R.V. FRANKLIN

NATIONAL FACILITY

OCEANOGRAPHIC RESEARCH VESSEL

CRUISE SUMMARY

R.V. 'FRANKLIN'

FR 9/86

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

CRUISE SUMMARY

R.V. FRANKLIN

FR 9/86

Itinerary

Departed Hobart	1100 h	Tuesday 4 November
Arrived Hobart	1400 h	Thursday 20 November

Outline of Cruise

Franklin left Hobart at 1100 on Nov 4th and proceeded to 55 S, 155 E. Two stations were occupied in transit in order to test the CTD system and to check for leakage of the Niskin bottles. The teflon coated Niskin bottles for trace metal work were fitted with teflon coated stainless springs and were prone to leakage when they were not in seawater. Preliminary results suggest that the bottles did not leak underwater.

We arrived at 55 S, 155 E at 0700 on Nov 7th and proceeded due south reaching 57 13 S at 1830. By this time the wind had risen to 45 knots gusting to 55 knots, the barometer had dropped to 962 mbar and it was snowing. There was a possibility of encountering ice at higher latitudes and the Master decided to hove to as he did not want to have to turn the ship at night in the deteriorating conditions. We remained hove to for the next 30 hours.

At 0000 on Nov 7th we steamed back to 57 08 S, 155 E to begin our series of stations along 155 E. At 1200 on Nov 10th we hove to for about 12 h during which time the wind increased to 65 knots with gusts to 75 knots. The seas rose to an estimated height of 16 metres. The fetch was quite short and as a consequence the waves were very steep and breaking. For the rest of the transect we were delayed by two hours at one station only. There were a few days of calm seas and clear skies but in general we had winds of about 25 knots with a moderate to heavy swell. It snowed quite heavily on a number of occasions.

A strong front was observed between 56 and 54 S when the surface temperature dropped from 7 C to 2 C. Subantarctic Mode Water (SAMW) having a temperature of about 8 C was observed north of 51 30 S and increased in depth to about 700 m at 44 S. A subsurface (220 m) temperature minimum (0.2 C) was observed south of 56 S.

Our route back to Hobart from 44 S passed almost directly over the Soela seamount and we took the opportunity to do a number of casts on the side of the seamount (in 2000 m) and on the top of the seamount. We made excellent time during most of the Cruise and arrived back in Hobart almost one day early at 1400 on Nov 20th.

The Cruise was an unqualified success in terms of the number and types of samples collected. The analysis of many of the samples will not be completed for 6 - 12 months but the range of analytical techniques used to assess the data will provide a wealth of information on the complex chemical, biological and physical interactions in the Southern Ocean.

This was our first attempt at the continuous monitoring of surface pH and fluorescence. Over the entire cruise track the general trend was for pH to increase with increasing temperature. In Antarctic waters, pH did not change in response to fluctuations in fluorescence (as measured by the Turner fluorometer). Only in Subantarctic and Subtropical waters was there an observable (positive) correlation between these two parameters. It was expected that fluorescence, i.e. biological activity, would influence pH in all water bodies, but it appears that upwelled southern surface waters, enriched in ' dissolved carbon dioxide ' levels, mask any effects that arise from photosynthesis, respiration or degradation of organic compounds.

Although the concentration of cyanobacteria was expected to decrease regularly with sea surface temperature, the results indicate that cell counts were low in the cold Antarctic water but were high and relatively constant between the Antarctic Convergence and the Tasman Sea despite the large difference in temperature. Preliminary examination of the data suggests that there is a downwelling of cyanobacteria at the Antarctic Convergence.

EQUIPMENT

XBT

30 XBTs were launched, mainly on the way south. A considerable number of these were lost due to the wire breaking in the stern launcher. Swells were only moderate at the time and it seems that the system needs checking. There seems to be a problem with the use of the stern XBT launcher in that wire stretch (producing a bulge of about 1 C in the near surface region) is fairly frequent. This is probably due to the current shear in the wake of the propeller. This problem is being investigated now, but the stern launcher should not be used again until the problem has been checked out.

Hydrology

Samples were analysed on board for salinity, dissolved oxygen, phosphate, silicate and nitrate + nitrite. A new nitrate channel (using imidazole as the buffer) was used on the cruise and produced much better results than the previous method. Nutrients were profiled to the bottom at 57 S, 51 S and 44 S and to 1500 m at 0.5 deg intervals in between. The teflon coated bottles for trace metal work often leaked on deck but did not seem to leak underwater.

CTD

The deep stations were occupied for up to 30 h and involved up to twelve casts including the deployment of the SEASTARS. All casts were therefore individually numbered and totalled 77 in all. The CTD splice was replaced after station 24. The pH probe was not fitted to CTD unit 1 for the reasons discussed elsewhere but the unit was fitted with an oxygen probe and was interfaced with the Variosens III.

