FRANKLIN

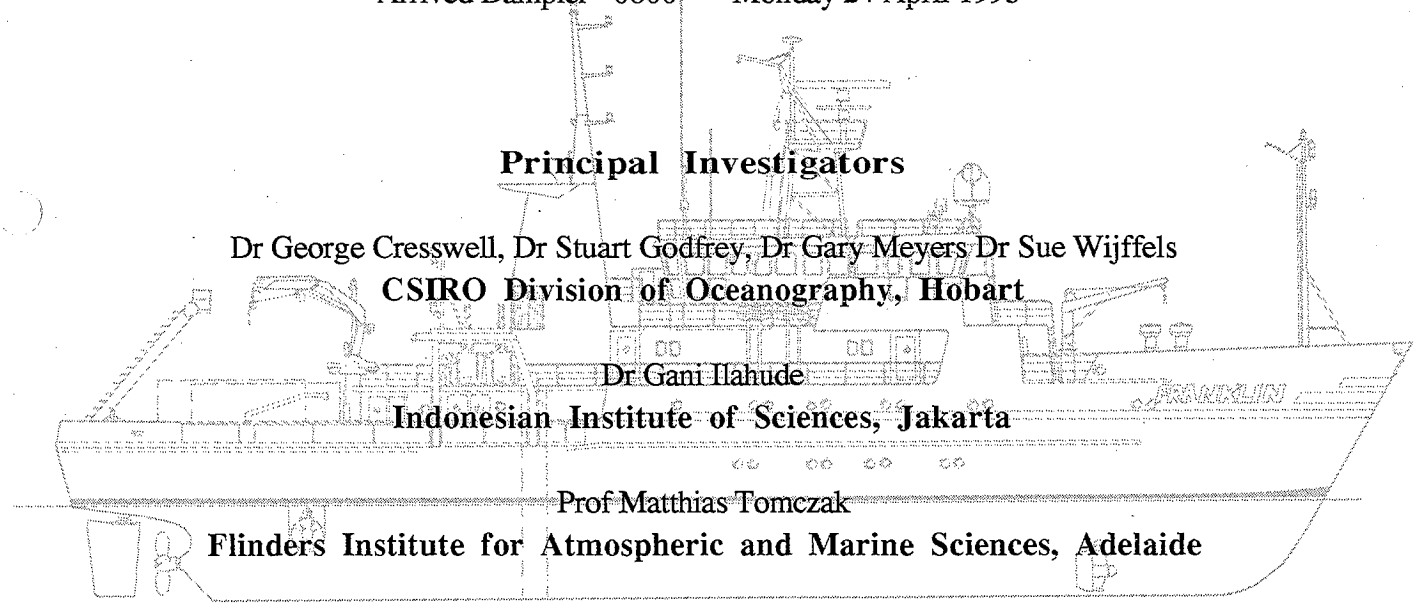
National Facility
Oceanographic Research Vessel

RESEARCH SUMMARY
CRUISE FR 3/95

WORLD OCEAN CIRCULATION EXPERIMENT (WOCE)

REPEAT HYDROGRAPHIC SECTIONS BETWEEN AUSTRALIA AND INDONESIA

Sailed Fremantle 0800 Saturday 1 April 1995
Arrived Dampier 0800 Monday 24 April 1995



Principal Investigators

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AUSTRALIA

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RESEARCH SUMMARY

Cruise FR 3/95

Repeat Hydrographic Sections between Australia and Indonesia

1.0 Scientific Objectives

- To observe the seasonal variation of the Indonesian through flow and the associated changes in hydrographic structure and regional currents

- To assess the representativeness of the once-off, basin-wide WOCE hydrographic survey in relation to annual and inter-annual variations.

- To assess the consistency of estimates of the volume transport of the currents and the distribution of chemical tracers using inverse methods.

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2.0 Cruise Narrative

All times are Australian Western Standard Time.

Franklin departed Fremantle on time at 0800 1/4/95. After a compass swing that took about one hour we proceeded northwest towards a nominal test site in 1000 m of water off Fremantle. Some minor problems occurred in getting the underway systems up and running. Once the ADCP was running we began dropping XBT's hourly as part of an opportunistic survey of the nascent Leeuwin Current.

During this time we had a muster and safety drill with the Second Mate and Master giving safety and operational briefings afterwards. Most of the way to the test site it was determined that the rubbers in the small CSIRO Niskins we too perished to use and that they would all have to be replaced. We decided to abandon the test cast that day in favour of a site off the Abrolhos Islands in daylight the next day.

A test station was completed using CTD #8 in approximately 800 m of water off the Abrolhos Islands at midday on 2/4/95. Due to strong currents and winds, the rosette had to be brought up about 100 m during the firing of the bottles as the ship was advected up the slope. The 1000 m of wire spliced onto the conductivity cable, worked fine at the test and at all subsequent stations.

