R.V. FRANKLIN

NATIONAL FACILITY
OCEANOGRAPHIC RESEARCH VESSEL

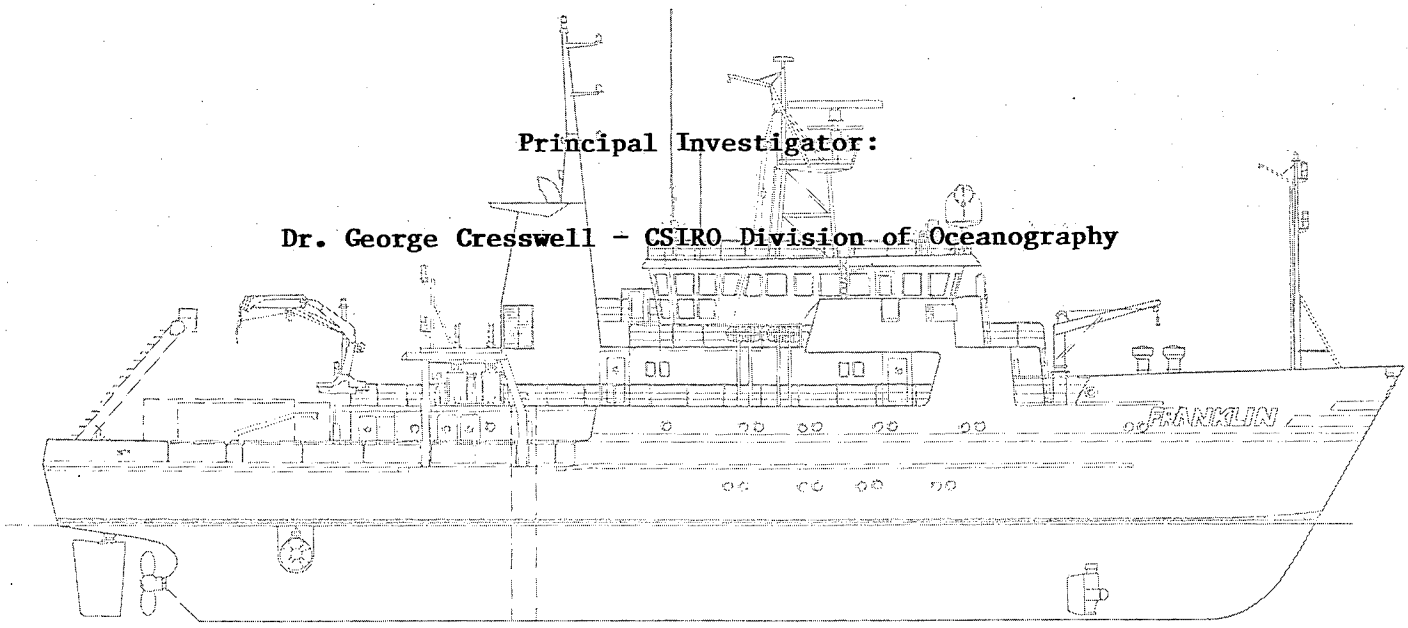
RESEARCH CRUISE SUMMARY

R.V. FRANKLIN

CRUISE FR 3/88

8 March 1988 - 22 March 1988

DARWIN - CAIRNS



Principal Investigator:

