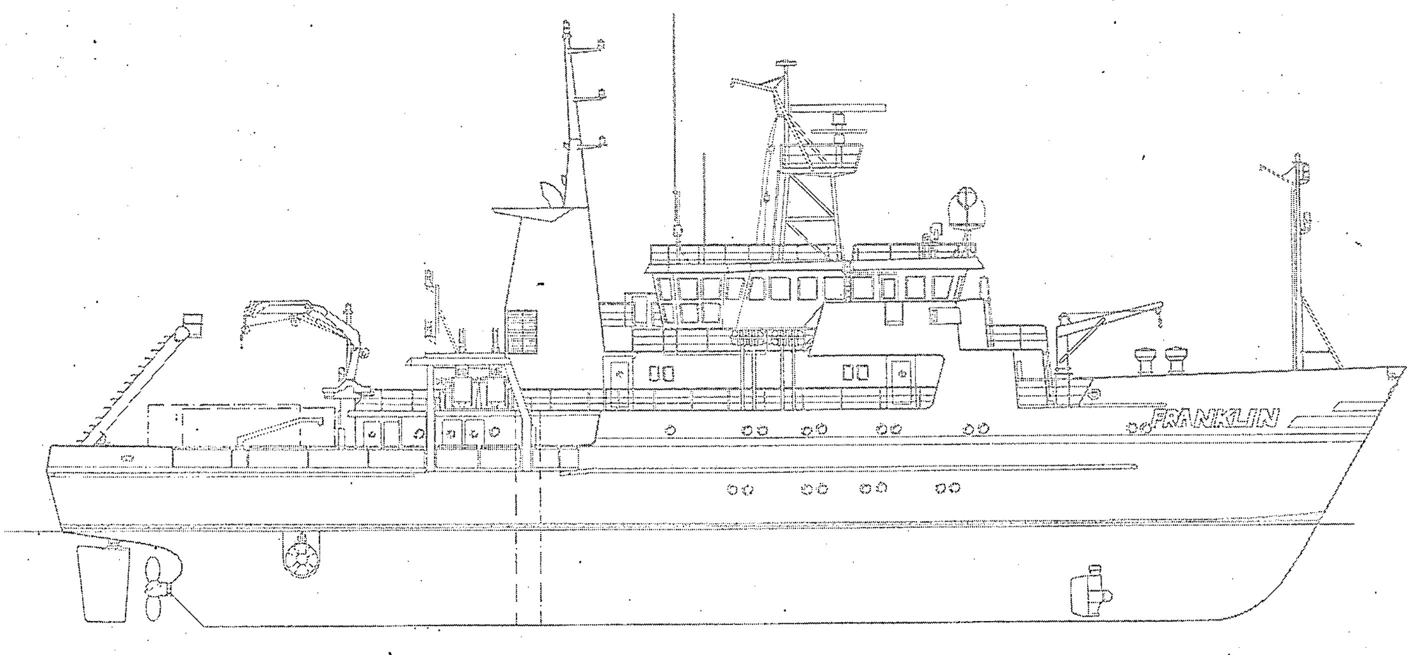
R.V. FRANKLIN

NATIONAL FACILITY
OCEANOGRAPHIC RESEARCH VESSEL

CRUISE SUMMARY

R.V. 'FRANKLIN'

FR 5/87



For further information contact

ORV Operations Manager
c/- CSIRO Division of Oceanography
GPO Box 1538, Hobart, Tas. 7001
Telephone (002) 20 6222
Telex AA 57182

AUSTRALIA

R.V. FRANKLIN IS OWNED AND OPERATED BY CSIRO

29 April 1987

Cruise Summary
RV 'Franklin'
5/87

Sailed Port Hedland	0030	2 April 1987
Arrived Fremantle	1630	20 April 1987

Major Objectives

1. To determine heatflow values in the Exmouth Plateau region.

2. To investigate the possibility that the western margin of Australia has been the site of considerable biological productivity during the last 20-30,000 years by a study of the recent sediments at a number of selected sites in the area.

3. To study certain aspects of current movement in the waters of Western Australia.

General Cruise Narrative

We were delayed in Port Hedland for 2 1/2 days due to problems with the ship's HIAB crane and finally sailed just after midnight on 2 April. We headed straight for the Exmouth Plateau and arrived at our first station (H/F 1) later that same day at 1700 hrs. Weather conditions were good and for the next 9 days we carried out a series of E - W transects across the plateau region, making a total of 57 successful drops with the ANU thermoprobe and 14 successful drops with the 750 kg ANU 8 cm diameter, round barrel gravity corer. The barrel length was 2.5 m. Cores varying in length from 1.2 - 2.0 m were collected. Some were kept for archive purposes and the remainder were extruded, described and sampled on board ship.

During our period on the Exmoutn Plateau a series of vertical net hauls (0-40 m) were made during the evenings and a series of surface and sub-surface net tows were made from the ship's dayboat during the days.

Weather conditions started to deteriorate on 9 April and by 11 April the sea state was rough with a fairly heavy swell from the south and southerly winds of around 25 knots. We finished our last thermoprobe station (H/F 59) at 1200 on 11 April and proceeded south-west towards the Cuvier Plateau. By then the wind was gusting 35 knots and the ships speed was reduced to around 9 knots.

We reached the Cuvier Plateau at 1330 on 12 April after a most uncomfortable day's steaming. The weather had not abated and with the ship fully hove to, head into the swell, the surge at the stern made coring operations quite impossible. We remained on station, hove to, until 0700 on 13 April waiting for a break in the weather. Unfortunately conditions if anything deteriorated further and we were forced, reluctantly, to abandon our plans for work on the Cuvier Plateau. From the available weather reports, conditions inshore along our proposed coring transect in towards Shark Bay appeared to be no better than the plateau itself. In addition Cyclone Kay appeared to be deepening and heading south-west in our direction. It was therefore decided to head directly south to our next planned work site on the Naturaliste Plateau. We should then have time in hand in case it was necessary to wait for a break in the weather at this site if the adverse weather conditions persisted.

We left the Cuvier Plateau region at 1500 on 13 April and steamed directly south. The weather worsened and by evening the ship's speed had been reduced to 6 knots, going into a short, heavy swell from the south and strong SE wind of 35 knots, gusting up to 45 knots. The sea state was extremely broken up and from the ship's set it was clear that we were suffering from the effect of the strong SE wind and its associated swell, over a strong southerly current of about one knot.

By the afternoon of 14 April the wind driven swell had gone down somewhat and we were able to increase speed to 8-9 knots. The wind however was still strong, SE 25-35 knots. Our first station on the Naturliste Plateau was in the northwest corner (Station M1) and we arrived at 1800 on 15 April. By then the wind speed had dropped below 25 knots and sea state conditions for gear deployment were quite reasonable. The first drop was with the IOS Kasten corer. The corer was fully loaded (1000 Kg) with a 15 cm square box barrel 2.4 m in length. The corer failed to take a sample and from the dynamometer trace it appeared that the corer had 'bounced' and fallen over. The core drop was repeated with the same result. We concluded that the bottom was hard in this region of the plateau and presumably subject to considerable erosion.

