I.O.S.

RRS DISCOVERY

CRUISE 138

17 JUNE – 9 JULY 1983

CURRENT STUDIES AND CTD STATIONS IN THE DISCOVERY GAP AND IN THE MADEIRA BASIN

CRUISE REPORT NO. 152

1983

INSTITUTE OF OCEANOGRAPHIC SCIENCES

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

Wormley, Godalming,
Surrey, GU8 5UB.
(0428 - 79 - 4141)

(Director: Dr. A.S. Laughton FRS)

Bidston Observatory,
Birkenhead,
Merseyside, L43 7RA.
(051 - 653 - 8633)

(Assistant Director: Dr. D.E. Cartwright)

Crossway,
Taunton,
Somerset, TA1 2DW.
(0823 - 86211)

(Assistant Director: M.J. Tucker)

When citing this document in a bibliography the reference should be given as

GOULD, W.J. *et al* 1983 RRS *Discovery* Cruise 138: 17 June - 9 July 1983. Current studies and CTD stations in the Discovery Gap and in the Madeira Basin.
Institute of Oceanographic Sciences, Cruise Report, No. 152, [25pp.]

INSTITUTE OF OCEANOGRAPHIC SCIENCES

WORMLEY

RRS DISCOVERY

Cruise 138

17 June - 9 July 1983

Current studies and CTD stations in the Discovery Gap and in the Madeira Basin

Principal Scientist

W.J. Gould

CRUISE REPORT No. 152

1983

The work described in this report has, in part, been carried out under contract for the Department of the Environment. The results will be used in the formulation of Government policy but at this stage they do not necessarily represent that policy.

Scientific Personnel

W.J. Gould	IOS (W)	Principal Scientist
R. Bonner	IOS (W)	
J. Cherriman	" "	
T. Hamlyn	" "	
N. Millard	" "	
J. Moorey	" "	
R. Pollard	" "	
P. Saunders	" "	Left ship 5 July
I. Rouse	" "	
M. Sawkins	" "	
J. Smithers	" "	
J. Swallow	" "	
N. Timmins	" "	
I. Waddington	" "	
D. Weddell	" "	
C. Whorlow	" "	
C. Griffiths	SMBA	
E. Cooper	RVS	
E. Lawson	RVS	

Ship's Officers

S. Mayl	Master
M. Bowen	Chief Officer
S. Sykes	2nd Officer
P. Pepler	3rd Officer
C. Storrier	Chief Engineer
T. Stevenson	Radio Officer

Acknowledgements

The cruise was extremely successful and enjoyed good weather throughout. The success of the cruise was helped by the happy and businesslike attitude of the officers and crew (aided perhaps by the unusually high quality of the food on board). It is a pleasure to acknowledge the willing cooperation of the Master, ship's officers and crew in carrying out the work programme.

CRUISE OBJECTIVES

(1) To recover moorings set in the Discovery Gap in July 1982.

(2) To carry out echo sounding & CTD surveys in the Discovery Gap area.

(3) To deploy three moored autonomous listening stations and to occupy CTD stations near to and between the ALS moorings.

(4) To deploy suitably ballasted neutrally buoyant SOFAR floats together with a mooring containing a SOFAR float.

(5) To deploy a moored current meter array west of Madeira.

(6) To occupy CTD stations within the Madeira array.

Narrative

RRS Discovery sailed from Gibraltar at 1600 local time on Friday June 17th having waited for the arrival of a spare CTD and a tranmissometer by RAF air freight. After passage through the Strait of Gibraltar course was set towards a site to the north of Discovery Gap (37°37'N 13°33'W). The PES fish was deployed at 0830A/18th (169) and a check made of the misalignment angle of the E-M log. Passage was resumed at a speed of ca 9.5 kts in good weather. The position was reached at noon/19th (170) and by 1300 a suitable position relative to the bathymetry had been found and a CTD station (10784) was occupied. The station suffered from the usual teething problems with faults in the CTD cable harness, in the pressure transducer during the up trace and with tangling of the lanyards on the multisampler bottles. The station was completed at 1830 and after a detour to obtain further bathymetric data course was set towards mooring 327 for recovery the following morning.

The mooring was reached at 0500/20th and was recovered without difficulty by 0720. During the day the remaining moorings were successfully recovered, the last one just

before night fall at 2008. (See notes on mooring operations).