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AUSTRALIA

R.V. FRANKLIN IS OWNED AND OPERATED BY CSIRO

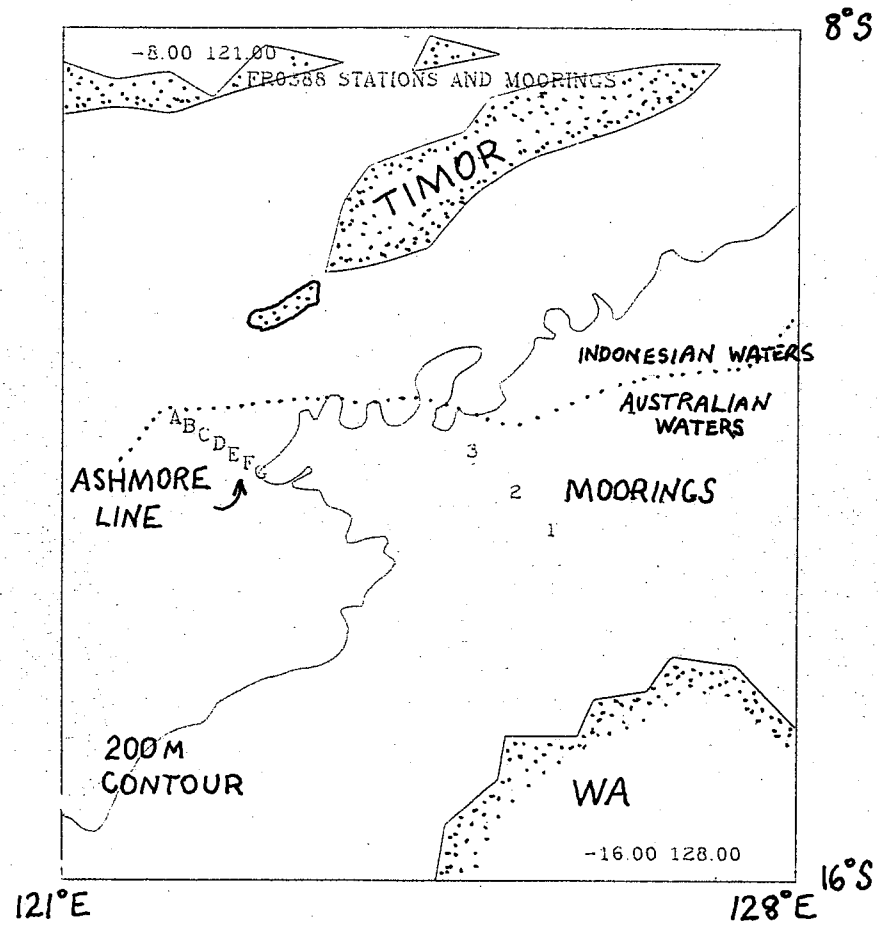
RESEARCH VOYAGE FR 3/88 - SUMMARY

Contents:

ITINERARY

Dep. DARWIN	0600h	8 Mar
Arr. DARWIN	1930h	15 Mar
Dep. DARWIN	2030h	15 Mar
Arr. CAIRNS	0730h	22 Mar

Figure 1 The locations of CTD stations A-G on the Ashmore line and the locations of moorings 1-3. Note that A, B, and C were Pegasus sites.



OBJECTIVES

G. Cresswell and D. Quadfasel:
To examine the throughflow from the Pacific to the Indian Ocean in Australian waters northwest of Ashmore Reef.

M. Tomcjak:
To further test and develop 'Prowas'.

OCEANOGRAPHIC WORK SUMMARY

The sequence of work conducted on the voyage is given in Table 1 below. The work included 28 CTD casts; 15 Pegasus current profiles; 3 continental shelf moorings deployed; 4 Prowas test casts; underway surface water properties; underway current profiles; one satellite drifter released; accurate soundings with GPS fixes; meteorological observations. Cross-calibrations:- ADCP/Pegasus; ADCP/drifter; Pegasus/CTD.

Table 1 Work sequence.
The nominal depths at stations A-G were: 2800, 1900, 1100, 1100, 800, 500, and 280m. The stations were roughly 1 hour's steaming apart. The CTD casts were near to the bottom unless the depth is specified. Pegasus cast numbers continue on from FR 9/87. GPS coverage for all or part of an operation is indicated √.

Date	Local Time	CTD#	Site	Operation	GPS
9 Mar	0800		Shelf	Deploy mooring #1	√
Wed	1200		Shelf	Deploy mooring #2	√
	1600		Shelf	Deploy mooring #3	
10 Mar	0100	1	G	CTD	
Thurs	0330	2	F	CTD	
	0600	3	E	CTD	√
	0900	4	D	CTD	√
	1300	5	C	CTD	√
	1500	6	B	CTD	
	1800	7	A	CTD + Pegasus #17	
11 Mar	0000	8	B	CTD + Pegasus #18	
Fri	0400	9	C	CTD + Pegasus #19	
	0700		C>A>C	ADCP alignment check	√
	1100	10	C	CTD + Pegasus #20 + Prowas (30m)	√
	1500	11	B	CTD (1200m) + Pegasus #21 + Prowas (30m)	
	1900	12	A	CTD (1200m) + Pegasus #22	
	2300	13	A	Calibration of Pegasus #23 attached to CTD for deep cast	
12 Mar	0200	14	A	CTD (1200m) + Pegasus #24	√
Sat	0800	15	B	CTD (1200m) + Pegasus #25	√
	1200	16	C	CTD + Pegasus #26	
	1600	17	A	CTD + Pegasus #27	
	2100	18	B	CTD + Pegasus #28	
13 Mar	0100	19	C	CTD + Pegasus #29	
Sun	0400	20	D	CTD	
	0700	21	E	CTD	√
	0900	22	F	CTD + Prowas (400m)	
	1900	23	F	CTD + Prowas (400m)	
14 Mar	0100	24	A	CTD (500m) + Pegasus #30	
Mon	0800	25	B	CTD (500m) + Pegasus #31	√
	1200	26	C	CTD (500m) + Pegasus #32	
	2000	27	Shelf	CTD (200m)	
15 Mar	1100	28	Shelf	CTD (100m) + release drifter	√
Tues	1200			Transit to Darwin and Cairns	

NARRATIVE

The ship departed Darwin in calm conditions pre-dawn at 0600h on Tuesday 8 March and set a course to the inshore mooring of the three to be deployed . A liferaft drill was conducted at 1100h followed by a safety lecture on the afterdeck from the Master of the vessel.

The ship arrived at the inshore mooring site at 0730h on Wednesday 9 March. The three moorings were deployed without incident during the day. Between moorings 1 and 2 Franklin passed the Jabiru production platform, the "Energy Searcher", and the Sedco 708 platfrom, as well as two pairs of Taiwanese trawlers.

After deploying the moorings the ship headed to the line of seven stations from Ashmore Reef WNW towards Indonesian waters. These were defined in October 1987 on FR 9/87. The outermost 3 stations (A-C) had transponders installed on the bottom on FR 9/87 for current profiling with Dr. Quadfasel's Pegasus.