We left station M1 at 2230 on 15 April and proceeded to our next work site (station M2) which was in the middle of the plateau at its highest point. We were on station at 0530 on 16 April and deployed the fully loaded Kasten corer. The corer again failed to take a sample. We continued on to station M3, arriving at 1500 that same day. Station M3 was on the position of the DSDP drill site 258. Once again the fully loaded Kasten corer failed to collect a sample and sustained some damage due apparently to the wire tangling around the weight stand. Station M3 was 1000 m deeper than any of the previous stations on the cruise and it was considered likely that the wire on the main winch beyond the first 2000 m was still relatively unused and hence 'lively' once the weight came off on corer impact. We repeated the drop with the ANU gravity corer at a site some few miles away from M3 and collected a short (1.2 m) core of buff-coloured, coarse grained carbonate material. We then returned to the site of station M3 and deployed the ANU corer once more. This time the corer 'bounced' and fell over as had the Kasten corer at this site.

We left station M3 just after midnight on 17 April and steamed south to a deepwater site well beyond the plateau rim. If the small grained, softer sediments were being eroded from the plateau we reasoned that they should be accumulating in much deeper water areas. We arrived at station M4 at 1000 on 17 April. The water depth was 4860 m. The ANU corer was deployed and run out to 4500 m. At this stage it was apparent that there was insufficient wire on the main winch for us to be able to complete the station. We estimated that there was only 4700 m instead of the expected 5500-6000 m. For safety reasons it was clear that we were limited to work in water depths < 4400 m.

After recovery of the corer we proceeded directly to our next work site (station M5) which was on the site of the DSDP hole 264. We arrived at 2100 on 17 April. The ANU corer was deployed but failed to take a sample. We left station M5 at 2330 and steamed east. At 0430 on 18 April we commenced a series of echo sounding runs across an area midway between the eastern flank of the Naturaliste Plateau and the continental slope leading up towards Cape Leeuwin. We were searching for a deep water site <4400 m which still might be accumulating sediment eroded from the plateau. We eventually found a suitable flat bottomed canyon (water depth 3600 m). We came onto station at 0830 (station M3) and deployed the ANU corer. Once again the corer failed to collect a sample.

We continued on up the continental slope with the intention of making a core drop at a site somewhere between 1400-1500 m. Unfortunately the sea state deteriorated rapidly. A heavy swell from the south pushed by a strong SE wind, was running up against the southerly flowing Leeuwin Current. It became impossible to deploy either of the corers and we continued up on the continental slope. Our intention was to look for a core site to the leeward of Cape Leeuwin where we thought sea conditions might be more favourable. At 2130 we hove to at site to the east of Cape Naturaliste in a water depth of 600 m (station M7). We deployed the ANU gravity corer but this failed to take a sample. It was clear from the dynamometer trace that the corer had 'bounced' and fallen over. We finished the station at 1045 and steamed NW towards our next worksite.

At 0500 on 19 April we commenced an echo-sounder search along a series of parallel tracks in order to find a suitable coring site on the NE flank of the Naturaliste Plateau. At 0800 we hove to ready to deploy a corer but the weather conditions made this impossible. The easterly winds had strengthened considerably (25-30 knots) and there was now a swell from the east. In addition the swell from the south was now heavy. The result was a very confused sea and when on station the vessel was cork-screwing and surging badly. We remained on station until 1400 in the hope that conditions might moderate. Unfortunately they deteriorated further, the wind increasing to 30-35 knots. We were forced to abandon plans for sampling at the remainging core sites.

We steamed eastwards and between 1400 on 19 April and 20 April made 3 transects of the continental slope between Cape Naturaliste and Fremantle. During that period we continuously logged surface salinity and temperature, and the ships set and made a series of XBT casts. Our objective was to gather information on the southern section of the Leeuwin Current.

We finally finished all scientific work at 1200 on 20 April and took the pilot on board at 1500. We were alongside the pier at Fremantle at 1630 on 20 April.

Scientific Work - Results and Discussion

1. Heatflow work

EXMOUTH PLATEAU HEATFLOW

INTRODUCTION

An important and straightforward extension of seismic/sampling studies in any area is evaluation of the present and past heatflow regimes, with the aim of assessing the thermal and burial history of sediments and elucidating the importance of different processes in the geological evolution of an area. The surface heatflow becomes an important constraint for most theories regarding the constitution and history of the earth, and for assessing the maturity of sediments for the production of hydrocarbons.

INITIAL CRUISE PLAN

There are 8 heatflow transects planned. These are co-incident with pre-existing seismic reflection lines, and where possible over abandoned oil exploration wells. Due to the limitations on the winch, (maximum pull of 80 kN (8 tonne) on 5000 m of 12 mm steel cable), it is only possible to survey on the western margin to a depth of 2000 m. This is not viewed as a serious limitition. Each transect will consist of a series of thermal gradient measurements, usually 14 with a core taken at the mid-point and ends of the transect. For an average line length of 130 nautical miles this gives a point spacing of 10 nautical miles and a line separation of 18 nautical miles. Transit time-non survey is calculated as 12 hrs from Port Hedland to the first point. End of line-start of line transits is 16 hrs and in-survey transit is 93 hrs (all using ship speed of 10 knots). This leaves 215 hrs for heatflow/coring work for an average of 2 hrs per site, this gives 108 sites. It is planned that 20x2 metre cores be taken for conductivity measurements and 87 thermal gradient measurements, giving 87 new heatflow stations. The first two transects are on the WACDP lines 20 & 21 from BMR cruise 55, the remained on GSI Group Shop Survey WAS-76 & 77.

CRUISE OBJECTIVES

The principal objective is to expand the heatflow data base in the Exmouth Plateau region, and use the data for maturation and tectonic modelling.

Of particular interest is the low heatflow, nose of 40 mW/m over the plateau arch, Fig.1 and the high heatflow over the Kangaroo Syncline, 50-75 mW/m over the Exmouth Plateau. The margins mark the location of weakness in the continental crust due to the presence of a hot spot when the margin was created and as such the heatflow is low for a rifted margin. The NW margin experienced rifting in the Late Jurassic and Early Cretaceous. As the diffusivity of near surface rocks is of the order 0.01 cm/sec the thermal time constant of 100 km thick lithosphere is about 150 million years. That is heatflow may reflect thermal history back into the Mesozoic and lateral variations in heatflow may detail subsequent operators, such as fluid flow within the rock column.

There are about 240 offshore heatflow values on the whole of the Australian margin. It is hoped that this cruise will add significantly to the number of offshore values, more than double the present day number! The Exmouth Plateau is an excellent area to do a detailed survey as:

1. Regional heatflow is determined.

2. There already exists large amounts of multichannel seismic reflectioin surveys and oil exploration wells.

3. Geological history is well inferred.

4. Relatively small basins exist for detailed study.

5. Water is not too deep over a large area away from the shelf, i.e. Exmouth Plateau itself.

6. Heatflow will complement pre-existing geophysical data.

7. Thermal history determinations will change or confirm the existing models of margin evolution.

Some of the more general applications of heatflow studies are: detailing hydrocarbon prospectivity of a basin, as oil maturation is temperature dependant and present day heat is largely dependant on palaeo-heatflow and fluid motion. With a large enough data set these aspects can be modelled.

INSTRUMENTATION

The two essential parameters in determining heatflow are; thermal gradient and thermal conductivity. Ship-board heatflow instrumentation comprises a thermal gradient probe (heatflow probe), gravity corer and thermal conductivity device.