After the test station we proceeded to the first station off Shark Bay in following seas and winds. We continued to drop XBT's every hour on route. Comparison of the CTD and bottle salinities from the test cast showed a large offset (>0.5psu) but otherwise the bottles appeared to be working well. Only one leaker was found on the test cast.

We started the first shelf occupation off Shark Bay at 15:47 on 3/4/95. To make up for the disruption of the bottle firing in the test cast all the bottles were fired again in the salinity minimum. Through the subsequent shallow stations on the slope the Niskins performed well. However, problems with the Niskins arose at station 19. Several bad leakers occurred on nearly every subsequent station. It was soon discovered that the o-rings in the bottom of the Niskins were displaced on retrieval.

We started carefully checking all the o-rings on the rosette before each cast. This appeared to stem the worst leaks (i.e. no water making it to deck) however, numerous smaller leaks persisted, and sometimes the o-rings would still be displaced after the cast. Some experiments with the knot position in the rubbers was tried to little effect. We had swapped out the worst of the CSIRO bottles but there were only two spare CSIRO bottles that would fit the rosette.

A table was started to keep note of the leakers. After station 34, with bottle problems not being solved by changing rubber positions, we found that we could fit the General Oceanics (GO) bottles on certain positions on the rosette. We started to replace the worst CSIRO leakers with the GO bottles. In hindsight, I realize that we should have swapped over to using the larger rosette frame with all GO bottles, despite the time needed to make the change over and the difficulty in handling the larger rosette.

By station 24, inter-comparison with the 3 previous deep casts (21-23) revealed large drifts in the CTD conductivity. A hysteresis in the upcast was also noted on the display by the watch standers. At station 25 after a cast with CTD #8, were swapped in CTD #2 and made a second cast at the same location. While CTD#2 was in the water, exploratory surgery on CTD #8 showed a cracked conductivity cell. However, the repeat cast with CTD#2 produced data from the oxygen channels. We subsequently found that the oxygen board was not working and that we had no spare. Rather than going on with CTD #2 without oxygen traces, we opted to replace the conductivity probe in CTD #8.

All subsequent stations were carried out with CTD #8 with a new conductivity probe. The conductivity trace showed little drift between casts and no hysteresis. As leakers were identified via the bottle table, they were replaced by GO bottles where possible. By station 40,

eight GO bottles were on the rosette. Close examination of the leaking CSIRO Niskins showed that the bottom lips were deformed and flared outwards, possibly explaining the leaks. This problem must have occurred previously as four of the CSIRO niskins had replaced lip rings of grey plastic. These niskins only rarely leaked.

At station 40, deep oxygen CTD traces showed a shift and a strange feature turned up at depth (~4000 db). This feature persisted from cast to cast. Examination of the upcast data showed the feature was not at the same pressure. At station 48 we replaced the oxygen sensor in CTD #8. The feature persisted. Subsequent analysis of the raw data showed that the oxygen current channel was not registering over a specific range. This was deduced to be due to problems with the A-D converter in the CTD. We later found a similar problem in the primary pressure and oxygen temperature channels. The CTD was powered down between stations 49 and 50 which seemed to solve the problem. However, it turned up again in later casts.

Our final station on the outgoing leg north of Christmas Island occurred on 14/4/95 at 0400 in calm seas. Being in 5990 m of water, we took the CTD down to its pressure rating of 6000 db. It was not only the CTD that had not been down that deep before! As the last few wraps of wire went out, a spacer-plate on the winch drum cheek came loose. As the wire started to come in again, it caught and buckled the plate. Luckily Erik Madsen was up by the drum to wash the wire, and saw the buckled plate under the first incoming wrap, preventing a possible disaster (damaged cable at the least, perhaps even a loss of the CTD and cable). The upcast was made slowly by bashing the plate away from the wire as it came in, taking about 4 hours. The level-wind was a mess. With further CTD work uncertain we headed south again as planned, steaming over our track with the ADCP logging.

On 14/4/95 in 5830 m of water we stopped to attempt to fix the wire drum. The wire was spooled out to the last wrap with a dead weight at the end. A strong wire angle was maintained by steaming ahead at 1-2 kt. The ships' engineers did a remarkable job at straightening the plate and welding it in place again. As the wire was spooled on, the level wind worked well. The entire operation took eight and one half hours.

After a rough ride into the wind and swell, which contrasted dramatically with our northward leg, we started a reoccupation of the Shark Bay shelf section at 1000 19/4/95. This section was completed in rough seas at 0930 20/4/95. The newly repaired winch drum performed well. We then proceeded onto the shelf to carry out a 6 hour ADCP calibration run. Once done, we steamed back out to sea along the Shark Bay line. An XBT/ADCP survey consisting of two shelf crossings was made between the Shark Bay line and the ICM6 current meter line (see cruise track).