A CTD station (10785) at 37°20'N 15°50'W was then occupied in the centre of Discovery Gap. On completion of the station at 0130/21st an echo sounding run was made over the southern entrance of the Discovery Gap. During this run a gyro fault developed (noticed by the Chief Officer when the sun rose in the west).

At 0940/21st the ship stopped and a 150m length of kinked wire on the midships CTD winch was cut off and dumped. The echo sounding run continued until 1300 when a SOFAR float attached to a MkII minimode float was launched ballasted for 3500m (see notes on float operations). After watching the float pair sink CTD Stn. 10786, the first of several over the topography near the southern entrance to Discovery Gap, was occupied between 1528 and 1844 and during the station a hydrophone was lowered on the forward electric winch to observe the signals transmitted by the SOFAR float. At the end of the station the ship steamed to the float launch position in order to estimate the depth of the float pair.

Overnight CTD Stns. 10787 and 10788 were occupied. At the end of 10788 at 0615/22nd the ship located the float pair and released them at 0725. The ship remained hove to while the floats surfaced and the opportunity was taken to measure the strength of the rope to be used in the moorings later in the cruise. The float pair was recovered at 1017 and CTD 10789 was occupied. In the afternoon the second SOFAR float (No. 4) paired with a minimode float was deployed. CTD Stn. 10790 was occupied between 1810 and 2137 followed by a PES Survey and a position and depth check on the float pair.

The PES Survey was completed by 0930/23rd, the float released and recovered by 1230. A further set of echo sounding runs was then carried out and a suitable site found for a drift CTD station across a slope along which the water entering the Discovery Gap was thought to be flowing. The

drift station 10791 started at 1900/23rd and ended at 0400/24th. Two CTD stations (10792,3) were worked to the the south of the Discovery Gap during the 24th and course was then set towards the first ALS station position (35°N 21°W). The position was reached at 1130/25th and the mooring set from aft, buoy first. The mooring was in position by 1506 and the ship moved westward two miles to occupy a CTD stn. (10795). The conductivity sensor failed at 2250m but appeared to recover, eventually it failed again and on recovery the CTD and multisampler were found to be draped with a large ($1m^2$) mass of red biological matter. A further attempt was made at occupying the CTD station but again conductivity failed. The ship steamed westward while the change was made to the old CTD unit and between 2100/25 and 0100/26th the station (10797) was occupied successfully. A further two stations were occupied on passage towards the second ALS position (34°30'N 26°00'W) which was reached at 1030/27th. The ALS mooring was released by 1219 but before the mooring reached the sea bed the anchor released and the mooring returned to the surface. While the ship was moving to pick up the buoy a total power failure was experienced, lasting 20 mins. The mooring was recovered by 1630 and revealed that one of the pyrolease units had become unglued. The mooring was relaid with the offending part of the pyros drilled and pinned. By 1938/27th the mooring was in place and the ship moved 2 miles to the south to occupy a CTD station (10801). Shortly after the start of the station a message was received requiring Dr. Saunders to return to the UK on compassionate grounds. The station was abandoned and after recovery of the PES and interrogator fishes course was set towards Ponta Delgada Azores. Using 3 engines the port ws reached by 1530/28th and Dr. Saunders landed via the pilot boat. The vessel then returned to the abandoned CTD station position which was reoccupied (Stn. 10802) and completed by 1400/29th.

Course was set towards the southernmost ALS position

30°N 23°30'W with two CTD stations on passage. The ALS site was reached by 0800/1st, a CTD station (10805) occupied and the ALS mooring launched by 1640. The next CTD station 10807 near 31°40'W 23°35'W revealed a series of faults on the CTD eventually traced to a defective cable harness which was replaced. The station took a little over 9 hrs for completion.

The position for the release of the SOFAR floats and the moored float was reached by 2150/2nd. The moored float was in place by 0006/3rd and the first free float deployed at 2315/2nd. The descent of the float was monitored by means of a lowered hydrophone and at the end of its 2hr 40 min telemetry cycle course was set for a position 30 miles to the north for a CTD stn. This Station (10809) was occupied between 0518 and 0931/3rd and the transmissions from the float monitored by hydrophone around 0800. The second float was deployed at 1230/3rd and its descent monitored until 1615. The moored float position was then checked and course set towards the final CTD station of the ALS triangle. A stop was made at 2330/3rd to monitor the pressure telemetry of the free floats (see float report). The CTD station was reached at 0612/4th and completed by 1018 (10810).