Thermal gradient measurements were made with a Nichiyu Giken Kogyo NTS-11AU thermograd. This a a hybrid probe, using thermistors mounted on outriggers, as does the Ewing-type probe, but using a lance, as does a Bullard probe rather than a corer barrel. Lance lengths varied from 2.4 to 3.0 m, but in all cases the thermistor separation was 0.4 m. The thermistors are arranged spirally around the lance so as to avoid the prospect of them travelling through the same vertical column of sediment, and so ensuring each come to rest in undisturbed sediment. The NTS-11AU utilizes 64 Kbytes of RAM (solid state memory) and with a 30 second sample rate with 8 channels being recorded it has sufficient memory for 13 hours continuous operation. As well as recording thermistor voltages the NTS-11AU also records elapsed time since system initialization, data from two X-Y tilt sensors and three precision reference resistors. The device has a temperature range of -2° to 20°C with an absolute temperature accuracy of 0.01°C and relative accuracy of 0.003°C.

The gravity corer consists of a 750 kg core head with a dismountable 2.5 m core barrel. The sediment is forced into a clear core liner inside the barrel (70 mm diameter) on input. The core liner is removed from the barrel and the recovered sediment stored in the liner. The conductivity measurements are independent laboratory measurements. They are conducted on the retrieved core whilst it is still in the core liner, using the transient needle probe method. The needle is 5 cm long with a power of 2.8 W/m, enough to raise the sample about 4°C above ambient temperature. The cores were usually tested for conductivity 16-24 hours after retrieval, during which time they had been placed in a stable temperature environment. A conductivity value was taken every 0.2 m along the length of the core.

POST CRUISE SUMMARY

The ANU heatflow program over the Exmouth Plateau was an unqualified success. Due to the delay in leaving Port Hedland only 9 days real time was spent on this leg. The number of proposed heat flow sites had to be cut back from 84 to 52. However the scientific objectives were still met and time was so efficiently used that an additional 7 stations were added on at the end of the proposed leg. A full station description is given in Table 1 and Figure 2 shows the location of the 59 successful thermal gradient measurements. In all a transit length of 1051 nautical miles (2000 km) over an area of 29,000 nm^2 (100,000 sq km) was covered, giving an adequately coverage to delineate the regional and local heatflow of the Exmouth Plateau. The 59 new data points when added to the 40 existing heatflow values provide a definative heatflow data set for the region.

DISCUSSION

The coring operations proved to be the most difficult aspect of the heatflow program. Good weather facilitated in the easy deployment and recovery of the 750 kg gravity corer. However on the southern margin the weather worsened and safety became a real concern. In general it took six personnel plus two winch operators to deploy and recover the corer, the likelihood of injury in rough seas, of such a labour intensive operation, was increased. The recovery of the core from the 14 core stations ranged from 1.4 to 1.9 m from a 2.4 metre core barrel. The lack of full recovery is attributed to the low run-in speed, 50 m/min, of the main winch. This particular gravity corer has taken 5 metre cores with a run-in speed of 80 m/min on the Exmouth Plateau on previous occasions. Monitoring of tension readouts from the winch would indicate that it is capable of pulling out a 5 metre core. Consequently consideration should be given to re-gearing the winch. This would also reduce the time spent running the wire in and out. Another alternative would be to use a trigger arm on all coring devices. Preliminary results from shipboard determination of the thermal conductivity show that there is very little lateral variation. Visual inspection of the cores and samples retrieved from the core catcher indicate a similar homogenuity in the sediment type. Four core samples forming an E-W transect over the Exmouth Plateau have been passed on to IOS to form part of their work. The remaining ten cores will have futher conductivity studies performed on them, as well as porosity and permiability studies.

The heatflow probe (thermograd) was easily deployed by 2 personnel. Although some care had to taken, no damage to the probe occured on deployment and recovery. The lance length of the thermograd varied from 2.4 to 3.0 metres, with a thermistor spacing of 0.4 metres. Full penetration was achieved on most occassions. Although the lances did not bend on every occassion it was decided not to 'page' the probe as the station spacing was too great and a reduction of transit speed from 13 to 5 knots could not be considered in the light of the reduced project time available. On the occassions the probe was not fully recovered it was made secure to the main deck aft gates. The only set back for the leg was the loss of one lance and a set of thermistors due to a shank pin shearing. Preliminary results of the thermal data are very encouraging, with 4-7 points defining a linear temperature gradient. Data reduction at this stage is crude, however the heatflow pattern seen in Fig. 1 is supported by the new data set.

In conclusion the principal objective of expanding the heatflow data set has been met. Further studies into maturation and tectonic modelling will now be undertaken using this enhanced data set.

2. Sediment work related to palaeoproductivity

(a) Exmouth Plateau

Cores from stations H/F 1, 15, 38 & 45 were extruded from their liners by means of a plunger, described and sampled on board. The cores represent an E - W transect across the Exmouth Plateau with H/F 1 being the inshore station and H/F 45 the offshore station. All cores showed a brown, oxic surface layer of 10-20 cm depth. Much of this deposit was unconsolidated and at the earlier core sites this was lost due to the absence of a flap-valve on the ANU corer. A valve was added at H/F 15 allowing for a much improved core recovery. Below the oxic surface layer there was a rapid colour change to green-grey, the green colour being more pronounced in H/F 1, 15 & 45. Cores H/F 15 & 38 showed a distinct increase in stiffness between 50-70 cm depth, presumably as a result of a significant change in water content. Pronounced bioturbation was also evident in this section of these two cores. It would appear there has been a major change in the sedimentary history of cores H/F 15 & 38 during this period.

The colour change brown-green is indicative of a redox change in the core. This in turn suggests that there is a significant organic component of the original sedimentary input which is being preserved in the deeper sediments below the level of oxygen diffusion. Of particular interest in this area are the high heat flows (see earlier). This fact taken in conjunction with the apparent preservation of a significant proportion of the original sedimentary organic matter in the deeper sediments, suggests that there may be some interesting diagenetic reactions occurring at depth in the sediment column as temperatures rise. In addition the presence of the redox front close to the sediment-water interface also indicates that productivity in the overlying water column has been relatively high until quite recently.

It is proposed to carry out a detailed inorganic and organic geochemical analysis of the samples from these cores in order to first examine the degree of preservation of organic material which is occurring in the surface and near surface sediment layers, second, look for recogniseable biomarkers from which the main sources of supply of this organic matter may be determined, third, look for any evidence of metal-organic complexes and lastly, follow the early stages of organic diagenesis which are taking place in the sediments.

Present day, the waters over the Exmouth Plateau appear to support a considerable density of marine life. Strong scattering layers were observed both during the day and at night. Typical daytime maxima was at depth of 500-600 m with a secondary maxima some 100-200 m off the bottom. At dusk a very rapid upward migration of the plankton occurred into the upper 100 m. The bulk of this migration occurred over a 30-40 minute period following sunset. A similar, very rapid downward migration was observed at dawn.

From the various net hauls made during the period on the Exmouth Plateau a rough inventory may be made of the major plankton groups present at this time of the year. During daylight hours the surface waters were found to be rich in both phytoplankton and zooplankton. Dinoflagellates dominated the phytoplankton assemblage and on calm days quite dense patches of floating cells were seen at the surface. A sample of the dinoflagellate bloom was taken for biochemical analysis and the data will be compared with the analyses of the recent sediments from the area. It may be that dinoflagellates are an important source of organic material to the water column in this area and hence represent a potentially important input to the underlying sediments.