The CTD section along the ICM6 mooring line (#64 - #71) started at 0720 on 21/4/95 and ended at 0120 on the 22/4/29 in lumpy seas and moderate winds. With a 24 hours steam ahead we then proceeded to Dampier.

3.0 Results

An full depth CTD/02 and nutrient section with 30 nm or less station spacing was obtained between Shark Bay and the boundary of the Indonesian territorial waters (roughly 9°N) along the IX1 Volunteer Observing Ship track. A second realization of the upper 350 m currents was obtained via the ADCP on the return steam along the track. In all, three shelf/slope sections were made off Shark Bay and one along the ICM6 mooring line. A total of 71 stations were occupied (see Figure 1). Failures for the cruise include the fact that the cracked conductivity cell was used on about 24 stations before being swapped out, and the poor performance of the Niskins resulted in the loss of some samples, and possible contamination of others. Denial of permission to enter the Indonesian territorial waters also prevented us from sampling the energetic flow off Java, thus under-mining some of the scientific objectives of the cruise. Successes for the cruise include the good performance of the 1000 m CTD wire splice which allowed us to make full depth stations, as well as the occupation all stations as planned, including repeat stations at the Australian coast. Repair of the winch cheek plate was also a major success, as station work with the badly wound cable would have been slow and possibly dangerous.

The preliminary data reveal a property field rich in mesoscale and fine structure. At least two sharp property fronts between waters of subtropical South Indian and those of Pacific/ Indonesian origin are evident near 18^0S and 16^0S in the upper 500 db. The change in salinity across these fronts is around 0.5 (Figure 2a). An extremely fresh 80 m thick layer was found north of about 13^0S. Surprisingly this layer appeared to be moving southwards at over 1kt (Figure 3a,b), a feature of the velocity field that persisted for the several days that we sampled in that region.

An opportunistic ADCP/XBT survey was made of the Leeuwin Current which encloses four ocean volumes (Fremantle-Abrolhos, Abrolhos-Carnarvon, Carnarvon-Point Farquhar, Point Farquhar-Exmouth). Preliminary analysis of these data show a robust Leeuwin Current flowing south at the shelf break, except off Fremantle and Exmouth. Off Fremantle the main current core is headed directly offshore, consistent with a meander seen in a satellite surface temperature image from several days earlier. Off Exmouth, the current was absent from the shelf break and appeared to be flowing southwards in deeper waters offshore (Figure 3b).

4.0 Recommendations

- Replace lips on CSIRO small Niskin bottles or make the GO bottles and large rosette the primary working package for hydrography. If the CSIRO bottles are to be the primary set, more than two working spare Niskins should be aboard.

- Though the in-house software for examining the CTD data is sufficient for rough data plots, it is not flexible enough to examine and compare deep property traces for real time quality control. The part of the software for overlying bottle/CTD data did not work. A wish list for making data quality control easier:

- a quicker and easier means of plotting bottle data and comparing/differencing it with the CTD traces. Ideally one would like to be able to plot against potential temperature as well as against Niskin number and rosette position. Asking the hydrography team to do this on top of their work load resulted in long delays before such plots were produced.

- A means of comparing or accessing the upcast as well as the downcast data to hydrography and each other.

- It would be good to have a second temperature trace with the CTD data to replace the reversing thermometers.

- Data quality control/analysis at sea could be made a lot easier for this Chief Scientist with the addition of MATLAB to the software available on the ship's systems.

5.0 Personnel

Scientific Personnel

Susan Wijffels	CSIRO DO	Chief Scientist
Jeff Butt	CSIRO DO	Cruise Manager
Brett Goldsworthy	CSIRO DO	
Werner Morawitz	Scripps Oceanographic Institution (USA)	
Andrew Walch	AODC	
Chris Surman	Murdoch University	
Bob Griffiths	CSIRO ORV	
Bernadette Heaney	CSIRO ORV	
Val Latham	CSIRO ORV	
Erik Madsen	CSIRO ORV	
Dave Terhell	CSIRO ORV	