Turner Fluorometer

The output of the Turner fluorometer was logged continuously during the Cruise and was also recorded on a YEW chart recorder. Data were archived hourly on to general data tapes. The range was changed early in the Cruise and remained at that setting for the remainder of the Cruise. There were no major problems with instrument drift but blank values were affected by water condensation. There was a scaling mismatch between the Turner instrument reading and the computer readout but the logging program was fine. The Turner emission filter sees only the red fluorescence (648 - 725 nm) and therefore does not respond to cyanobacterial fluorescence (510 - 535 nm). The flow rate through the instrument is marginal (3.0 - 3.6 l/min) when the pH system is operating.

Samples were periodically collected from the water supply to the pH meter and Turner. These samples will be used for the determination of chlorophyll content by HPLC and for cyanobacterial and eubacterial counts.

Surface pH

The surface pH was monitored continuously during the cruise using a Radiometer PHM 85 meter and a Ross electrode. The results were recorded on the same YEW recorder as the fluorescence and on magnetic tape. The complete data was stored on 3xVAX tapes. Noise in the system was reduced by earthing the water stream but the system became fairly noisy in rough seas or when the stern thrusters were operating. Much of this noise is expected to disappear when one minute averages are taken., The system was calibrated every second day; it may be possible to perform this procedure less frequently.

Doppler Profiler

Data prior to DOP file 045 is probably not worth looking at. Better data were collected during the transect north from 57 S. Sea conditions were not favourable for measurements so results were averaged over 200 pings (16 m pulses, 16 m bins). There were many bit failure messages early in the Cruise until the connectors on the power amplifier board were fixed. An EOF was accidently put onto the start of the tape and may present a problem when we try to access the data.

Navigation

The navigation program 'hung' a few times on the 4th and 18th of Nov. There was often a 1-2 mile discrepancy between the NAV and GPS systems. The full Cruise data set is archived and stored on VAX tape.

GPS SatNav

The entire cruise was logged at 2 sec fix intervals subject to satellite availability (approximately 7 hours per day). The data quality has not been assessed and has been recorded without processing to remove extraneous data. It is important to reinitialize the reference position regularly. The GPS will quite happily give positions that are in error by hundreds of miles if it is not told roughly where it is.

Sounder

The sounder trace was generally OK but the digitizing circuitry was unable to lock onto the bottom for most of the Cruise. The reason for this is unknown.

Thermosalinograph

Good data were obtained for the entire cruise and the data is stored on the general data tape and on VAX tape. Comparison with CTD surface data indicates that the T/S reads low in T and S by 0.14 C and 0.19.

Meteorology

The met failed initially for radiance but valid data were obtained after 1600 on 4/11. The barometric pressure decreased to 900 mbar and the results are suspect (the lowest reading on the bridge was about 960 mbar). The wind speed received by the computer seems to be 5-10 knots less than the display on the bridge.

SEASTAR

The SEASTARs were deployed at 10, 50 and 250 metres at three stations(57, 51 and 46 S). Sample volumes ranged from 40 to 130 litres. The samplers provide an uncontaminated POM fraction and an operationally defined DOC fraction. The POM samples will provide a useful comparison with POM samples obtained from Niskin bottles. DOC fractions were successfully eluted from the XAD-2 columns while at sea - despite the weather conditions.

Scintillation Counter

No problems were encountered and preliminary results indicate that C14 uptake increased with temperature. Samples were analysed at 0, 4, 8, 12, and 24 h based on a 12/12 photoperiod.

Iatroscan (TLC-FID)

Water samples were obtained from the fluorometer (and pH) outlet hose in the wet lab. Particulate matter was analysed for concentrations of total lipid and individual lipid classes. The instrument initially worked satisfactorily but developed a baseline problem. However, it seems that the instrument can be operated successfully in rough seas.

Underwater light meter

Reasonable results were obtained at one station to 50 metres. There were problems with cable connections, lack of sufficient weight at the end of the cable and cable length. These faults could be readily remedied.

Variosens III

Variosens III was used in conjunction with the CTD unit and an underwater power supply. The data were logged with the rest of the CTD data. The turbidity channel was identified by immersing the unit in a very dilute solution of milk. The turbidity channel essentially gave no signal as the waters were too clear. The fluorescence channel normally gave no signal at the surface even though readings (often low) were always obtained from the Turner. Spurious signals were sometimes obtained due to (i) water in the cable connector to the power supply (ii) flat batteries and (iii) insufficient current from the power supply. The power supply was modified by E. Madsen to increase the output from 200 mA to 250 mA. The signals were obtained as spikes rather than as a continuous profile and the reason for this is under investigation.

The power supply used for the Variosens on this cruise is not part of the ORV equipment. At present the only way to use the

Variosens on Franklin, using ORV equipment, is to lower the Variosens on the hydrowire, feed out the non load bearing cable (100 m maximum) and record the fluorescence and turbidity on the chart recorder of the deck unit. As a matter of urgency, it must be ascertained whether it is possible to supply power to the Variosens via the CTD unit, and modify the system accordingly. If this cannot be done, then two underwater power supplies must be built as soon as possible.