During the day the zooplankton were largely dominated by the gelatinous species (ctenophores, tunicates, medusae) and the blue pigmented crustaceans. In addition to the common blue copepods (Pontella sp.), a single blue pigmented mysid (?) was caught at this surface. This animal was preserved for further identification. Soon after dark the surface waters became greatly enriched with many species of the migratory red-pigmented copepods and euphausiids and later the larger predators, the myctophids and squid, appeared.

(b) Cuvier Plateau

Unfortunately due to adverse weather conditions we were unable to carry out any of our planned work on the plateau or any work along the proposed transect between the Cuvier Plateau and Shark Bay.

(c) Naturaliste Plateau

A total of 10 drops were made with heavy gravity corers on the top and flanks of the Naturaliste Plateau. The results were extremely surprising. Only one short (1.2 m) core was taken. The corers used were the IOS Kasten corer fully loaded (1000 Kg) and the ANU 750 Kg corer. Both corers would normally be expected to collect between 2-4 m of core in most marine sedimentary areas. Our notable lack of success may in part be due to the speed restrictions (40-45 m/minute payout) imposed on us by Franklin's main winch, but this cannot be the only reason. Cores of between 1.2 and 2.0 m were regualarly taken on the Exmount Plateau and during no core drop did we fail to take a core sample. In addition, even with a reduced payout speed (normal payout speed for these corers would be 60-90 m/minute) at least a short core should have been taken. Our conclusion is that the recent sediments on the top and flanks of the plateau are heavily eroded by bottom current movement leaving only a residue of coarse grained sediment. This sediment is difficult to penetrate with conventional gravity corers as they tend to bounce on impact and fall over without taking any sample. If correct this would imply an extremely high energy regime of water movement over and around the plateau. What samples were collected on the plateau proved to be composed mainly of coarse grained carbonate and quartz. The soft green nanno-fossil ooze reported by DSDP workers at our core site M3 (DSDP hole 258) must lie some metres below the sediment surface, but unfortunately we could not penetrate the sediment sufficiently far enough to reach these deposits.

A number of attempts were made to take core samples at deep water sites away from the plateau. We reasoned that if the fine grained, recent sediments were being eroded from the plateau, they should be accumulating around the base of the plateau. Unfortunately the maximum amount of wire on the main winch was 4700 m and this was insufficient for sampling at any of the suitable deep water areas.

It seems that for the present this is now a problem for the physical oceanographers -- why are the sediments of the Naturaliste Plateau being so heavily eroded at the present time, because the evidence from the DSDP holes suggests that up until comparatively recently soft, nanno ooze had been accumulating on the plateau for over 10 million years?

3. Observations on surface currents between Exmouth Plateau and Naturaliste Plateau off the coast of Western Australia

Information on the major movements of water masses off Western Australia is, at present, limited. Our understanding is that the Leeuwin Current, which is thought to be the major current in the region, is driven by longshore pressure gradients and accelerates south along the shelf edge into the prevailing SE wind. At Cape Leeuwin the current appears to become narrow and the boundary temperature front is most clearly defined. Further offshore the weak equatorward eastern boundary current of the Indian Ocean gyre carries cool, high salinity nutrient rich waters north east.

Throughout this cruise logs of surface temperature and salinity, sounder depth, wind speed and direction, ship's course and speed were kept with additional information on the ship's set and drift being obtained from the bridge log. This data has been used as the basis for a preliminary investigation into the surface currents operating in the area of the ship's track.

During a period of strong south-easterly winds (11-14 April) it was seen that the ship's drift was consistently southerly and at a rate of about one knot. This water movement cannot, we believe, be accounted for by simple wind forcing over the ocean, yet there are no literature references to any polewards current at a distance of 400-500 km from the western Australian coast. In order to investigate this further, plots of surface temperature and salinity were produced together with vectoral representations of the ship's drift and set. This data is summarised in Figure 3 and are discussed below:

(a) evidence for the presence of a polewards current 400-500 km offshore.

Between 11-14 April the SE trades were consistenly over 25 knots and gusting up to 45 knots. The angle between the ship's drift and wind direction increased through that period from 60° to 120° and the set from 0.6 to 1.4 knots. During that period the sea state was observed to be far heavier and more confused than would be expected based on wind strength alone. It was thought that this could be due to the effects of a southerly current heading into the wind, superimposed upon the normal air-sea interactions of a 30 knot wind. The surface water temperature was found to decrease along our track south and the salinity to increase. At around 23°S: 110°E there is evidence of a front separating tropical water (low salinity, high temperature) from a more temperate water mass (high salinity, low temperature).

Our conclusion is that during the period of the cruise, there was a cool, high salinity water mass moving southwards at an average speed of one knot between 24°S-34°S at a distance of 400-500 km from the Western Australian Shelf Break.

(b) observations over Naturlist Plateau

There appears to be a distinct body of cool (18-19°C), high salinity (35.8 psu) over the central body of the plateau. A sudden change in drift was encountered at 33°S with water moving north east. It is possible that this cooler water is the eastern boundary current of the Indian Ocean gyre and is heading equatorwards some 200-300 km off the coast. At first inspection the ADCP appeared to show a small northwards current between 113°15'E and 113°45'E whilst the ship was heading due east along 33°15'S.

(c) evidence for the presence of the Leeuwin Current

On route from Port Hedland to the Exmouth Plateau no distinct front was observed, suggesting that the Leeuwin Current at this latitude and this time of year is broad and ill defined. It is possible that the front observed at 23° S:110° E could be the western extent of the current - the tropical water then being confined to the shelf south of 24°S.

In the south between the Naturliste Plateau and Cape Leeuwin a sharp temperature/salinity front was observed (19.5-21.5°C, 35.8-35.6 psu) clearly indicating the western margin of the Leeuwin Current. On 19-20 April a series of XBT casts were made in order to further investigate water movement in this area. The front was traversed three times and the current showed up as warm core of water (<21°C) on the sections between 33°15'S:113°E, 33°15'S:114°40'E; 32°15'S:114°00'E and 32°S:115°20'E. The current appeared to be 10-20 miles wide running roughly 200° from 32°20'S 114°30'E to 33°20'S:114°10'E. The ADCP indicated the presence of a weak southerly flowing water mass on the first traverse which was supported by the drift records from the bridge log.

(d) floating debris on the Exmouth Plateau of an anthropogenic origin

An interesting feature of the surface net hauls in the plateau area was the virtual absence of floating debris such as tarballs or plastic pellets. These item are generally regarded as fairly ubiquitous pollutants of the ocean's surface waters but in this area they appear to be present in low concentrations (<1 per 500 m^2). This may reflect the particular nature of water mass movement in the region of the plateau.

(e) whale and dolphin watch

There is litte information of the distribution and migration patterns of whales and dolphins off the western Australian coast.