The aim of the work for the following few days (refer to Table 1) was to take 4 or more Pegasus profiles/CTD casts at each of stations A-C and CTD casts at sites D-G. The ADCP was to be run for cross-calibration with Pegasus. Prowas profiles were to made when appropriate.

On Thursday 10 March at 0300h the first CTD station was completed at site G and by 1100h three more stations, F-D, had been completed. The seas continued to be smooth. There was a little trouble with the altimeter on the first station and then more on the second. Mr. Madsen found the altimeter to be faulty and so it was removed. The salinity profile for CTD#4 (site D) was inaccurate because at 100m the instrument must have picked up a jelly fish, with the result that the profile was offset by .02 until the bottom of the cast. In addition, CTDs #1-6 had a small salinity offset that disappeared when the sensor was cleaned.

The transponders at site C were fixed a little better with the GPS than was possible on FR 9/87. Stations C, B, and A were completed during the evening and the first Pegasus profile for the voyage ,#17, was taken at site A.

The ship returned to site B at 0000h Friday 11 March for Pegasus profile #18 and a 1200m CTD cast. The procedure was repeated at site C at 0400h.

At 0700h an attempt was then made to determine the ADCP transducer misalignment by steaming from site C to A and back along the reciprocal course. The results proved confusing until a test of the gyro encoder was done by rotating the ship. This showed sinewave-type errors of up to 2.5°, which translate into unacceptable current errors of 0.5 knots at a ship speed of 12 knots . This is discussed in 'Difficulties' later.

The ship returned to site C at 1100h for Pegasus profile #20, CTD#10, and a Prowas leak test to 30 m. At Site B at 1500h Pegasus #21 profile and CTD #11 to 1200m were taken. Prowas was given another test.

The ship arrived at Site A at 1900h for Pegasus #22 and a 1200m CTD cast. At 2300h the Pegasus pressure and temperature sensors were calibrated by attaching Pegasus (#23) to the CTD and running it down to the bottom. Then at 0200h on Saturday 12 March, roughly a 1/4 tidal cycle after the 1900h work, Pegasus #24 and a 1200m CTD (#14) were taken.

The ship moved to Site B and at 0800h Pegasus #25 and a 1200m (#15) were taken. This combination of Pegasus and CTD casts at sites A-C was continued until 0400h on Sunday 13 March when the ship moved inshore along the line taking CTD stations #20-22 at sites D-F.

At site F at 1000h a Prowas cast to 400m resulted in some samples being injected into the high pressure hose, but there were problems with the oil injection and the oil hose burst during the ascent.

The ship was then in the vicinity of Ashmore Reef where over 20 Indonesian prahus with their lateen sails could be seen gliding across the sea, each as smoothly as a hot steam iron over a thin cotton shirt. We were visited by the

Australian representatives at the Reef, Mr. and Mrs. Sexton.

At 1900h CTD #23 was taken at site F, followed by a 400m Prowas cast. Prowas took samples and injected oil between them as it should. The oil hose burst on the ascent, but the samples were already secured.

In the event that Prowas might be further tested we stayed in the deep water west of Ashmore Reef on Monday 14 March and used the time to take 500m CTD casts #24-26 and Pegasus casts #30-32 at sites A-C. This concluded the work that had been planned on the throughflow.

It was decided that shallow tests with Prowas as the ship traversed across the top of Australia and possibly a deep test in the Coral Sea would be sufficient and so the ship headed eastward to reoccupy shelf CTD stations #85 and #86 from FR 9/87 and then CTD stations at the moorings.

The 200m CTD station #85 from FR 9/87 was reoccupied as CTD #27 at 2000h. Bad weather overnight prevented #86 from being reoccupied.

At 1100h on Tuesday 15 March the weather had ameliorated sufficiently for a satellite drifter with a parachute drogue to be released near the moorings and for a 100m CTD #28 to be taken. By way of an intercomparison of drifter and ADCP, the drifter was position-fixed twice 24 minutes apart by bringing the ship near it; the termination of the day's GPS coverage prevented the interval from being longer. Five good ADCP profiles with the ship drifting gave, for the 20m bin, mean velocity components (-.17,-.27) [both ±.04] while drifter gave (-.18,-.32) m/s. The drifter moved (-263 m,-466 m) during the 24 minutes and the Chief Scientist's estimate of the drifter's distance from the ship at the time of noting the GPS positions would have lead to uncertainty in the drift distances given above [a 50m error translates into .02 m/s].

A little before the drifter release a message was received that Chief Cook Mike Taylor's mother had died and so the ship set course for Darwin so that he could disembark. En route data were processed and the ADCP was operated in a number of modes to determine effective techniques for shallow water operation.

The ship arrived at the Darwin anchorage at 1930h Wednesday 16 March and departed about one hour later. Mike Taylor, Danny McLaughlin, Neil Trenaman, and Mark Groscops disembarked. The replacement Chief Cook, Anton Turnsek joined the ship.

The next few days were spent on analysing samples, processing data, trying various ADCP settings, and dismantling the computer room for the refurbishing to be done in Cairns. Friday 18 March saw rain and head winds of typically 20 knots. The weather lifted briefly in the morning for a partial solar eclipse to be observed. In the evening the data processing with Pegasus reached a stage where comparisons could be made with the ADCP profiles obtained when the ship was drifting; the complex structures of the current profiles were reflected in the results from both techniques.