Clean Container

The containers were used for the entire Cruise and could be safely entered even under quite adverse weather conditions. The Clean container performed exceptionally well as far as providing a satisfactory working environment. Its performance in terms of providing a clean environment will be assessed after laboratory analysis of the samples collected. The diffusing panel for the light in the entrance port of the container fell out and will need to be replaced. There were no problems with cupboard doors and drawers opening in rough seas. However hand holds should be fitted for safety in rough weather. We should also look at the possibility of providing UPS outlets for future installation of instruments on the clean container benches. There was a surprising amount of after deck space available even with both containers on board. The master reported that it was a little more difficult to maintain station in cross winds of 30 knots with the containers on board.

Biological container

The biological container is in a poor state of repair and the condition of the container left a lot to be desired at the beginning of the cruise: it was generally dirty; the sliding doors were held together by rope; the catches designed to hold the sliding doors open did not work; most locks were difficult to use because they were either broken or rusted; the sliding partition doors were hanging off their rail; the catches designed to hold these sliding doors open were broken and useless; the handles on many sliding doors were damaged due to the weight of the doors; the catch on the freezer compartment of the frige was broken; the air conditioning system cannot be made to work without tripping out; the lock on the outside door was difficult to open and the door handle was hanging off; the catches on the window of the container door were seized with rust. There are also two dimmer switches at the entrance that operate the fans behind the cupboard to vent fumes and it would be an idea to put a notice somewhere informing personnel of their use.

Summary of station locations and samples collected

St	Lat(S)	Lon(E)	Depth	Samples
01	44 11	148 01	0 - 700	VAR,POM,BAC,CNB
02	47 18	149 46	1040	SAL
03			1031	SAL
04	57 08	154 59	0 - 300	VAR,NUT,OXY,SAL,BAC,CNB,EM,MUR, IOD,AS,PE
05			10	POM,NUT,OXY,SAL,C14,PE
06			0 - 700	VAR,SAL,CuCC,TM

07					20 - 3680	NUT,OXY,SAL,BAC,CNB,EM,MUR,IOD, AS,TN
08					800 - 1800	POM,NUT,SAL,CuCC,TM
09					250 - 500	POM,NUT,OXY,SAL
10					10 - 50	POM,SAL,IOD,AS,CuCC
11	56	31	155	02	0 - 1500	NUT,OXY,SAL,BAC,CNB,IOD,AS,TN, DOC,CuCC
12					10	POM,NUT,OXY,SAL,C14,PE
13	56	00	154	59	10	POM,NUT,OXY,SAL,PE
14					0 - 1500	BAC,CNB,IOD,AS,TN,DOC,CuCC,PE
15					25 - 430	POM,NUT,OXY,SAL,CuCC,TM,MOC
16	55	30	154	59	0 - 1500	NUT,OXY,SAL,BAC,CNB,IOD,AS,TN, CuCC,DOC
18	55	33	155	15	10	VAR,POM,SAL
19	55	00	155	00	10	VAR,POM,NOT,OXY,SAL,IOD,AS,TN, CuCC,DOC,PE
20					0 - 1500	NUT,OXY,SAL,BAC,CNB,IOD,AS,CuCC, DOC,PE
21	54	30	154	59	0 - 1500	NUT,OXY,SAL,BAC,CNB,IOD,TN,CuCC, DOC
22					10	VAR,POM,NUT,OXY,SAL,C14,PE
23	54	00	154	59	10	VAR,POM,NUT,OXY,SAL,PE
24					0 - 1500	NUT,OXY,SAL,BAC,CNB,IOD,AS,TN, CuCC,DOC,PE
25	53	30	154	56	0 - 1500	NUT,OXY,SAL,BAC,CNB,IOD,AS,TN, CuCC,DOC
26					10	VAR,POM,NUT,OXY,SAL,PE
27	53	00	155	00	10	VAR,POM,NUT,OXY,SAL,PE
28					0 - 1500	NUT,OXY,SAL,BAC,CNB,IOD,AS,TN, CuCC,DOC,PE
29	52	31	155	00	0 - 1500	NUT,OXY,SAL,BAC,CNB,IOD,TN,CuCC, DOC
30					10	POM,NUT,OXY,SAL,C14,PE
31	52	00	154	59	10	POM,NUT,OXY,SAL,PE
32					0 - 1500	NUT,OXY,SAL,BAC,CNB,IOD,AS,TN, CuCC,DOC,PE
33	51	30	155	00	0 - 1500	NUT,OXY,SAL,BAC,CNB,IOD,TN,CuCC, DOC
34					10	POM,NUT,OXY,SAL,PE
35	51	01	155	00	3200 - 4173	POM,TM,NUT,OXY,SAL,CuCC,DOC,MOC
37					2000 - 3000	POM,TM,NUT,OXY,SAL,CuCC,DOC,MOC
38					500 - 1800	POM,TM,NUT,OXY,SAL,CuCC,DOC,MOC
39					0 - 500	NUT,OXY,SAL,CNB,EM,MUR,IOD,AS,TN, CuCC,DOC,MOC,PE
40					10 - 600	POM,NUT,SAL
41					700 - 4100	NUT,OXY,SAL,BAC,CNB,EM,MUR,IOD,AS
42					10 - 50	POM,NUT,OXY,SAL
43	50	30	154	29	0 - 1500	NUT,OXY,SAL,BAC,CNB,IOD,TN,TM, CuCC,DOC,MOC
44	50	00	155	00	0 - 1500	NUT,OXY,SAL,BAC,CNB,IOD,AS,TN, CuCC,DOC,PE
45					10	POM,NUT,OXY,SAL,C14,PE
46	49	30	155	00	0 - 1500	NUT,OXY,SAL.BAC,CNB,IOD,TN,CuCC, DOC
47	49	00	155	00	0 - 1500	NUT,OXY,SAL,BAC,CNB,IOD,AS,TN, CuCC,DOC
48					10	POM,NUT,OXY,SAL,PE
49	48	30	150	01	0 - 1500	NUT,OXY,SAL,BAC,CNB,IOD,TN,CuCC, DOC