During the cruise a log was kept during daylight hours of all sightings. The results were extremely disappointing. In periods of bad weather it is most unlikely that any but the closest animals could have been seen, there were considerable periods of calm weather with a flat sea when any animals within a radius of 5 miles should have been visible. In spite of this there were only 3 sightings: a solitary sperm whale (ca 40') which approached the ship to within 100 m (19°47'S:115°5'E) making a series of short dives and single blows and then swam off towards the SE; a small school of dolphins (10-15 animals) seen at a distance of 500-600 m travelling south; (20°11'S:112°58'E); and a school of dolphins (20-30 animals) seen just off Fremantle. The paucity of sightings is somewhat surprising.

<u>Deployment of the sampling equipment</u> - details, comments and suggestions

1. Deck operations

All three heavy items of sampling equipment used on the cruise required a method of deployment and recovery not previously employed on board RV FRANKLIN. The items were a 250 Kg thermoprobe with a 3 m lance, a 750 Kg gravity corer with a round, 2.5 m long core barrel and a 1000 Kg Kasten gravity corer with a square box barrel 2.4 m in length.

It was necessary to deploy these items of equipment by lifting them over the stern in the horizontal mode. The weight was then slowly taken up on the main warp when they were outboard to bring them into the vertical mode, the A-frame was then fully extended and the main cable run out. Recovery of the equipment was the exact reverse of this operation. To avoid wire tangling when the weight came off the wire on impact of the equipment with the sediment, a 3 m strop with a swivel at each end was added to the main warp immediately above the equipment.

The lack of a heavy duty crane which could be used at the stern, in conjunction with the A-frame, for deployment and recovery operations was a great handicap. We improvised by using the stern captsan, a fixed block on the deck and a block on the A-frame. This arrangement, when used in conjunction with the A-frame gave us the equivalent of a crane for lifting the equipment across the deck and over the stern, the equipment in the horizontal mode, either a 3 legged strop was used (the lengths of the two lower legs being arranged to suit the weight distribution of the gear) or a heavy duty shackle was placed at a point where the equipment just balanced.

Deck operations were successful up to moderately rough weather conditions i.e. a moderate swell and wind speeds of 25-30 knots. Beyond this the pitch of the vessel made deployment and recovery of the heavy equipment very hazardous. It would appear that the relatively short length of RV FRANKLIN greatly accentuates this problem.

To be fully efficient, the double swiveled strop used to prevent wire tangling needs to be 7-8 m in length to allow for overrun of the main warp when the sampler hits the bottom. Unfortunately we found it was not safe to pass a shackled swivel through the main block on the A-frame and consequently it was necessary to reduce the length of this strop to 3 m.

General suggestions:

(a) need a crane which can give a SWL lift of 2-3 tons at the stern under the A-frame.

(b) need a bigger block on the A-frame which will pass a heavy duty shackle and swivel.

(c) there is a lack of handy cleats around the after deck for tying off or slipping ropes under load.

2. Winch

The winch on the RV FRANKLIN imposed a number of serious limitations on the type of sampling operations attempted during this present cruise. First, the drum only contained 4700 m of main warp which meant that stations could not be made in water depths much exceeding 4400 m. This prevented any work on the lower continental slope or abyssal plain. Second, the main warp is comparatively lightweight (12 mm diameter - 8.5 tonne breaking strain when new) and a heavier duty cable would be necessary for taking long core samples and/or working in deepwater areas (either a 16 mm cable-breaking strain ca 11-12 tons or a tapered warp 12-16 mm). Third, the lack of a two-speed gearing on the winch meant that the maximum pay-out/recovery speed was 38-52 m/minute depending on the amount of wire out. This greatly limits the speed at which a corer can be driven into the sediment under control (normal coring winches payout at speeds up to 90 m/minute) and necessitates the use of a much heavier corer than would otherwise be needed to collect a given length of core. The alternative is to free-fall the corer from a specified height off the bottom but this is an extremely hazardous operation when using heavy duty corers. In addition the restricted winch speed makes for inordinately long station times, particularly at deep water sites. For example, merely paying out and recovering the gear at our deepest station (4500 m) took over 4 hours of expensive shiptime. Fourth, the main cable is not torque balanced which means that it tends to be very 'lively' when the weight comes off it, at least until it has been used a number of times under a heavy load. It was clear that the last 2000 m of cable on the winch at present had not been used much under any significant load and we had some problems with tangling in spite of using the double swivelled strop.

3. Echo sounder and pinger

Any successful bottom sampling operation at a deep water site requires that the position of the sampler be accurately known with respect to the bottom. The use of the echo sounder/pinger system on RV FRANKLIN suffers from one main problem. The receiving hydrophone is hull mounted and well forward. When the ship is being held on station and the bow thruster is in operation at full power, the echo sounder and pinger traces are virtually unreadable. The bow thruster must be reduced to half power before the traces can be seen and it is not always possible to do this in bad weather. It is suggested that, for deep water work in particular, a towed hydrophone is necessary.

ANU Heatflow program - Exmouth Plateau. Post Cruise Summary

The ANU heatflow program over the Exmouth Plateau was an unqualified success. The deployment of the thermograd and gravity corer was satisfactorily worked out at the initiation of the project time. The weather was favourable and in the project time of 9 real days, 59 heat flow stations were visited, see Figure 1. This figure shows the location of 59 successful thermal gradient measurements taken on a zig-zag transit lasting 1050 nm (1950 km) covering an area of 27,000 nm^2 (100,000 km^2). There were also 14 gravity cores taken along the transit with recovery ranging from 1.4 to 1.9 metres. On board analysis of the temperature data and thermal conductivity measurements taken on the core samples are very favourable. Initial work on a heat-flow map indicate high heatflow on the southwest and eastern margins of the Exmouth Plateau with a low to the northeast.

Thanks are extended to Neil Cheshire (captain) and the crew of the ORV FRANKLIN for their support as well as to the officers from CSIRO and IOS who were a great help during this project.

Personnel

Bob Morris	IOS UK (chief scientist)
Mike McCartney	"
Mike Dearnaley	"
Ray Peters	"
John Tipper	ANU
Mike Swift	"
Jenny Stewart	"
Bob Edwards	CSIRO (cruise manager)
Alan Poole	"
Dave Terhell	"