On Saturday 19 March winds in the morning were around 30 knots on the bow with some spectacular rain squalls in which the winds reached 50 knots. A fire drill was held in the morning (a fire in the chemistry laboratory) and the ship's safety committee met in the afternoon.

The ship passed through Torres Strait in the morning of Sunday 20 March and Jan Peterson operated the ADCP/GPS. Currents up to 3 knots were measured. The work on preparing the computer room for refurbishing neared completion. The weather continued to be windy and rainy.

On Monday 21 March the work on the computer room continued, equipment such as the ADCP transducer was secured for in-port storage, data analysis continued, and a gyro repeater test was carried out.

The ship arrived Cairns at 0730h Tuesday 22 March.

DIFFICULTIES

It was pointed out in the summary of Voyage FR 9/87 that the repeater from the ship's gyro produces the dominant degradation of the ADCP data. The other source of error is the misalignment of the transducer assembly in the hull, which could easily be determined if it was not for the massive error in gyro repeater. What does this error amount to? As the ship is rotated first one way and then the other with checks every 5°, the value given by the repeater varies quasi-sinusoidally giving errors of up to 2.5° (Figure 2). At a ship speed of 12 knots this means an error of 0.5 m/s (1 knot) in the athwartship component - port or starboard depending on the ship's course. Therefore the apparent ocean current vectors change with each course change.

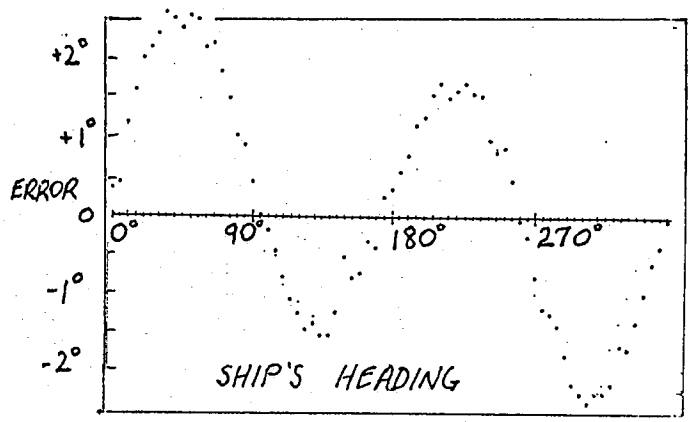


Figure 2 The error in the gyro repeater versus the ship's heading.

The ADCP data are, most likely, able to be corrected, but caution is called for, and it is necessary for gyro tests to be done on each voyage.

It is worth pointing out that the ship's gyro is tapped by 10 step repeaters - 2 radars, 2 bridge wing displays, 1 winch display, 1 satnav, 1 steering, 1 course recorder, 1 Inmarsat and 1 RDF - as well as the synchro repeater for the ADCP. A total of 11. The gyro is built for 6 repeaters. Perhaps it's time a suitable gyro was acquired for the ADCP.

(When the ship is stationary, the ADCP vectors seem to be quite good - at least from intercomparisons with drifting buoys and Pegasus).

A SELECTION OF THE RESULTS

General T-S

The T-S curves for stations along the Ashmore line (Figure 3a) showed relatively little variation when compared with those from last October (Figure 3b).

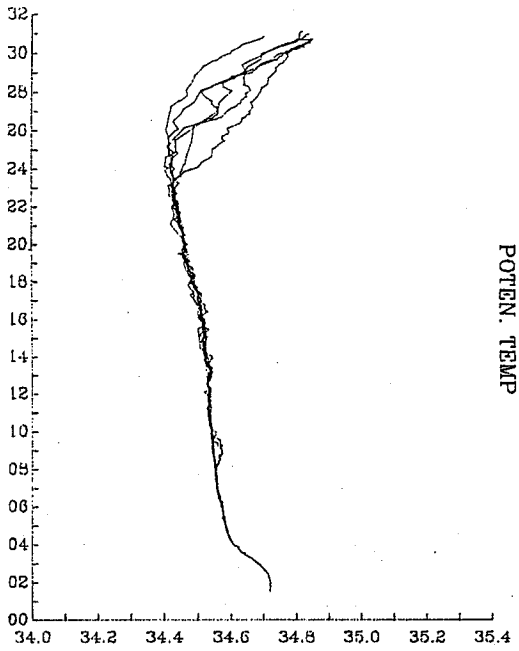


Figure 3a T-S curves for stations 7-22 along the Ashmore line during FR 3/88.

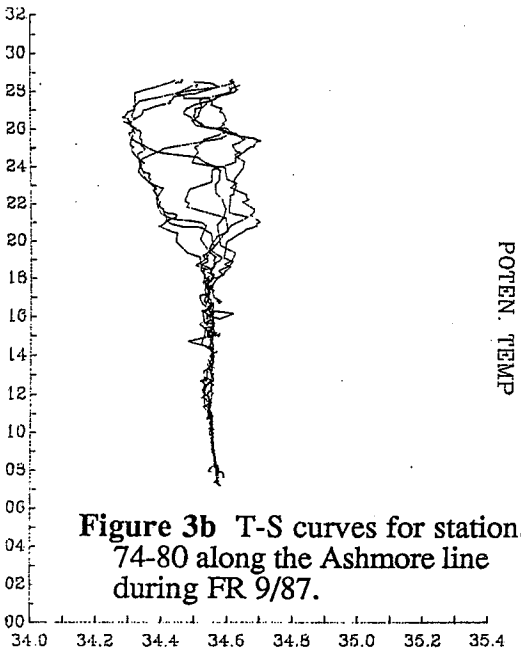


Figure 3b T-S curves for stations 74-80 along the Ashmore line during FR 9/87.