Ship's Company

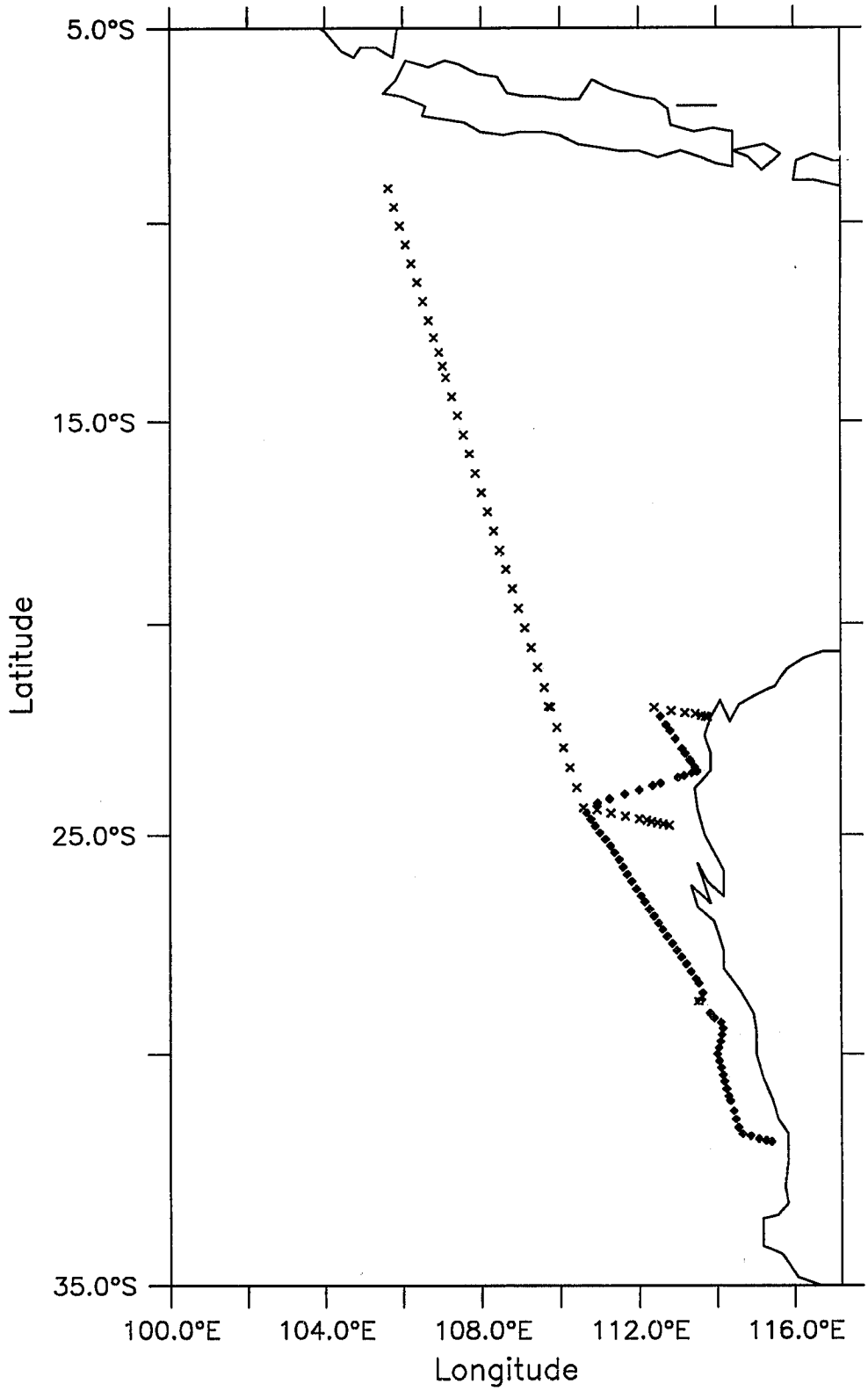
Neil Cheshire (Master)	Dick Dougal	Ian Menzies	John Formosa
Terry Carruthers	Syd Allen	Don Roberts	Gary Hall
Tony Clancy	Norm Marsh	Mick Devine	Peter Mason
Geoff Peacock	Charlie Daly		

6.0 Acknowledgements

Thanks go firstly to the crew of *Franklin* for helping us get the work done safely and in good time. Special thanks to the ship's engineers for the quick and effective repair of the winch drum. Sue Wijffels thanks Bob Edwards and Neil White for help both in planning the cruise and for advice while at sea. Finally thanks to the science party for their hard work and good humour.