Passage continued eastward towards the Madeira array area and a PES Survey carried out between 1910/4th and 0645. A final attempt at float ballasting together with a MkII minimode float was made with the float pair launched at 0845/5th. The ship then moved into position for the deployment of the central VACM mooring of the array. Deployment commenced at 1053 but the anchor swinging allowed the acoustic release to strike the A frame and fire the pyros. A replacement anchor was found and the mooring deployed by 1430. Course was set to the position of the northernmost mooring which was set between 1654 and 1750. A CTD station (10813) was worked nearby. On completion of the station at 2142/5th a PES Survey was started with a halt to listen to the SOFAR floats between 2330 and 0140/6th. A

further stop was made between 0624 and 0848 in an attempt to hear the French SOFAR floats which had been launched near 37°N 40°W the previous day. None of these was heard. The SOFAR/MkII float pair was released at 0705 and recovered at 0936. The MkII float was deployed on its own at 1007. During the daylight hours of July 6th the remaining 5 moorings of Madeira array and a test mooring for the Building Research Establishment were deployed. Throughout the remainder of July 6th and 7th a series of CTD stations near the moorings interspersed with echo sounding runs and fixes on the float were carried out. The final CTD (10824) was completed at 0930/8th and the float fixed and recovered. The ship then proceeded to Funchal Madeira arriving at 0800/9th.

Individual Project Reports

SOFAR floats

The Sofar floats being used on this cruise differ from the normal (WHOI) ones in being designed to work at greater depths. Trials last year showed that useful acoustic ranges could be got from depths as great as 4000m. The buoyancy elements in these new floats are 17" dia. glass spheres. The overall compressibility of the float (a composite of glass spheres, aluminium, and a fair amount of assorted plastic and rubber) is approximately two-thirds that of seawater and its uncertainty is estimated to be ±10%. The resultant uncertainty in calculated buoyancy at depth is ±20%, or ±700m approx. with a float intended for a working depth of 3500m. Another uncertainty in buoyancy of the Sofar floats comes from weighing them in a tank of salt water solution, not seawater. An unknown but possibly appreciable error is incurred in assuming that the salt solution has the same coefficient of expansion as seawater of the same density.

To reduce the effects of these uncertainties before launching any of the Sofar floats on their own, ballasting tests were made with an ordinary MkII float clamped on the

side of a Sofar float. This served two purposes. The depth of the combined package could be determined by observing the minimum range of the transponder in the MkII float, and the whole package could be recovered using the MkII float's acoustic release.

In the first test, using No. 2 Sofar float, the combined package went to 3950m, i.e. 450m more than the intended depth. The load was adjusted accordingly for the second trial, with No. 4 Sofar float, and the correct depth was obtained. It seems reasonable to assume that the same correction would be suitable for all four floats, though how much of the error should be assigned to compressibility and how much to initial buoyancy is unknown.

The listening station clocks were set to the correct time on day 140 before being shipped in a running condition to Gibraltar. Before deployment in a mooring their tapes were read and all three had good data. Their clocks on deployment in the moorings were:-

IOS 10 2.201 seconds slow on day 176
IOS 11 0.163 seconds slow on day 178
IOS 12 0.307 seconds fast on day 182.

It should be noted that a leap second was inserted on day 181/182. All listening stations and float 4 were timed prior to this time. Floats 1, 2 and 3 were timed after this time.

Each listening station has a 10 KHz telemetry system to send the most recently acquired data back to the ship. These were found to be not working correctly, the cause being traced to an oversight in programming when converting the listening stations to a 2 channel system.

Four floats were timed on day 139 and subsequently shipped to Gibraltar in running condition. When the float was checked out only Float 4 was working correctly. Float 1 had lost its battery voltage. This was caused by one of the packs rotating in the housing resulting in both fuses blowing. Float 2 had battery volts but its voltage regulator had been damaged by a drip of locktite onto the

printed circuit board. Float 3 would not switch into fast mode, although this was probably attributable to operator error as no fault was found.