50	48 00	155 00	0	-	1500	NUT,OXY,SAL,BAC,CNB,IOD,AS,TN, CuCC,DOC
51			10			POM,NUT,OXY,SAL,PE
52	47 30	155 00	0	-	1500	NUT,OXY,SAL,BAC,CNB,IOD,TN,CuCC, DOC
53	47 00	155 00	10	-	75	POM,NUT,OXY,SAL,C14,PE
54			0	-	1500	NUT,OXY,SAL,BAC,CNB,IOD,AS,TN, CuCC,DOC
55			100	-	150	POM,NUT,OXY,SAL,BAC,CNB
56			50			VAR,POM,NUT,OXY,SAL,PE
57			25			VAR,POM,NUT,OXY,SAL
58	46 29	155 00	20	-	40	VAR,NUT,OXY,SAL,BAC,CNB,IOD, AS
59			0	-	1500	NUT,OXY,SAL,BAC,CNB,IOD,TN,CuCC, DOC
60	46 00	155 00	10			VAR,POM,NUT,OXY,SAL,PE
61			3400	-	4380	POM,TM,NUT,OXY,SAL,CuCC,DOC,MOC
62			700	-	4300	NUT,OXY,SAL,BAC,CNB,MUR,IOD,AS
63			100			VAR,POM,NUT,OXY,SAL
64			2200	-	3200	TM,NUT,SAL,AS,CuCC,DOC,MOC
65			0	-	500	NUT,OXY,SAL,BAC,CNB,MUR,IOD,AS, TN
66			10			VAR,POM,NUT,OXY,SAL,C14,PE
67			50	-	2000	POM,TM,NUT,OXY,SAL,CuCC,DOC,MOC
68			1020	-	1240	NUT,OXY,SAL,CuCC,DOC
69			10	-	25	POM,NUT,OXY,SAL
70			0	-	800	TM,NUT,SAL,CuCC,DOC,MOC
71	45 30	155 00	0	-	1500	NUT,OXY,SAL,BAC,CNB,IOD,TN,CuCC
72	45 00	155 01	0	-	1500	NUT,OXY,SAL,BAC,CNB,IOD,AS,TN, CuCC
75			10			VAR,POM,NUT,OXY,SAL,PE
76	44 30	155 00	0	-	1500	NUT,OXY,SAL,BAC,CNB,IOD,TN,CuCC
77	44 00	155 00	10	-	1000	POM,NUT,OXY,SAL,BAC,CNB,IOD,AS, CuCC,PE
78	43 55	150 35	0	-	1500	OXY,BAC,CNB,IOD,AS,TN
79			10	-	600	VAR,POM,OXY,BAC,CNB,IOD,AS,TN,PE

Summary of analyses

AS	arsenic III/V speciation
BAC	eubacterial cell concentrations
CuCC	copper complexing capacity
CNB	cyanobacterial cell concentrations
DOC	dissolved organic carbon
EM	samples for analysis by electron microscopy
IOD	iodine speciation
MOC	metal organic complexes isolated on SEPPAK cartridges
MUR	muramic acid
NUT	nitrate+nitrite, phosphate, silicate
OXY	dissolved oxygen
POM	particulate organic matter - lipids, pigments and CHN
SAL	salinity
TM	trace metals (Cu, Ni, Cd, Mn, Fe)
TN	total nitrogen (50 metres)
VAR	Variosens III
C14	C14 productivity/end products of photosynthesis (EPPS)
PE	Quantitative phytoplankton ecology/particle size analysis

Samples were also collected daily and used for measurements of C14 uptake. Some of these samples are to be analysed in Hobart for EPPS. Samples were also regularly collected from the outlet in the general purpose laboratory for the analysis of pigments to calibrate the Turner results and for cyanobacterial and eubacterial counts. Underwater light measurements were taken at 55 30 S. The SEASTAR in situ water samplers were used to collect samples (10, 50 and 250 m) at 57, 51, and 46 S. These samples will be analysed for particulate organic matter and dissolved organic and metal organic compounds.