10:14:39 May 8 1995
EPIC: all.ptr

X = CTD/O_2
■ = XBT



CTD Station Locations

Figure 1

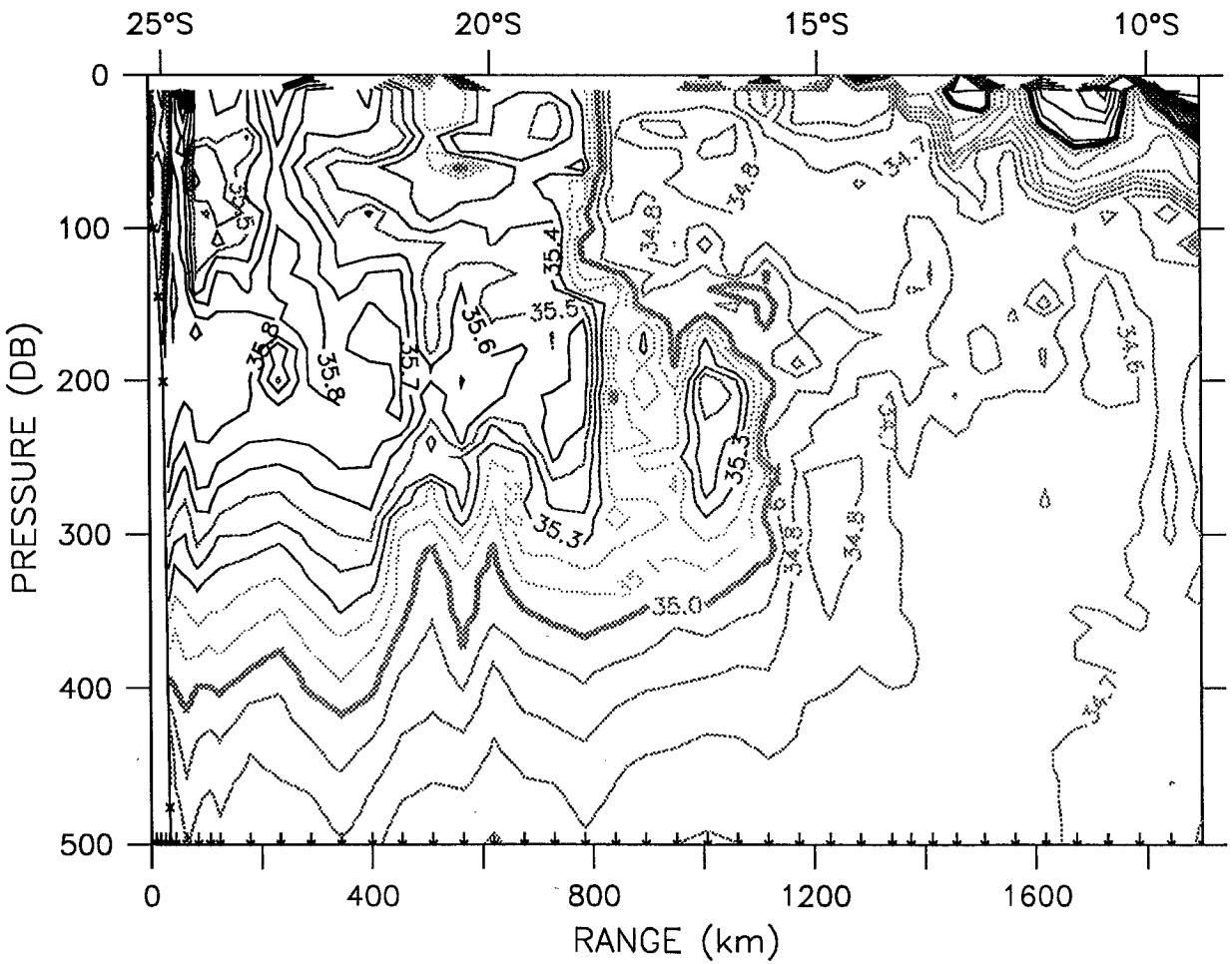
Figure 2a

17:1 48 May 5 1995
EPIC: fr395.ptr

108.9°E SALINITY (PSU)