However, as in October, the near-surface salinities in the east were higher than those in the west and there was a salinity minimum at 50-100m (Figure 4a).

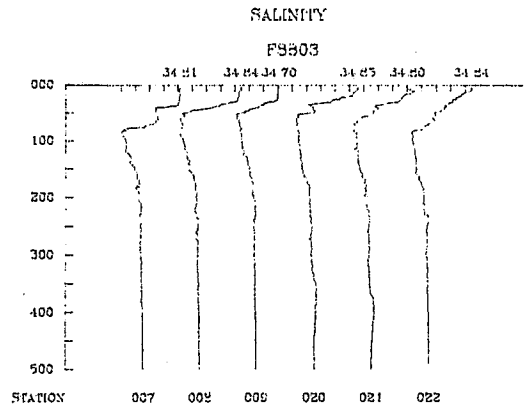


Figure 4a Salinity profiles at stations A-F (from left to right). Surface values are indicated.

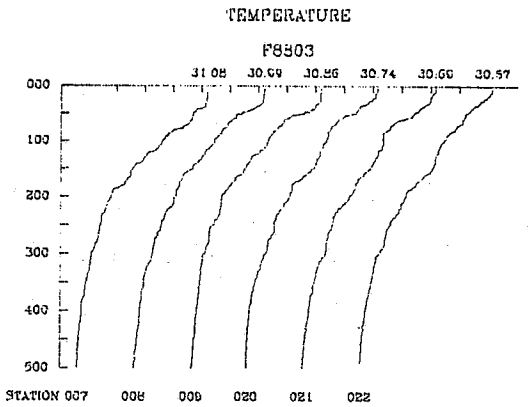


Figure 4b Temperature profiles at stations A-F (from left to right).

The water properties were near-identical at all stations from depth up to about 80-90m, where the temperature was 23°C. Above this the T-S curves for the eastern stations went almost in a straight line to 31° C, 34.85 while those in the west bowed upwards to lower salinities, sometimes asymptoting to the eastern curves by the time the surface had been reached. A few stations showed a subsurface salinity maximum in the upper 50m.

Current profiles

In order to avoid the problems of gyro encoder error and transducer misalignment, which introduce errors of ship's speed times the sine of the angle of error, opportunities were taken, when possible, to acquire ADCP/GPS profiles when the ship was drifting for CTD casts or Pegasus profiles. These ADCP/GPS profiles showed a reassuring repeatability as well as progressive changes with time. In all, there were 9 stations at which such profiles were obtained and, of these, 4 were concurrent with Pegasus profiles and 1 was the release of the drifter and the comparison of its velocity with the ADCP/GPS. The comparison with the drifter was favourable, being within the measurement errors, as was a comparison that was done on FR 9/87. Here we take two of the stations at which concurrent Pegasus profiles were obtained.

Site C CTD #10 / Pegasus #20

Figure 5 (page 7) shows one of 9 ADCP/GPS profiles obtained at the station, the down and up Pegasus profiles (full and dashed lines) in the upper 500m, and the T and S profiles for the upper 500m. The ADCP/GPS and Pegasus profiles compare very well considering that the former was obtained over 4 minutes and the latter over more than an hour as it travelled down to the bottom and up again. All these data can be interpreted to show surface high salinity water flowed W at 0.3 m/s; low salinity water at 100-150m flowed to the S and SW at 0.2-0.3 m/s; and below this to 300m the vector swung anticlockwise from SW around to NE, decreasing as it went . Below this the thermocline tended to be less steep and the flow became southward.