General

Ctd unit 1 was still not properly calibrated before the Cruise although we had none of the earlier problems that had occurred with the unit. Temperature calibration of the unit should be completed within the next few weeks. The pH probe was not fitted to the unit even though this had been listed as a vital piece of equipment for the Cruise. The probe had seemed to function satisfactorily when it was first tested about 6 months ago but gave highly erratic results when it was fitted to the CTD unit a few weeks before the Cruise. At this time there were problems arising from the calibration of CTD unit 1 that had led to delays in fitting and calibrating the pH probe. It was not clear whether the problems were due to the pH sensor itself, to the underwater cables that were needed because of the requirement to relocate the position of the probe on the CTD unit or to problems associated with the electronics. The electronics group were also making an underwater power supply for Variosens, working on fitting the Variosens to the CTD unit and modifying a SDL to accept data from the Variosens in case there were problems with the CTD unit. In the week before the Cruise it was discovered that isolation amplifiers were needed to interface the Variosens to the CTD and the SDL and the electronics group did not have sufficient to fit the Variosens to both devices, nor was there enough time to purchase any. In addition, we had no spare probe for the pH sensor which would have made it easier to locate the faults in that system. By the time that we found that the probe was faulty it was far too late to obtain another one from the USA. Fortunately we did not need to use the SDL with the Variosens (only one channel could have been logged), but the pH probe was not fitted for the Cruise and we therefore missed the opportunity to obtain much potentially valuable data.

There are three deficiencies in the system that contributed to the fact that the pH probe was not operational and these should be addressed as a matter of priority. First, there is no deck unit for the CTD at the Division and hence any modifications or calibration of the underwater units can only be done between cruises. The underwater units are of little value without the deck unit and hence both underwater units are usually put on Franklin so that there is a spare. This means that the deck unit and the underwater units have to be continually freighted around the country and it is very difficult to work on the CTD units for an extended period. Second, everything seems to be left to the last moment. I submitted workshop requests for the underwater power supply for the Variosens in Nov 1985 and requested at about the same time that my SDL be modified for use with both Variosens II and III. The pH probe arrived in Hobart some time ago and I formally requested its installation on the CTD unit in a memo dated Jun 20. All of these requests were still being worked on the week before the Cruise but the pH probe was not installed and the SDL and underwater power supply are still not completed so that they can operate with both Variosens II and III. While there have been staffing shortages in the electronics group and the situation was exacerbated by demands on the support groups created by the Open Days, I feel that something is wrong with our priorities. Third, no spare pH probe was purchased even though the probes are fragile and should be considered as expendable items. Had a spare been available we would not only have obtained pH data on the Cruise but have saved the electronics personnel much valuable time in trying to locate the fault(s). This may also have given us the time to order replacement parts from the USA had they been required. As a matter of course, I suggest that we should aim for the completion of all workshop, electronics and computing requests at least one cruise in advance so that we have the opportunity to rectify problems that may occur.

A few faults/problems arose during the cruise and should be addressed.

1. Hooks should be installed on the freezers in the scientific hold to keep the lids open when storing and removing samples.

2. A hook should also be installed on the door to the refrigerator in the scientific hold.

3. The shelves of the refrigerator should be modified to keep things in place when the door is opened in rough seas.

4. Alarms should be installed on freezers/frige in the scientific hold to warn of failure.

5. The "dumb waiter" system for transferring heavy items from the chemistry lab to the GP lab needs to be completed.

6. Fire alarm bells and boat station whistles might not be heard by personnel wearing earmuffs. These alarms also cannot be heard in the clean container. Flashing lights need to be installed in the appropriate locations or someone (shift leader) needs to ensure that all the scientific staff are alerted to any alarms.

7. The acid waste system needs to be completely overhauled. The alarms do not work, fittings are broken, previous GP lab users did not empty containers etc. The containers should have marble chips added to neutralize acids and prevent the emission of noxious gases such as sulfur dioxide and hydrogen sulfide.

8. Frequency changes in the electrical supply (UPS) are very large. Even when an HST Technology Power Conditioner was fitted to the UPS supply to the pH meter, this did not prevent frequency fluctuations observed in rough seas from being manifested in the signal from the continuous pH trace. The problem seems to derive from the use of a shaft alternator. On the one occasion when the diesel generator was used, there was a noticable reduction in the noise.