These faults were fixed but problems were encountered with the floats turning themselves into fast cycle. This was eventually cured by realising that the anodes which are used to initiate the fast cycle needed to be grounded to avoid spurious 'pick up'. During one of these unsolicited cycles Float 2 damaged its output transistor probably because they overheated in direct sunlight.

On two occasions timing was lost during changes from auxiliary power to main power, showing a need for a more fool proof system.

During ballasting trials with Floats 2 and 4, Float 2 worked acoustically but Float 4 failed between its main 'pong' and its telemetry 'pong'. On recovery the failure was found to be due to leakage of water into the junction box, resulting in blown battery pack fuses. New junction boxes were made on board, which appear to work satisfactorily.

Floats 2 and 4 were redeployed, this time on their own, and the indications were from the fast cycle and pressure telemetry pulses, that they had gone too deep. However further trials using Float 3 in conjunction with a MkII float show that the pressure telemetry on the floats are in error. The reason for which has yet to be established. Float 1 was modified mechanically to allow it to be placed in a mooring which was laid placing it at 3500m. Good signals were being received from the floats at a range of 3 mins (about 180 miles). The floats were timed for

Float 1 00 hrs. 00 mins 19 secs. ODD
Float 2 00 hrs. 20 mins 19 secs. ODD
Float 3 00 hrs. 41 mins 19 secs. ODD
Float 4 01 hrs. 00 mins 19 secs. ODD

all with 3 transmissions per day.

The time reference used for the Sofar float system has

a satellite synchronised clock. Its performance at sea has been very reliable and seems to be almost independent of which direction the aerial points.

J.C. Swallow
N.W. Millard
I. Rouse
W.J. Gould

Acoustic Command Release System (CR200 series)

The six moorings (numbers 321, 322, 323, 324, 326 and 327) left in the summer of 1982 were all successfully recoverd on the 20th June. The Titanium used was all in very good condition.

The wire tests for the moorings on this cruise were done on the multi-sampler frame of the CTD system used from the hydraulic mid-ships winch. A total of seventeen tests were performed. All tests were successful bar two. Two of the units flooded, one of them was a low pressure leak and on inspection nothing was found to indicate why it had leaked, the other unit leaked under high pressure (at approx. 4500m), on inspection it was found that a Marsh Marine 2 pin connector had cracked and leaked.

A total of thirteen units were laid during the cruise listed as follows:-

3 units on ALS sites
1 unit sound source sites
9 units in the Madeira array (one short term B.R.E. exp. mooring).

Near Bottom Echo Sounder (N.B.E.S.)

This unit was used on the CTD/Multisampler unit on a total of twenty nine occasions. It performed well and was completely successful on twenty five of these stations. The first three stations (10784, 10785, 10786) there were problems with the unit seeing either the weight used below the CTD frame or at first the Release (CR200) below the frame, both

were soon rectified. On two other occasions the unit failed to see the sea bed and on inspection the batteries were found to be low and also the unit needed retuning. Both faults were easily rectified. The total number of hours the unit was used was 115 hrs.

Mufax Precision Echo-Sounder (PES) System

The unit used on this trip was No. 12. This unit worked well and required very little attention. The adjustment and repairs needed were as follows:

(i) Chain tension

(ii) LED clock readout (Display segment broken)

(iii) During one mooring deployment the Helix stopped and it was found that a fuse had broken (-12V) and the Helix trigger card was suspect (No. 8).

On occasions through the cruise, interference was seen on the Mufax, seen to be at 100 Hz. With the help of the ship's engineers the fault was traced to an alternator. Another cause of some interference was when the forward electric winch was used.

The towed fish performed well, the only repairs necessary were the replacement of some of the clips.

The beam steering unit was not used on this trip, the Mufax was wired such that Tx and Rx was on eight of the PES array and the single element wired permanently to the Acoustic Deck Unit.

Acoustic Command Deck Control Unit (No. 25)

This unit performed without fault all through the cruise.

Comments on Pyroleases

During a deployment of one of the moorings (after it had been cut free) the mooring was seen to be returning to the surface. The cause was later found to be the pyro parting (ungluing). The pyros were from a batch stamped 3/83 and it was seen that the gluing was poorly done. All the pyros to be

used were then pinned to prevent this happening again.