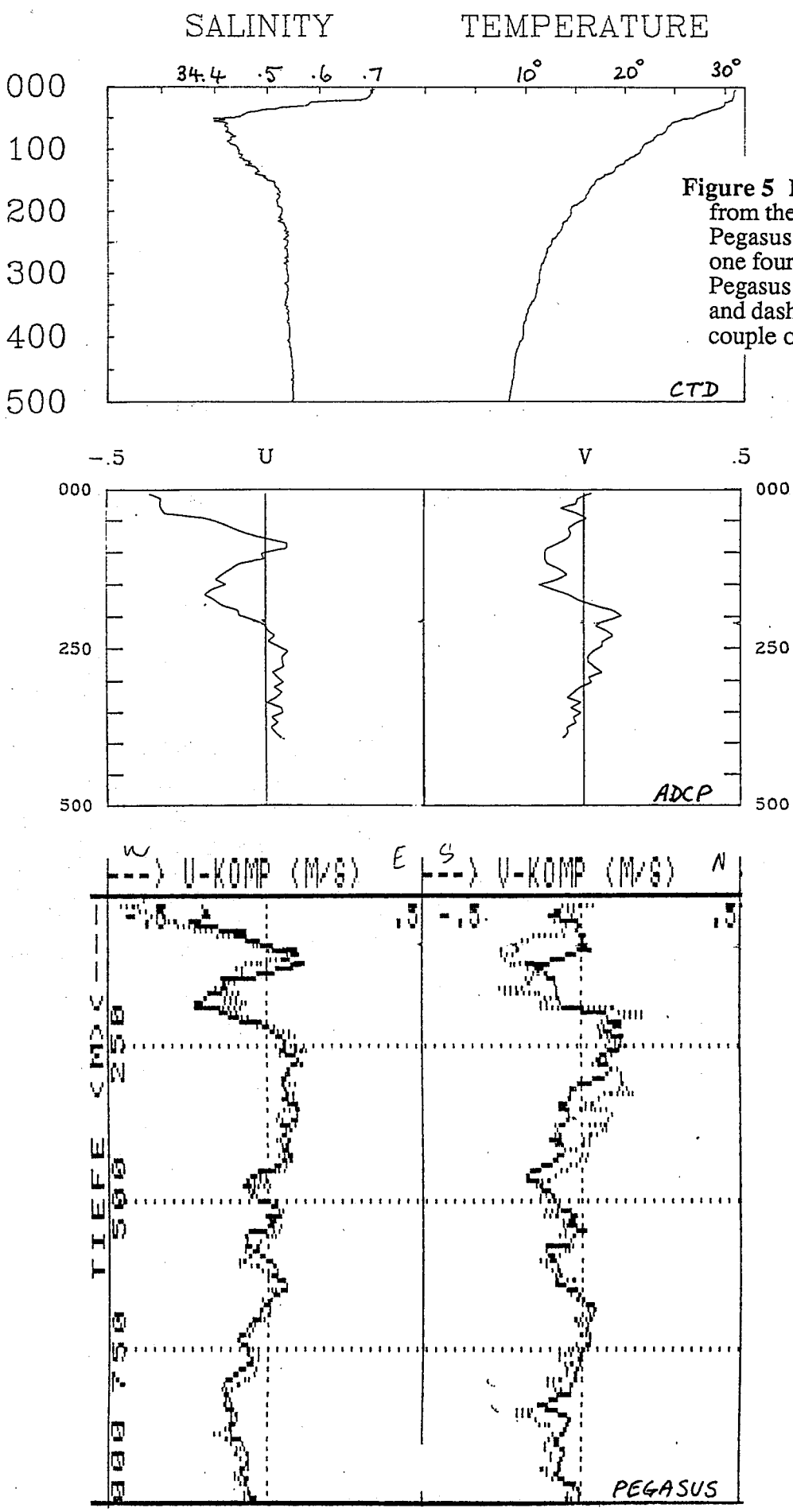


Figure 5 Data at CTD #10, site C from the CTD, ADCP, and Pegasus. The ADCP profile is for one four-minute period. The Pegasus profiles are full line down and dashed line up and took a couple of hours.