9. Diesel fumes were quite bad in the GP laboratory on a number of occasions.

10. There is insufficient rack space for Niskin bottles. During the Cruise we were sampling from 36 bottles and it was difficult to sample from the various bottles without using the rosette as rack space and delaying the next cast. One solution may be to fasten the spare rosette to the deck outside the wet laboratory.

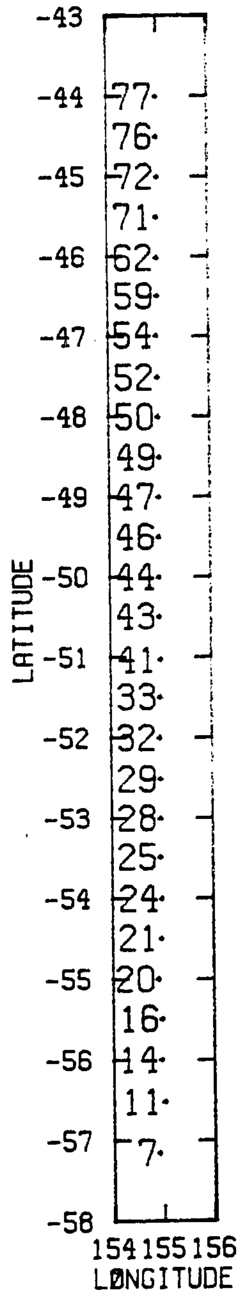
Scientific Personnel

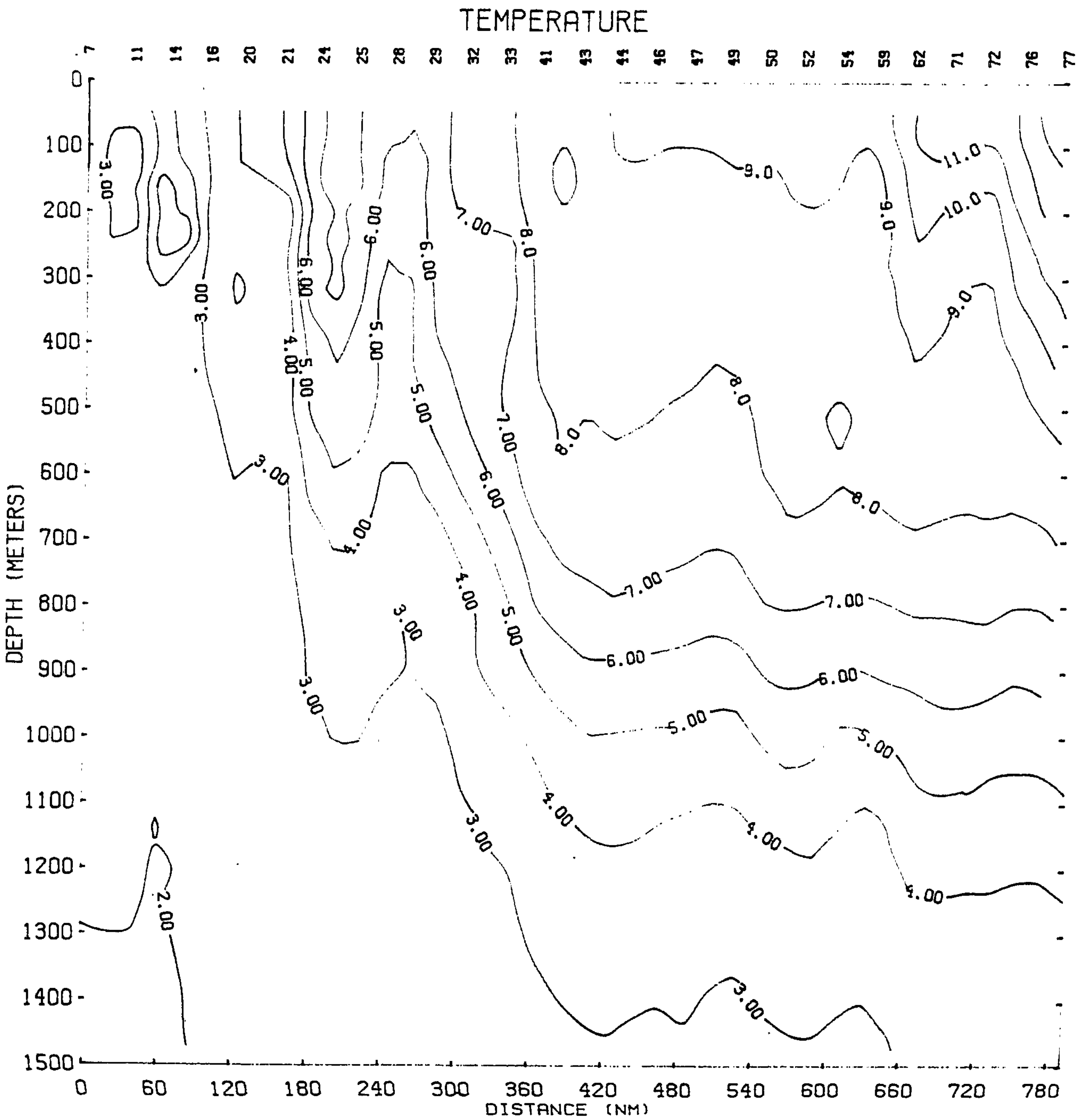
1. Dr Denis Mackey (Cruise Leader)
2. Dr John Volkman
3. Dr Edward Butler
4. Dr Peter Nichols
5. Dr Eric Lindstrom
6. Dr David Thomas
7. Mr Harry Higgins
8. Mr David Everitt
9. Mr Robert Beattie
10. Mr Eric Madsen
11. Mr Ron Plaschke
12. Mr Gary Critchley