04 – 14 Apr 95

LATITUDE ALONG TRACK



TRACK: 25.2S 111.7E to 9.2S 105.4E

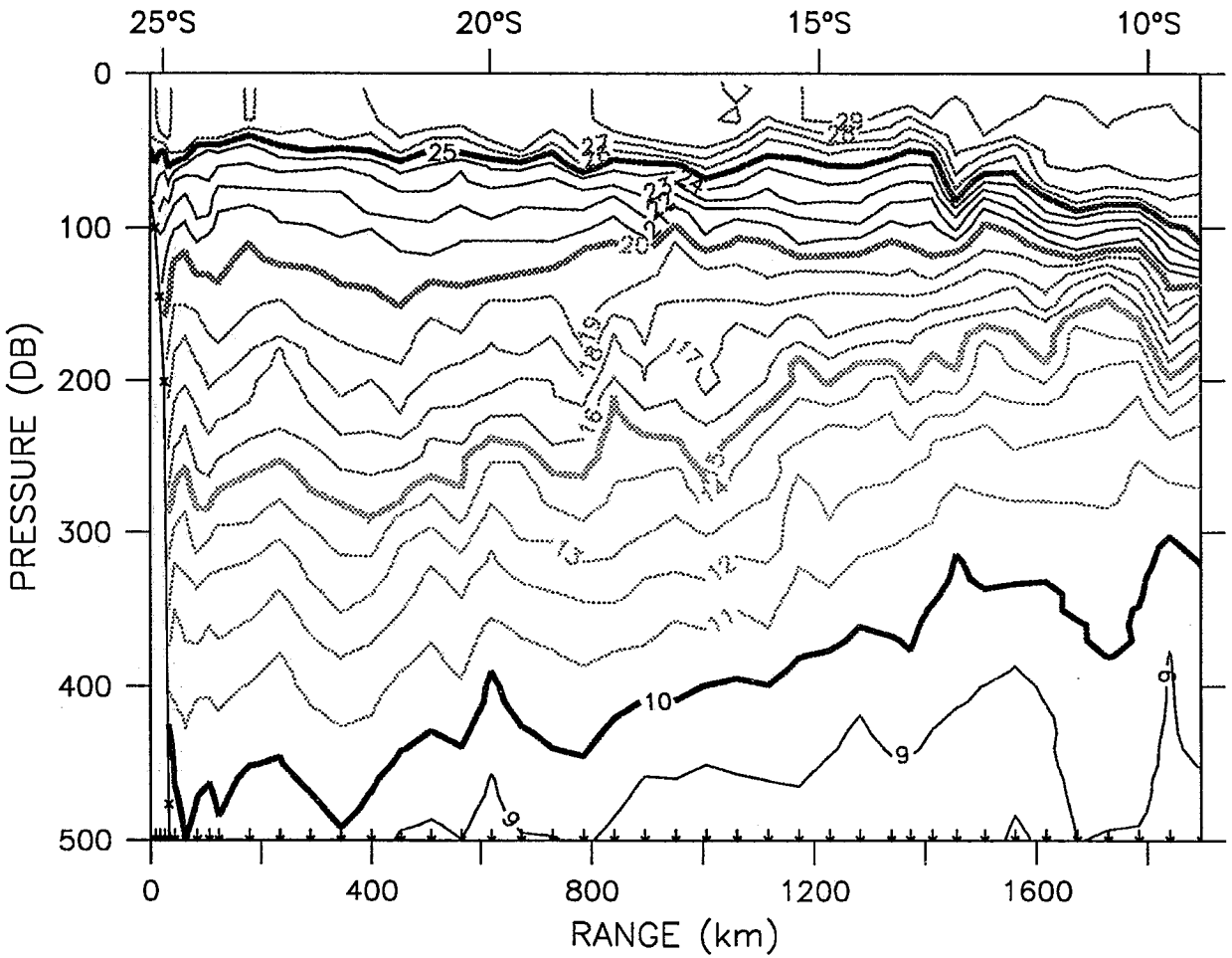
Figure 2b

17:56:48 May 5 1995
EPIC: fr395.ptr

108.9°E TEMPERATURE (C)