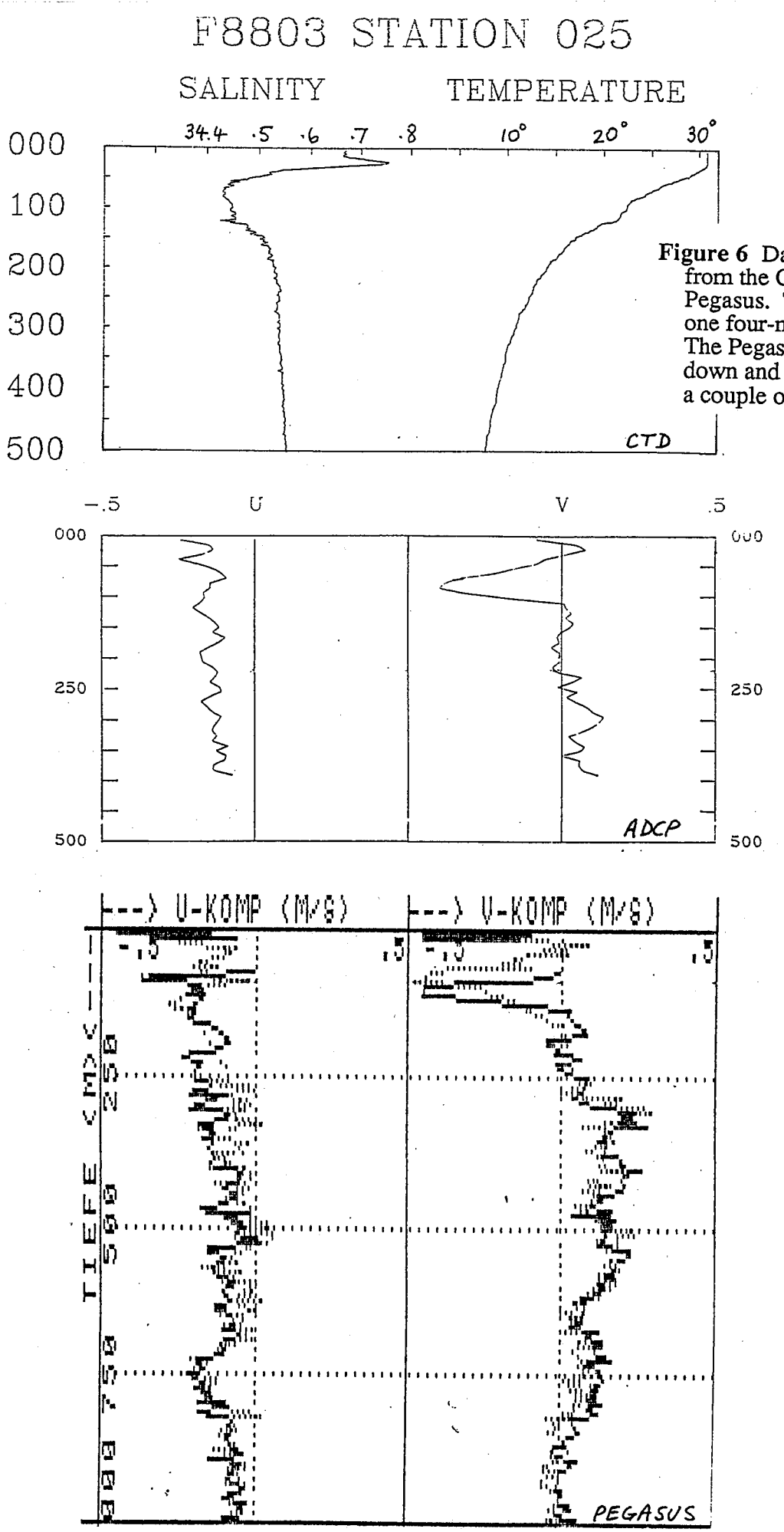


Figure 6 Data at CTD #25, site B from the CTD, ADCP, and Pegasus. The ADCP profile is for one four-minute averaging period. The Pegasus profiles are full line down and dashed line up and took a couple of hours.

Site B CTD #25 / Pegasus #31

Figure 6 (page 8) also shows favourable agreement between the ADCP/GPS and the Pegasus profiles. The whole profile down to 500m has a westward component of around 0.2 m/s. There is a very obvious 0.4 m/s "jet' to the SSW that is about 50m thick and centred at around 80m. This coincides with the steepest part of the thermocline.

Interestingly enough, in the lower part of the mixed layer, as would be defined by temperature, is an increase in salinity that peaks at the bottom of the layer. Structure of this type occurred on several other occasions.

Dr. Quadfasel made some preliminary calculations of transports from taking means from the Pegasus profiles at each of the sites and assuming that the profiles in each case were representative of the situation 5 miles on either side. The values of the throughflow for the resulting thirty miles were: October 1987, 1.9 and 3.2 sv for 0/500 and 0/1000 db respectively; March 1988, 3.9 and 5.9 sv for 0/500 and 0/1000 db respectively.

REPORTS

Electronics Report - S. E. Madsen

CTD and deck unit

During the second cast on the first Ashmore transect I was called to diagnose a problem with the CTD. At 250 dB all displays had become erratic and the altimeter indicated 0.0, although we had 500m water below the keel. On retrieving the CTD I noticed that as it went through 200 dB all displays reverted to normal. With the CTD on deck, I disconnected the altimeter and dropped the u/w unit back to 350 dB without any sign of problems. The altimeter was dismantled and examined, but no visible causes were apparent. I suspect that the problem might be a faulty transducer at pressures in excess of 250 dB. With the altimeter removed for the remainder of the voyage no further problems were encountered.

Trimble Satnav

Once again I had problems with the inability of the Trimble to lock onto the best three of the satellites available when there were more than the required number. Possibly part of the problem was satellite No. 8 which was later declared unhealthy. After I disabled it in the receiver there were no further problems.

Acoustic Doppler Current Profiler

Initially this went very well, but as we got into deeper water (100m) I got numerous bit failures with error codes relating to spectrum width and Doppler frequency. After much board swapping it was traced to menu setting of bins/ping.

Computers and printers

No problems with hardware on this trip. MTSPOOL took about two days to spring into action, and it would be nice not to have to reboot DELP to remove the alarm each time CLEAN has a new tape, and then having to reboot MICRO6 for CLEAN to run again.

The temperature alarm for the VAX was OK at the end of FR 10/87, and it was not touched by anyone during FR02/88 until I discovered it disabled on Feb. 29. To remedy this problem I suggest the following modification:

(a) The alarm be moved to the front of the rack and at eye level where it can be readily observed.

(b) The alarm be modified such that it can not easily be disabled.

(c) When the computer room is moved, a remote alarm siren be fitted in the operations room.

Prowas

I spent numerous hours fault finding and repairing this instrument. I would suggest that future prospective users of RV

Franklin be notified that if they require the services of the electronics technician then they should at least bring circuit diagrams and, if possible, circuit descriptions with them.

Computer room general

The ship engineers did much preparatory work for the computer room move during the voyage. Towards the end of the voyage I disconnected all RS232 lines and relocated all MICROs, terminals, disk and tape drives to the electronics lab. Racks and bases were removed in readiness for "Harder' to start on landing in Cairns.

In order to have similar terminals mounted in the ops. room I suggest that we use the two VT220s from the computer room and the VT220 from the communications room or, as an alternative, get a VT241 for the DELP monitor and use this VT220.