R.J. Edwards
Cruise Manager

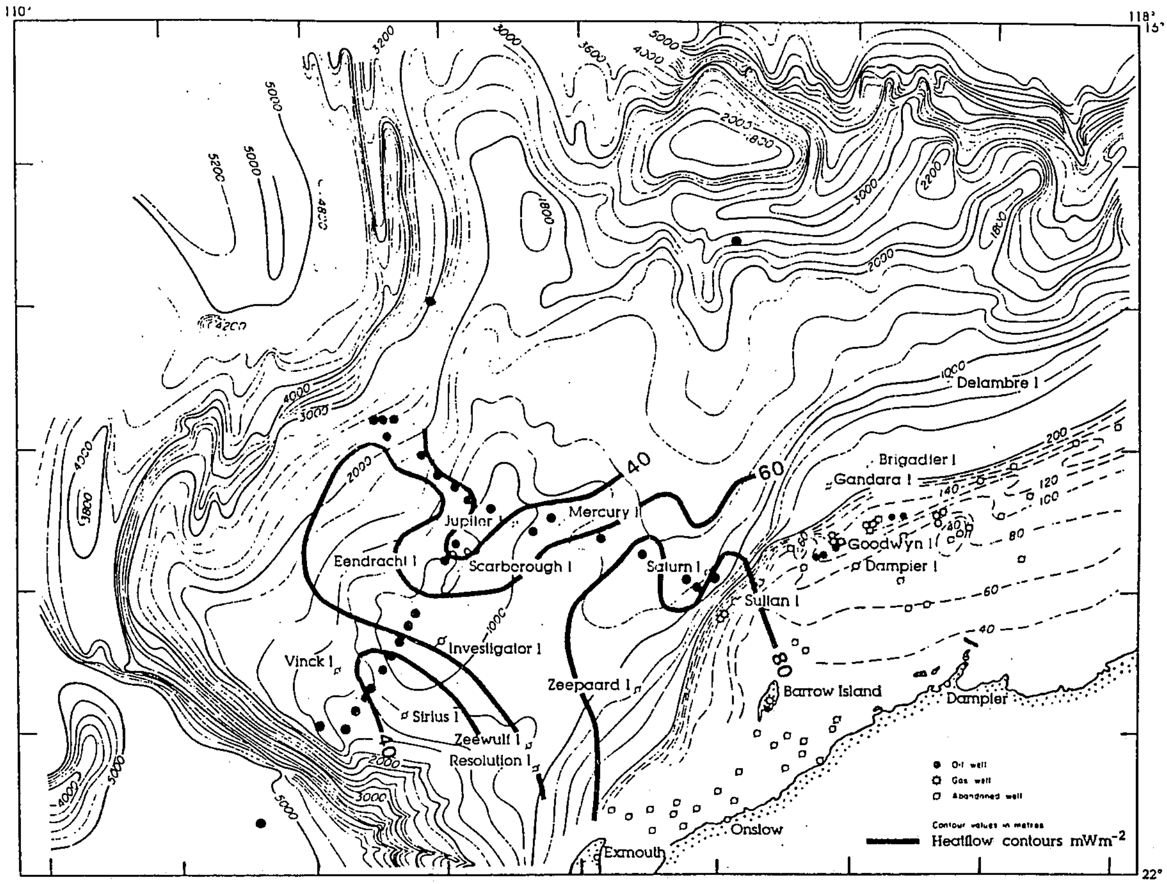


Figure 1 Exmouth Plateau region showing present day heatflow pattern derived from marine heatflow data (location shown by black dots) and well data. (Swift et al., 1986).

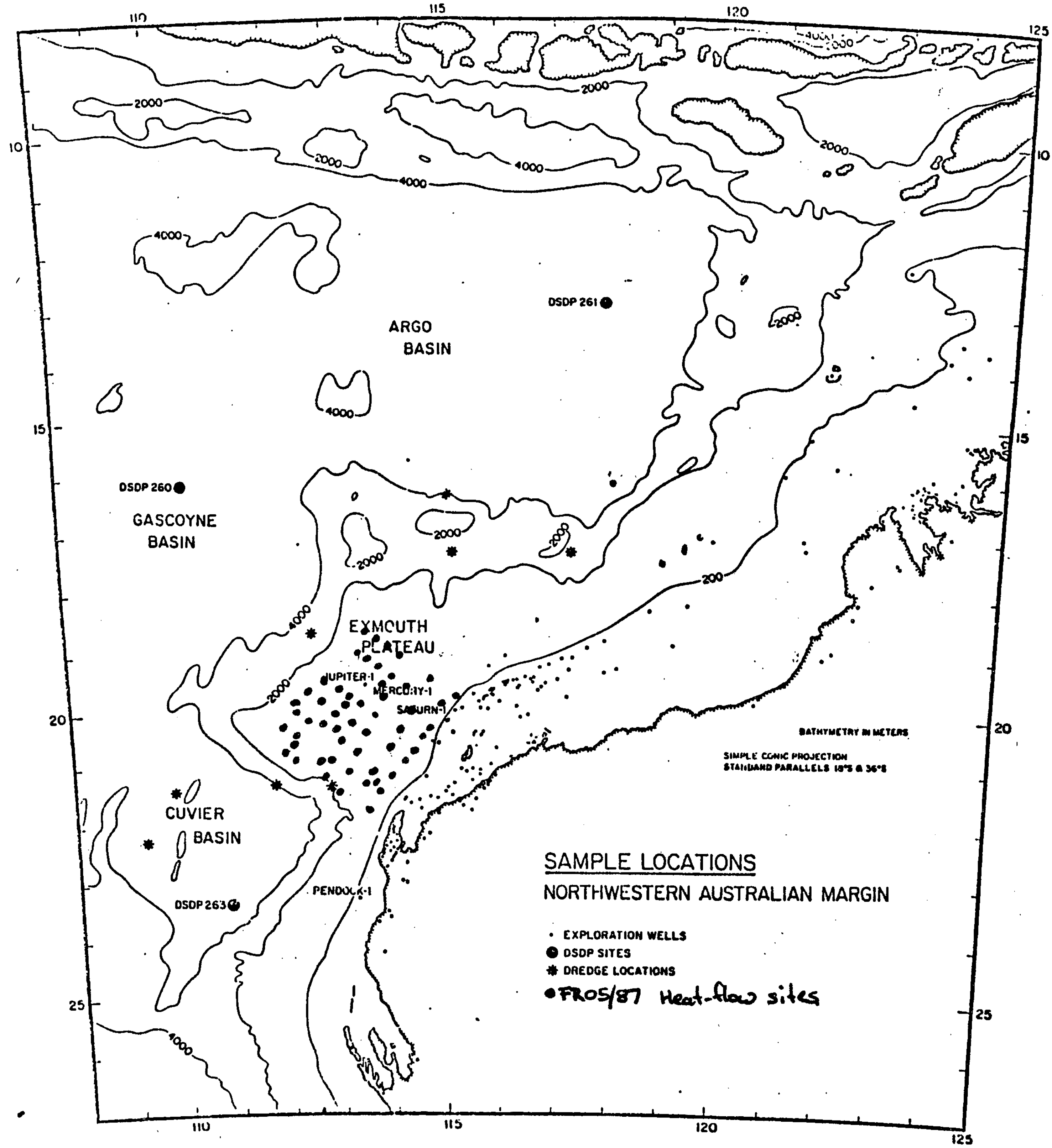


Figure 2 Heatflow stations on cruise FR05/87.