DJ Mackey

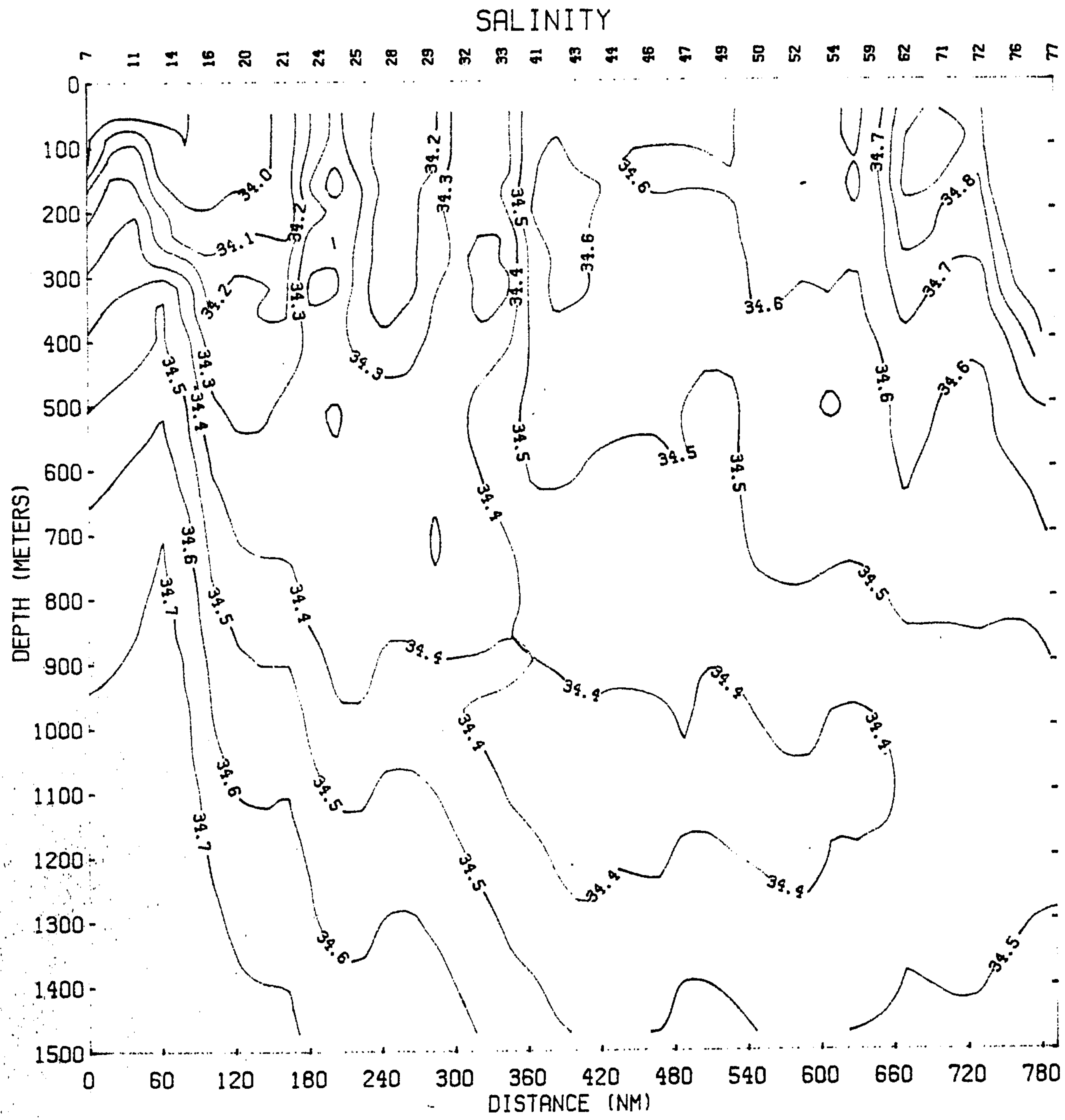
Denis Mackey
(Cruise Leader)

