test use of the ship's 12 kHz "in-hull" transducers to communicate with seafloor instruments, using deck units brought on board by the scientific party. Most success was achieved with the 400 W transducer, and use of this transducer continued throughout the cruise. At 1100 hr a safety drill was held, with personnel reporting to muster stations.

With the southerly abating, the ship now commenced to run from the coast in a direction approximately east by south, to traverse the eddy apparent in the satellite images. Magnetometer 2 (site "Kurrewa") was deployed during the day, and Magnetometer 3 (site "Malohi") was deployed at 2000 hr. During this day also, XBT casts were initiated, to gain information on eddy structure.

Tuesday 30 Sept

The ship was on station at Magnetometer site 4 ("Trade Winds") early in the morning, and two separate instruments, each of which measure both the seafloor electric and magnetic fields, were deployed there near each other, to enable a cross check between the instruments for data consistency. The ship was in a current of some 3 kt to the north, in pleasing confirmation of the prediction from the satellite data. The "floater" magnetometer was deployed for the first time, and streamed out from the ship on its 300 m tether.

CTD casts were commenced in the afternoon. Initially, a tutorial was given by Gary Critchley to the students on board, about CTD procedures and technique. In the evening, still in the vicinity of site "Trade Winds", the first magnetometer profiler cast was carried out from the ship, using the CTD A-frame and the hydrology winch. Lowering the profiler at 60 m/min and raising at 60 m/min on the hydrology winch worked fine. On a second drop, experimenting with lowering at 80 m/min produced a slight cable tangle, implying that 80 m/min was faster than the "terminal velocity" of the profiler package, as deployed. However, retrieval at 80 m/min worked fine, and subsequent profiler casts were run at 60 m/min down, and 80 m/min up. The profiler casts finished just before midnight. The floater was then brought on board. The ship continued further east to obtain two more XBT casts, which further documented the setting of site Trade Winds in the eddy. The ship then moved to "site 3.5", (halfway between Trade Winds and Malohi).

Wednesday 1 Oct

A beautiful calm morning, northerly breeze at 10 kt; northerly-setting current. On station at "site 3.5", at 0800 hr deployed floater, and at 0900 hr commenced CTD cast. Afternoon commenced magnetic profiler casts. During the second drop the floater tether parted, the opposing wind and current having caused it to chafe against the hull of the ship; the remaining part of the magnetic profile cast was curtailed, and priority given to recovering the floater; the tether was then repaired. The ship then moved to site 3 (Malohi) and commenced a CTD cast, followed by a magnetic profiler cast.

Thursday 2 Oct

On station at site 2.5 (midway between Malohi and Kurrewa), a CTD cast was run early, followed by a magnetometer cast. During the day the wind freshened to 25 kt from the north, but swung mid-afternoon to the south with a front. By evening, mild breezes, with the ship at site 2 (Kurrewa) carrying out first a magnetic profiler cast, and then a CTD cast (the latter was curtailed at

depth 1400 m due to *Franklin* engine trouble). The south coast of NSW was now in sight, and Bogong moths, off course from their migration from Queensland to the mountains of southeast Australia, clouded around the ship; in the container laboratory on the after deck, moths kept appearing from crevices amongst equipment for the rest of the cruise. In the morning some time had been spent correcting an "over-run" by the CTD cable on its winch.

Friday 3 Oct

Overnight the ship stayed near site Kurrewa, while the trouble with the engine fuel pump was addressed, and a new unit was built from spares. In the morning the southerly wind freshened to 25-30 kt, with building seas. The current was strong to the south (2.5 kt). In the rough seas, the *Franklin* hove to.

The series of magnetometer casts by lowering the profiler from the ship having now been accomplished, the profiler equipment was down-loaded and inspected, and then prepared for "free-falling". Overnight the ship ran north with the gale.