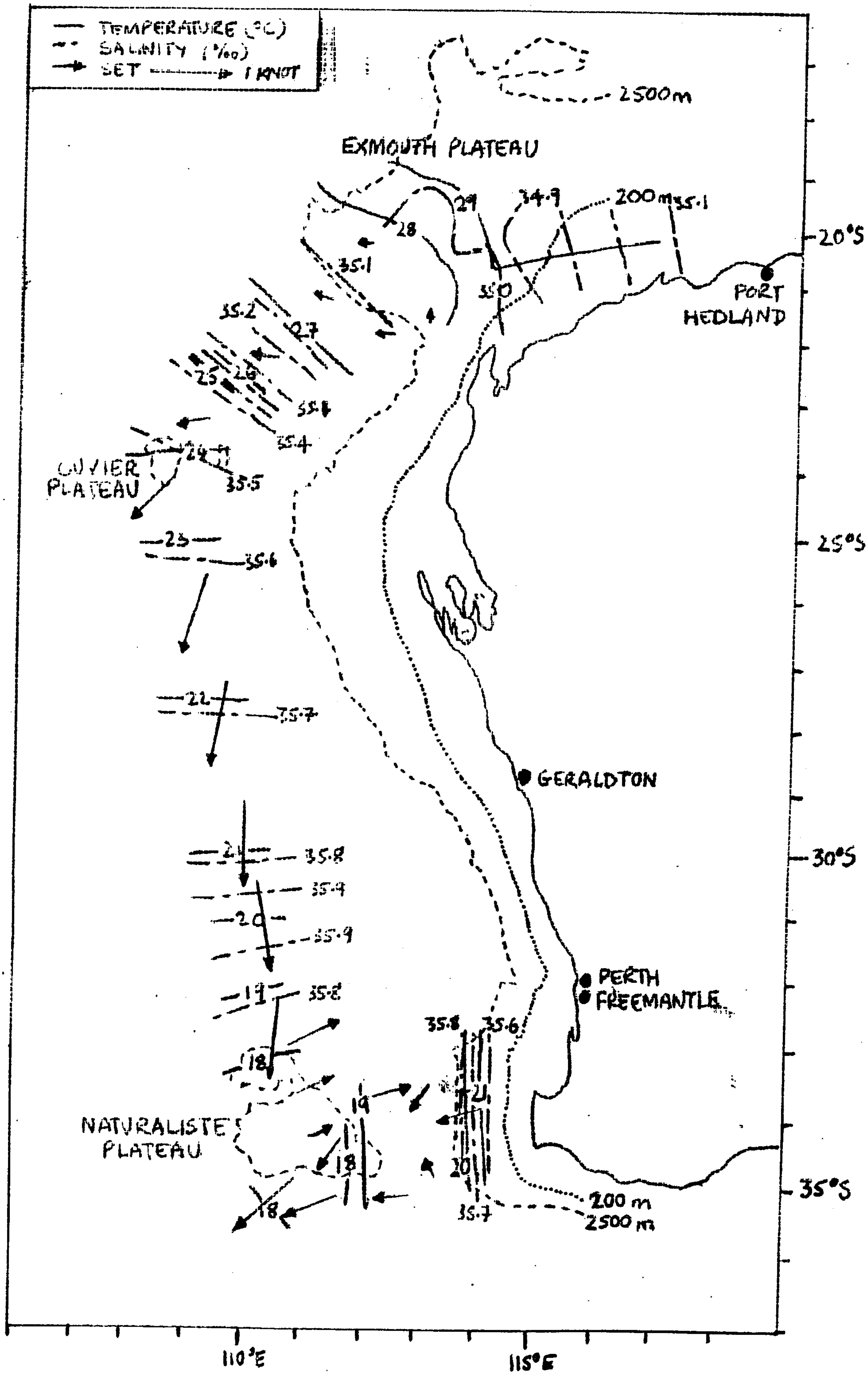


Figure 3 Sea surface temperature and salinity and drift and set of vessel

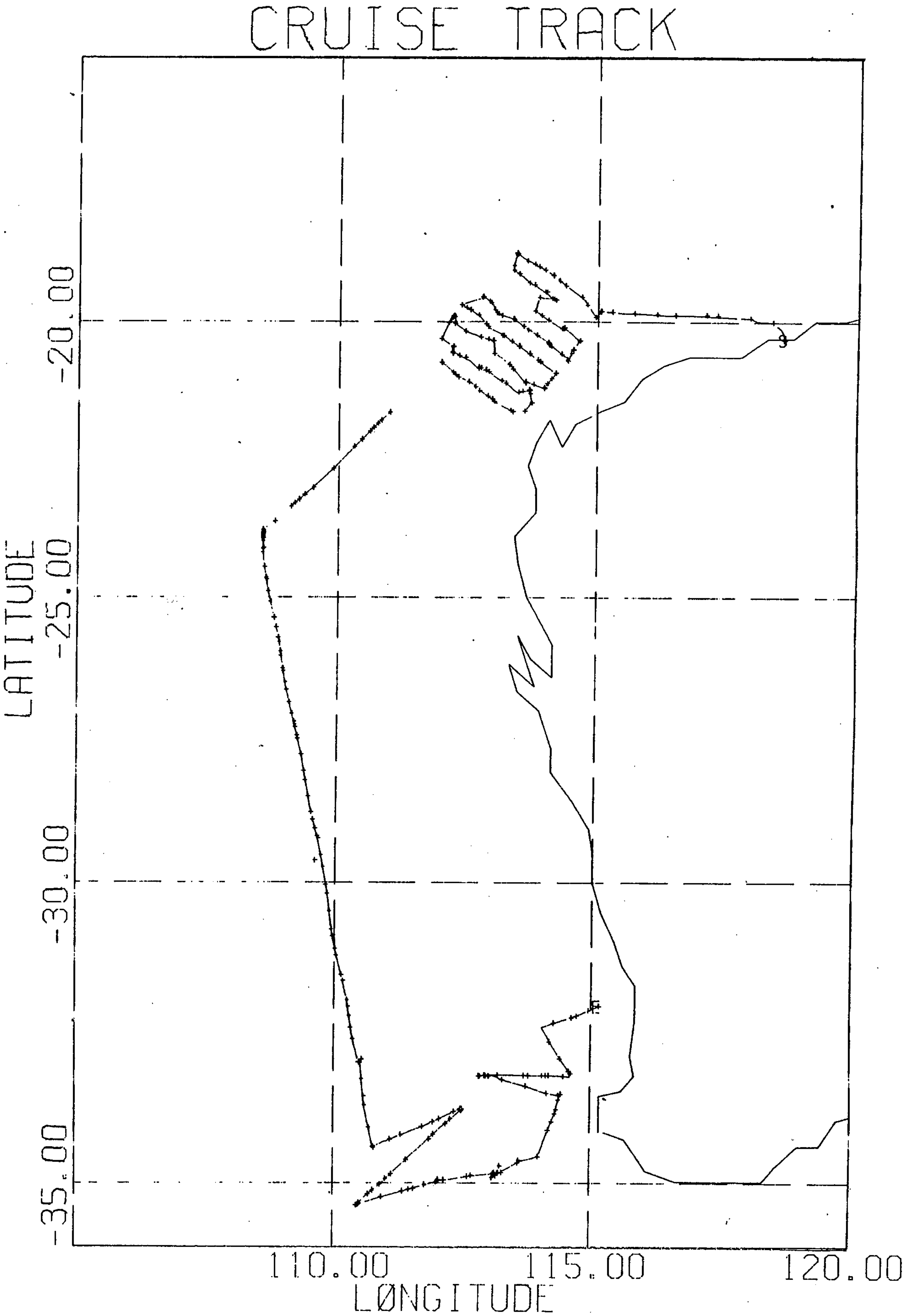


Figure 4 Cruise track RV 'Franklin' 5/87

Table 1 RV FRANKLIN HEAT FLOW STATIONS

STATION	LINES	S.P.	W.D.	Type	LAT.	LONG
1	WAS76-17/14	1090/1292	1040	HF/C	19 47.653	115 05.465
2	SATURN		1178	HF	19 54.398	114 58.145
3	WAS76-14/18	1161/4265	1450	HF	19 31.101	114 42.037
4	WAS76-14/19	67/322	1300	HF/C	19 07.428	114 08.805
5	WAS77-11/8	1397/1059	1400	HF	18 58.042	113 53.015
6	WAS77-11/12	1001/1014	1500	HF	18 50.505	113 40.319
7	WAS77-11/18	605/720	1428	HF/C	18 42.879	113 27.533
8	WAS76-12/22	3017/75	1150	HF	19 02.121	113 21.302
9	WAS76-12/21	2758/3675	1000	HF	19 07.603	113 29.249
10	WAS76-12/20	2311/3709	1200	HF	19 17.195	113 42.707
11	WAS76-19/12	957/1807	1150	HF	19 27.904	113 58.385
12	WAS76-12	1400	1220	HF	19 36.574	114 10.858
13	MERCURY		1142	HF	19 33.230	113 53.164
14	WAS76-10/19	2097/1570	1185	HF	19 48.066	113 48.383
15	WAS76-10/18	3035/3065	1250	HF/C	20 07.803	114 174.97
16	WAS76-10/17	3713/2269	1000	HF	20 21.960	114 38.697
17	WAS76-17/9	2586/3243	800	HF	20 31.115	114 31.518
18	ZEEPARD		740	HF/C	20 44.139	114 25.220
19	WAS76-8/18	896/2463	1000	HF	20 26.135	114 05.128
20	WAS76-8/19	1758/2175	1100	HF	20 07.895	113 38.456
21	WAS75-8/20	2310/2478	980	HF	19 56.250	113 21.741
22	SCARBOROUGH		922	HF	19 53.066	113 08.445
23	WAS76-21	2300	940	HF	19 49.974	113 02.074
24	WAS76-8/WAI	3140/55.091	1175	HF	19 38.395	112 55.992
25	WAS76-8/23	3472/2503	1400	HF/C	19 31.309	112 45.829
26	WAS76-8/23	3472/2503	1400	HF	19 31.309	112 45.829
27	WAS76-6	3700	1528	HF	19 40.217	112 20.366
28	WAS76-6/23	3398/1917	1368	HF	19 46.713	112 30.564
29	WAS76-6/22	3069/1863	1100	HF	19 53.736	112 40.614
30	WAS76-21	1800	925	HF	20 05.648	112 52.082
31	WAS76-6/20	2062/593	875	HF	20 15.284	113 11.387
32	WAS76-6/19	1500/2769	1000	HF	20 27.245	113 28.638
33	WAS76-6	1100	1100	HF	20 35.767	113 40.960
34	WAS76-6/18	711/1876	1070	HF/C	20 44.029	113 52.993
35	WAS76-6/17	118/3464	650	HF	20 56.612	114 11.365
36	WAS76-4/17	4085/4065	750	HF	21 14.092	113 57.579
37	ZEEWULF		1194	HF/C	21 06.325	113 37.132
38	WAS76-4/19	2822/3384	1110	HF	20 47.249	113 18.442
39	WAS76-4/20	2243/1278	940	HF	20 34.983	113 00.597
40	INVESTIGATOR		841	HF/C	20 21.066	112 58.015
41	WAS76-21	1400	851	HF	20 17.380	112 44.152
42	WAS76-4/22	1136/2473	850	HF	20 11.343	112 26.573
43	WAS76-4/23	740/1305	1200	HF	20 02.820	112 14.455
44	EENDRACT		1350	HF/C	19 54.289	112 14.352
45	WAS76-2/23	89/698	1500	HF	20 18.840	111 58.368
46	WAS76-2/22	553/3073	1350	HF	20 28.700	112 12.660
47	VINCK		1373	HF/C	20 35.044	112 11.339
48	WAS76-21	580	1230	HF	20 42.373	112 26.911
49	SIRIUS		1174	HF/C	20 53.044	112 41.213
50	WAS76-2/20	1753/680	1100	HF	20 54.225	112 49.986
51	WAS76-2/19	2347/3980	1200		21 06.797	113 08.438

STATION	LINES	S.P.	W.D.	Type	LAT.	LONG
52	WAS76-2/18	2985/690	1250	HF	21 20.226	113 28.310
53	RESOLUTION		1085	HF/C	21 17.564	113 41.244
54	WAS76-2/17	3491/4516	980	HF	21 30.844	113 44.132
55	WAS76-1/17	88/5248	1300	HF/C	21 48.255	113 30.229
56	WAS76-1/19	1111/4579	1525	HF	21 26.429	112 58.252
57	WAS76-1/20	1717/86	1820	HF	21 13.459	112 39.384
58	WAS76-1/21	1	1525	HF	21 00.986	112 15.925
59	WAS76-1/22	3021/3646	1400	HF	20 45.461	111 59.145

NOTES

'Lines' refer to the location of the station with respect to an existing seismic line.