04 – 14 Apr 95

LATITUDE ALONG TRACK



TRACK: 25.2S 111.7E to 9.2S 105.4E

Figure 2c

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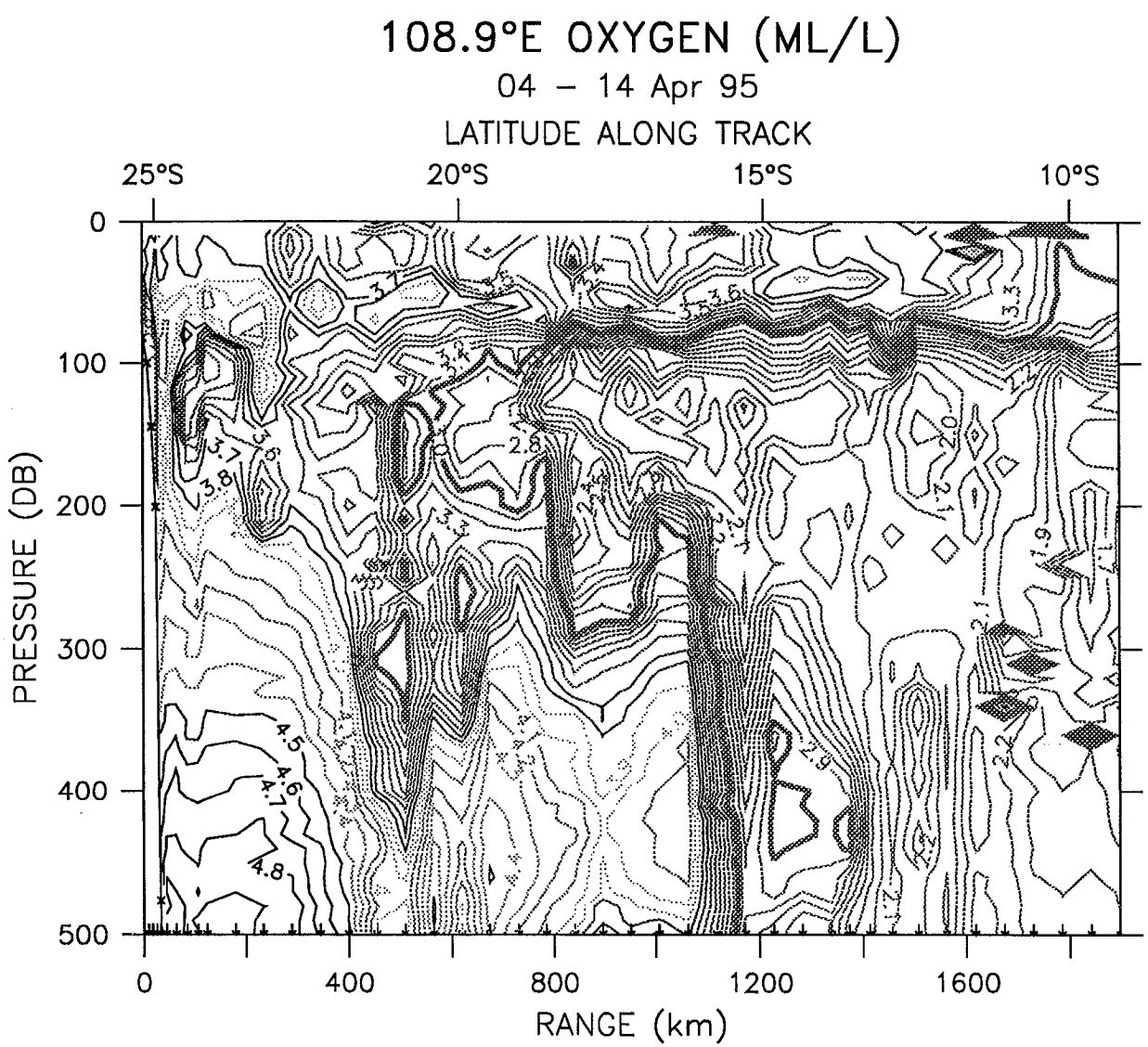
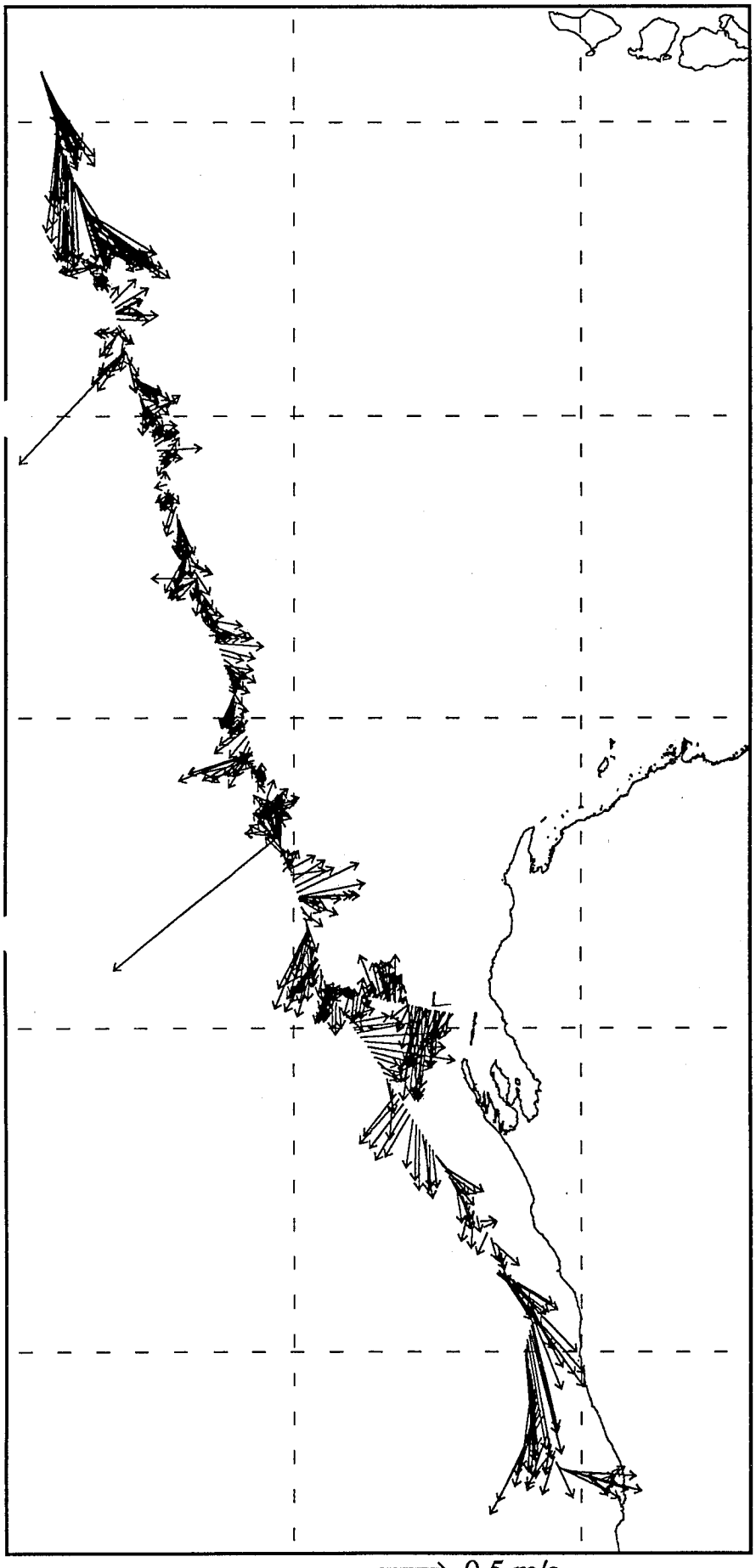