I do not think that we need extra Ethernet cable. The length that I gathered from under the racks should be ample to reach the new computer room, especially with the new multi-outlet interface. A cabling schedule was produced to assist in rewiring the new rack positions.

Hydrology Report - R. Griffiths

All hydrology, chemical and station data were completed and entered on the VAX.

Approximately 280 samples were processed on the autoanalyser for nitrate, silicate and phosphate. 260 samples were processed for oxygen and salinity.

The Filhan program still has problems and did not run interactively on all stations so that many stations required re-entering and editing.

The laboratory and instruments, including the autoanalyser (after some nursing), performed well. The acid waste disposal, however, is unfunctional. A proper holding tank system needs to be devised. Throwing acid overboard from jerry cans is not an acceptable practice.

SCIENTIFIC CREW

George Cresswell	CSIRO Chief Scientist
Jan Peterson	CSIRO
Fred Boland	CSIRO
Peter Campbell	CSIRO
Bob Griffiths	CSIRO
Erik Madsen	CSIRO
Kevin Miller	CSIRO
Danny McLaughlin*	CSIRO
Detlef R. Quadfasel	Univ. of Hamburg
Klaus Schulze	Univ. of Hamburg
Neil Trenaman*	Univ. of Sydney
Mark Groscops*	Univ. of Sydney

SHIP'S OFFICERS AND CREW

Captain Neil Cheshire, Mate Peter Hinksman, Second Mate Dick Dougal.

Chief Engineer Ian Mann, Second Engineer Peter Noble, Electrical Engineer Jeff Cullen, Greaser Paddy Mclure.

Bosun Janek Hansen, AB Don Dickson, AB Bluey Hughes, AB Andrew (Spike) Grey.

Chief Cook Mike Taylor*, Chief Cook Anton Turnsek~, Second Cook Brett Marshall, Steward Ernie Standen.

(* Darwin-Darwin 8-16 March)
(~ Darwin-Cairns 16-22 March)

GLOSSARY

ADCP - acoustic Doppler current profiler. Four acoustic beams are projected downward from transducers in the ship's hull. The reflections from biological scatterers and ocean structures are arranged according to depth. The frequencies of the reflected signals give a measure of the current profile down to several hundred metres . Substantial errors are introduced by gyro inaccuracies and the misalignment of the ADCP transducer package in the ship's hull.

CTD - a profiling instrument for measuring conductivity, temperature, and pressure (depth) and estimating oxygen

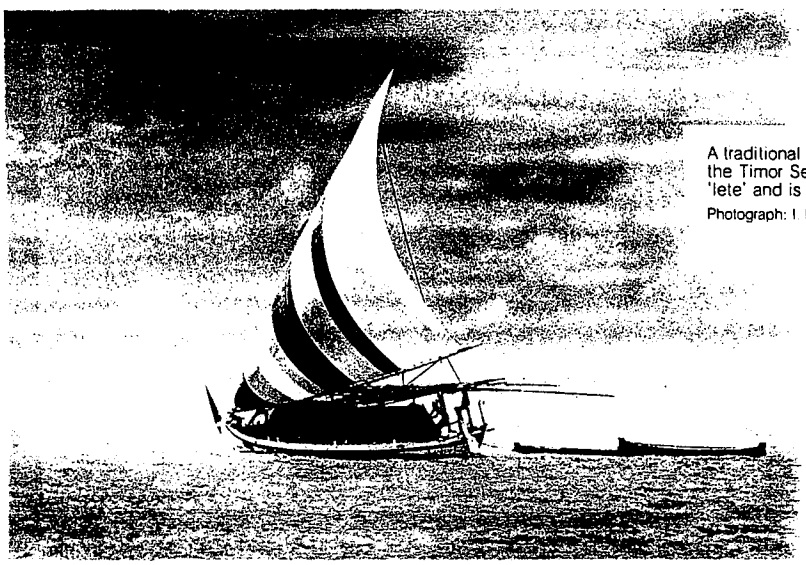
content. Salinity can be inferred from the conductivity and temperature measurements. A rosette of 12 water sampling bottles is attached to the CTD; the bottles close sequentially on commands from a shipboard console, thereby providing samples both for CTD sensor calibration and nutrient analysis.

GPS - Global Positioning System. A network of satellites and a shipboard receiver capable of fixing the ship's position to several metres. This information is invaluable for determining absolute current profiles from the ADCP and, of course, for any precision navigation. The present network of satellites gives a GPS coverage of about 6 hours per day.

Pegasus - a ballasted sonde that sinks at ~ 0.5 m/s to the ocean floor, or to some predetermined depth. It pings to transponders that have been carefully position-fixed on the sea floor . The times of the round trips from Pegasus to the transponders enable the position of Pegasus to be known in three dimensions. From this, current profiles can be inferred. Pegasus has a flag, radio beacon, and strobe attached to enable it to be sighted and recovered.

George Cresswell
13/4/88

Prowas - a programmable water sampler for nutrient measurements in which a series of samples separated by oil is injected into a high-pressure hose as the instrument is lowered.



A traditional Indonesian fishing prahu off the Ashmore Reef in the Timor Sea taken in 1968. This type of prahu is called a 'lete' and is derived from the Arabic prototype.
Photograph: I. M. Crawford.

Western Australian Museum