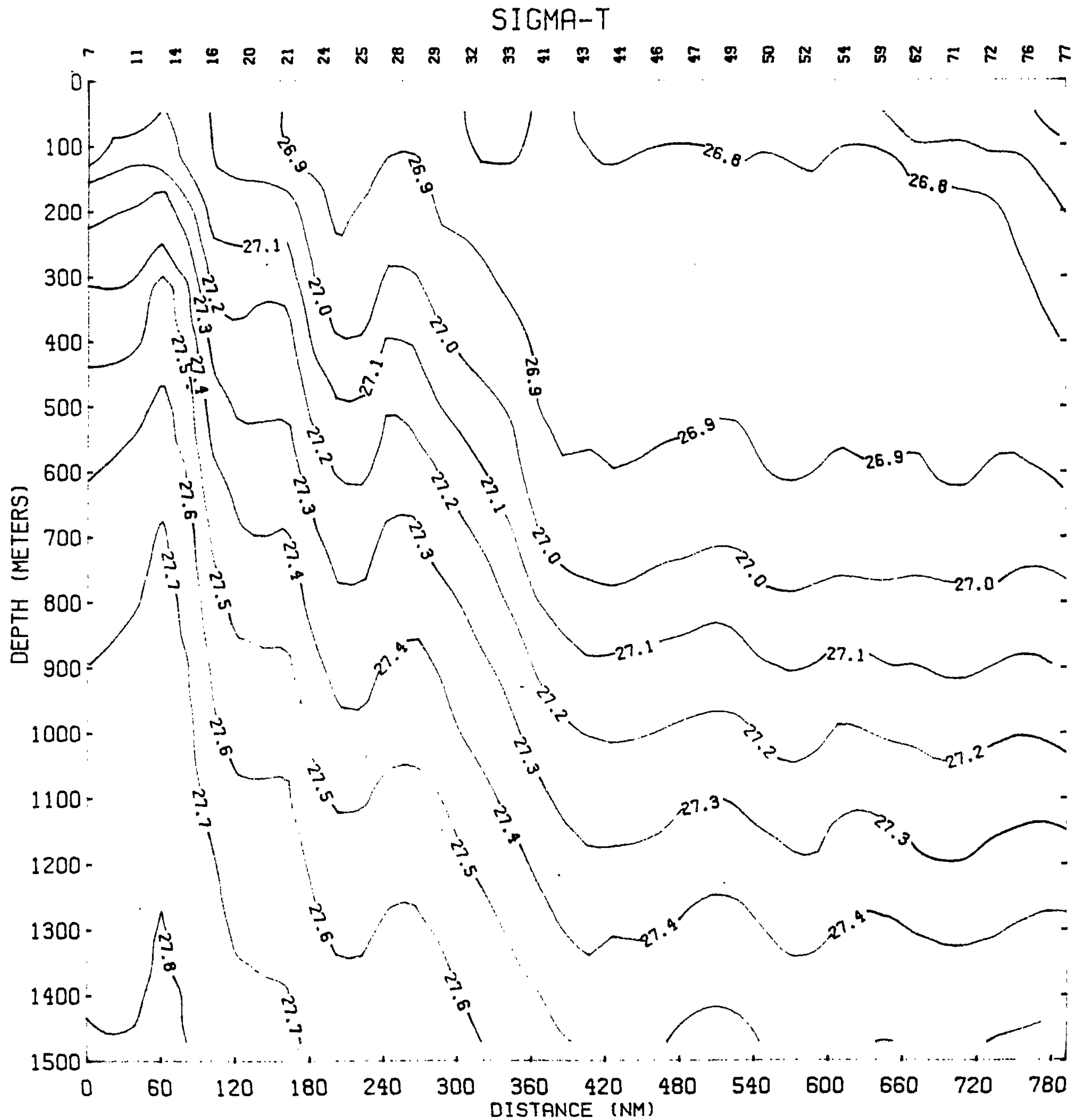
CTD STATIØN LØCATIØNS





TEMPERATURE
7 11 14 16 20 21 24 25 28 29 32 33 41 43 44 46 47 49 50 52 54 59 62 71 72 76 77
DEPTH (METERS)
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500
0 60 120 180 240 300 360 420 480 540 600 660 720 780
DISTANCE (NM)


SALINITY
7 11 14 16 20 21 24 25 28 29 32 33 41 43 44 46 47 49 50 52 54 59 62 71 72 76 77
DEPTH (METERS)
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500
DISTANCE (NM)
0 60 120 180 240 300 360 420 480 540 600 660 720 780
34.0
34.1
34.2
34.3
34.4
34.5
34.6
34.7
34.8



SIGMA-T
7 11 14 16 20 21 24 25 28 29 32 33 41 43 44 46 47 49 50 52 54 59 62 71 72 76 77
DEPTH (METERS)
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500
DISTANCE (NM)
0 60 120 180 240 300 360 420 480 540 600 660 720 780
26.8 26.9 27.0 27.1 27.2 27.3 27.4 27.5 27.6 27.7 27.8