TRACK: 25.2S 111.7E to 9.2S 105.4E

Start cruise – 15/4/95 01:30

30 min av

Corrected Currents [ny] at 15m

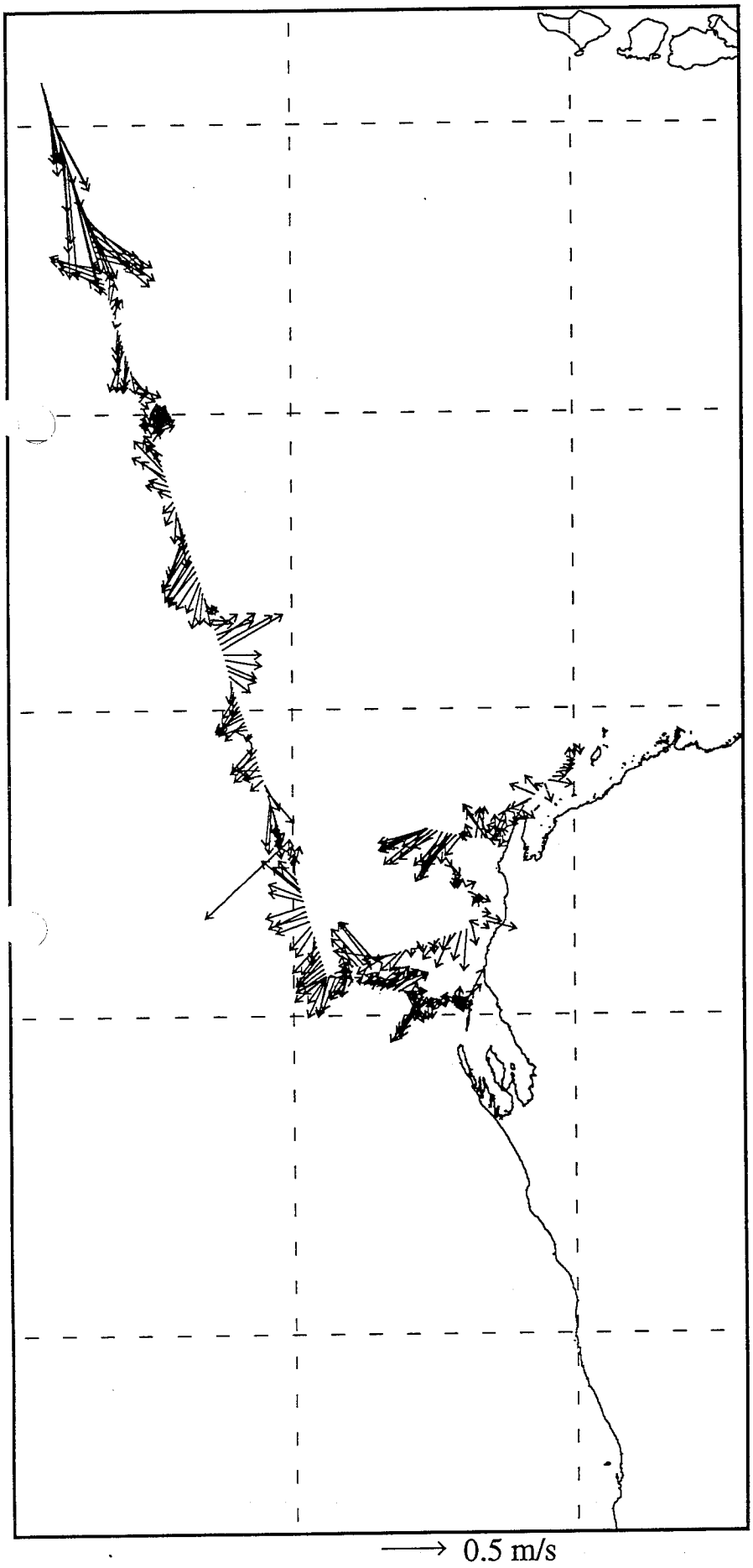


2 crossings

Figure 3a

15/4/95 02:00 – 00:00 23/4/95

Corrected Currents [ny] at 15m 30 min av.



2 crossings

Figure 36.