'S.P.' is the shot point number on the seismic line.

'W.D.' is water depth.

'type' refers to the measurement taken. If HF then a thermal gradient was taken of C then a core was taken for the purpose of taking a series of thermal conductivity measurements.

'Lat' is latitude south.

'Long' is longitude east.

ELECTRONICS REPORT FR05/87.

EK400 SOUNDER.

The EK400 performed well the entire cruise. The new clock interface was implemented and both the time and cruise number are now displayed on the top of the sounder recording. The pinger was used with good results.

ADCP PROFILER.

No problems were experienced during the cruise.

GPS NAVIGATOR.

A software update was installed at the start of the cruise and no problems were encountered.

XBT SYSTEM.

There were no problems experienced during the cruise.

INMARSAT.

Since the work was performed on the gyro in Fremantle the Inmarsat system has been tracking with very little error and as a result no problems were experienced.

THERMOSALINOGRAPH.

The erratic behaviour of the thermosalinograph was traced to interference entering through the main thermistor cable. Some basic filtering was applied to the cable which has reduced the interference to the point where the instrument now runs normally however a new cable may be required to completely eliminate the problem.

INTECH SATELLITE NAVIGATOR.

The Intech has now logged over 5000 miles without a failure. I am not optimistic however of its long term reliability.

MET SYSTEM.

No problems were encountered with the system.

UNINTERRUPTABLE POWER SUPPLY.

This unit failed twice during the cruise. The first time the unit stopped momentarily causing the the computers to go down and restart. A few hours later it failed completely. The fault was traced to a faulty component in the transfer supply logic. A temporary repair was effected and the correct component will be installed prior to the next cruise. It was obvious when repairing the unit that a cooling problem exists in the UPS area which could have directly caused the failure of the system. The EK400, VAX, GPS and ALL TAPE DRIVES would not restart after the failure and about 10 fuses later all the equipment was up and running again. The METSPOL tape drive refused to start after fuse replacement and this was eventually traced to a faulty mains switch which was bypassed temporarily.

G.O. BLOCK.

Several problems were encountered during the cruise. This was the first cruise that the readouts were working in the ops. room and the bridge. Initially the zero control would not work. This was traced to a faulty hall effect switch in the master control readout. An analog output of the load cell was provided on the soltec on the bridge and on a yew recorder in the ops. room. This proved to be very successful for determining when the instruments had hit the bottom. After a few days of operation the readouts began to give erratic readings. The block was taken down and a small amount of moisture was removed from the electronic assy. and the contacts cleaned. The block gave no further problems however the load readings on the bridge readout are not correct and will require further attention.

Overall, all instruments performed satisfactorily and no insurmountable problems were encountered.

ALAN POOLE.