Saturday 4 Oct

In the morning the ship turned to head slowly south into the winds and seas, which eased during the day. Lack of time now acted against moving to cross the current further south, as was earlier planned. By 1800 hr conditions allowed the deployment, for the first time, of the profiler in free-fall mode. The objective: to obtain profiles which were clear, in their upper 200 m, from the effects of the ship. The profiler was set free behind the ship, and kept on the surface by the floater (doubling as an auxiliary buoy), while the ship moved away. With the ship at least 500 m distant, the profiler was released (using an acoustic signal) to fall to the seafloor: its progress was tracked acoustically. When the profiler reached the seafloor, a second release was activated. Concrete ballast blocks were jettisoned, and the profiler, now buoyant, floated back to the surface, where three different beacons (radio, light and acoustic) aided its recovery by the ship. This first free-fall deployment was accomplished in the southerly-setting current inshore, in depth 2500 m.

After releasing the profiler, the floater was left free of the ship, ranged on acoustically, and kept in visual contact by a light beacon. The profiler worked well, and was recovered about midnight.

Sunday 5 Oct

Overnight the ship moved to the most easterly site (Trade Winds, site 4). Early on station, the two seafloor instruments were released, with a time lag between them, for their journey to the sea-surface. In calm seas the retrievals went smoothly, and both instruments were on board *Franklin* by 1400 hr.

A second free-fall profiler exercise was then commenced, in the vicinity of this same most easterly site; the surface current was some 2 kt to bearing 325 deg. This second free-fall exercise also went well, and was completed, with floater and profiler back on board, by 1840 hr. The ship then proceeded to site 3 (Malohi), arriving at 2130 hr. The retrieval of the seafloor magnetometer there commenced, and was completed about midnight, in a wind freshening from the south.

Monday 6 Oct

In the morning, seafloor magnetometers were retrieved successfully from sites 2 (Kurrewa) and 1 (Solo), in a southerly wind now building up seas. The last instrument, from site 1, was on board by noon.

Franklin then headed north up to the coast to Sydney. During the afternoon the opportunity was taken to test a new marine proton precession magnetometer. The instrument was towed behind the ship for an hour, and the output of the instrument monitored while the ship took different headings.

Tuesday 7 Oct

The pilot was met at 0600 hr off Sydney heads, and *Franklin* docked at 0700 hr at Darling Harbour No 10 wharf. The scientific parties from ANU and Flinders unloaded their gear and disembarked, and the ship sailed for Brisbane without delay.

Preliminary Results

At the time of writing, the observed data are still being downloaded from the variety of instruments used during the cruise. It is not possible therefore to give results in any comprehensive manner. However a main purpose of the cruise was to test and develop logistics, i.e. methods for using the instruments. It is possible at this stage to report on these:

Magnetic profiler: The data from both the ship and "free-fall" look great. The trials from *Franklin* in 1994 and 1995 appear to have paid off handsomely, in that the instrument now appears clean of magnetic contamination. Basically, it worked as planned, and worked well.

Profiler in "free-fall" mode: The data from the two "free-falls" look splendid, and have the potential to give good results for the magnetic profiles in the distinctive upper 1000 m of the water column. This effect is hoped to be especially clear when the profiles for north-flowing and south-flowing currents are compared.

More free-falls would have been run had time not been lost towards the end of the cruise, but in fact two sets of free-fall data, in currents running north and south, have the potential to demonstrate the key point.

Floater: The "floater" magnetometer, and logistics, came through the first test at sea very well. The records from it will be used (i) to correct the profiler data for certain effects, (ii) to combine with the land data as a marine measure of the coast effect in micropulsations, and (iii) to analyse for magnetic signals due to waves and swell. Work ahead will address checking any possible benefits of a tether longer than 300 m. The success of the floater so far may suggest that it is useful to have a magnetometer which samples more frequently than every 3 sec (the sampling frequency of the floater during Fr08/97), especially for the purpose of detecting the magnetic effects of waves and swell.

Seafloor magnetometers: Logistically, these instruments performed well. An improvement needs to be made for their ease of grappling, such as by adding a float to the end of their buoyant snag line.

Use of Ship's transducers: The tests of using the ship's 12 kHz transducers to communicate with acoustic releases at the surface, in the ocean column and on the seafloor were regarded as a substantial advance. In particular, a major increase in convenience and efficiency was demonstrated, relative to the basic technique in which the motion of the ship through the water is stopped, and a transducer is lowered over the side on a cable.

Other ship's equipment: (i) The ADCP data during the cruise were incorrect, and this could have had serious consequences as strong currents were being chased intentionally, and decisions about where to make observations were being based on ADCP data. (After the cruise it was possible to correct the ADCP data, once the error and its cause, transducer alignment, were identified).

(ii) It was reported that the equipment for determining nutrients was unserviceable. The samples taken during the cruise have been preserved. It is hoped that the nutrient samples will be analysed during a subsequent voyage (Fr10/97).

(iii) In a general discussion on options for lowering the magnetic profiler to the seafloor, the point was made that the main stern cable of the *Franklin* is at present less than is needed to lower an instrument to the floor of the Tasman Sea. On Fr08/97 the hydrology winch worked well for the magnetic profiling; it is made somewhat labour intensive in use by the need for a rope link between the actual profiler package and the end of the hydrology cable. The purpose of the rope link, 40 m long, is to separate the profiler from the magnetic effects of the steel cable.

Summary

My overall impression of the cruise, and of the SODA project, is that it has been a great success, which went very much as the P.I.'s had hoped, when first applying for the ship-time several years earlier. Important ingredients included the good eddy present when the time for the cruise arrived, so that (with the help of George Cresswell) it was possible to take the ship straight to optimum sites, and obtain the contrast of measurements where the ocean current flowed both north and south.

Secondly, the profiler worked well, after several development trials on earlier *Franklin* cruises; both lowered from the ship and (of especial significance) in its free-fall mode. A first look at the recorded data shows the characteristics being sought.

Thirdly the floater worked well in its logistics, as did the seafloor magnetometers. Subsequent to the cruise the land magnetometers have been visited and downloaded; good data are also now held for the line of land instruments. As a further touch of good fortune, there is evident for moderate magnetic activity (originating in the ionosphere) on the first two days of the cruise, and then a period of magnetic "quiet" conditions. Such a distribution of activity is expected to be favourable to the objectives of the cruise; for example, for coast-effect studies some magnetic activity is needed, while it is much preferable to carry out magnetic profiling in "quiet" conditions.

To the best knowledge of the P.I.'s the SODA experiment, taken in the wider sense to include also the first magnetic profiler test conducted in the EAC from *Franklin* on cruise Fr 04/94 in April 1994, represents the first known attempt to measure, as a profile down through the water column, the magnetic fields generated by the dynamo action of an ocean current, moving in Earth's main magnetic field.

Summary of the Radiometry Project (provided by Ken Suber)

The objective was to provide surface truth and calibration for sea surface temperatures remotely sensed by the ATSR on ERS-2, and secondarily, by the AVHRR on NOAA-12 and 14.

The logging of data by the AHDS radiometer, provided by Bob Cechet at DAR, proceeded smoothly once the details of its internal software were better known. The AHDS was periodically calibrated indirectly by a black body, with the help of a hand-held Tasco radiometer. The Tasco radiometer was used to measure SST, and also sky brightness temperatures.

The radiosonde launches were timed to coincide with ERS-2 satellite overpasses. The first two launches went smoothly, but the telemetered signal was lost when the sonde reached about 1000 m altitude. The antenna was suspected, and later confirmed to be corroded beyond repair. A stand-alone system, provided by Bob Cechet as a back-up, was used for subsequent launches.

Logging of data by the AHDS radiometer was carried out for most of the cruise, except during some periods of bad weather. The combination of equipment problems and bad weather resulted in fewer sonde launches than planned. All analysis will be performed after the cruise.

(Ken Suber, CSIRO Divn of Marine Research, 7 Oct 97)