During the laying of the VACM mooring the Acoustic Release hit the top of the forward 'A' frame and fired the pyros so releasing the anchor. The releases were checked and found to be in A1 condition and so were re-used in the mooring. The pyros fired due to the relay inside the release being operated by the knock on the 'A' Frame.

M. Sawkins

Computer Operations

S1 (Data Logging) System

The resident operating system and data logging programs on the winchester drive DP3 of the S1 computer wre not used on this cruise. Instead an earlier version of the system from an RL01 disc, WALES83XEC20 was run. This was done because the STARTUP files present on the winchester were clearly incorrect. Also many of the tasks on that drive were old versions prior to corrected versions made through to April 1983. It thus appeared that the winchester DP3 tasks and files must have been copied from an outdated backup tape. Nor was it clear whether the system file was the latest 20k version, so the only safe course was to revert to the RL01 version created in late April.

Navigation

The S1 computer logged navigation and met data at 1 minute intervals throughout the cruise. Two problems arose concerning the e/m log. Just after leaving Gibraltar the log was found to be 2.2 degrees out of alignment and had to be re-calibrated. Occasionally ship's radio transmissions would send its output awry and navigation was lost during these periods in spite of despiking mechanisms in the CALDR software.

CTD

The results of 28 CTD dips were logged and archived. A new version of CTDAVG, the averaging program was used. This

sorted every 16 samples into ascending order and picked out the two median values (for each variable) as correct. The difference between these two values, suitably scaled, was used to eliminate serious out-of-range values from each end of the sorted series. The algorithm proved efficient at eliminating most spikes from the final record. Only radio interference from the ship's transmitter seriously disrupted things.

The baud rate converter, linking the deck unit with the computer was temperamental. On several occasions logging would not start until this unit had been switched off and on. The switch on the power supply was suspected and replaced which seemed to improve but not cure the problem.

Plotting

The CTD plotting programs XYPLOT and DIPLOH both worked well. Generally two versions of XYPLOT (one installed as XYPLOT) ran during dips. One wrote onto the HP terminal in the computer room from which hard copies could be taken and the other plotted on the Tektronics display in the electronics lab where the deck unit operator could see it.

Archiving

Archiving went well, the only problem being that tape drive 0 could not be used. It had a tendency to lose tension occasionally without warning. It has not been possible to investigate this fault while the other drive is still archiving.

There is now a simple and moderately foolproof progam for copying CTD/Batfish and most other tapes. DUPLITAPE will copy an S1 system archive tape verbatim onto a backup tape. The program is self explanatory, quite fast and does its best to stop the operator from erroneously wiping out the master tape.

Inter Machine Links

Daily batches of navigation and met data were passed from the S1 system to the other on-board computer, the Usersystem, using a pair of ordinary V24 terminal lines as the link. Once

on the Usersystem, plotting and other processing could be carried out without fear of upsetting logging. New versions (V 3.0) of the programs used for transferring data were brought out from Barry then built and installed at the start of the cruise. These worked satisfactorily throughout.

In addition, a high speed HDLC link board was fitted inside each machine so that in principle much higher transfer rates became possible. However the software to drive these was not completely installed until late in the cruise. The new link was found to be much faster though not as reliable as the V24 arrangement. Typically 500 disc blocks of data could be passed through the link in under 3 minutes but quite often the receiving program would crash mysteriously. We understand that improvements will be made during the next leg.

User System

The second on-board computer, the User System, suported two completely separate program suites. First there was the IOS PSTAR system for data analysis, calibration, editing, plotting and contouring. It was used particularly to read in and fully process current meter data (see below). It ran on its own RL01 disc but used one of the winchesters, DP1 to hold its data.

Then there was the resident RVS prototype Level C system. This lived on DP3 and kept its data in two files on DP0. On previous cruises the pre-processing data file (called FIRST) had resided on DP1 but on this cruise it had to move into DP0 alongside the processed data file (called FINAL) so that PSTAR could have DP1 for its data. The only way that FIRST and FINAL could be made to fit onto the same disc was to change their data interval from 30 seconds per record to 60 seconds.

The Level C was used to produce navigation plots and to correct manually entered bathymetry data. Getting it to work properly threw up some difficulties. To begin with, the winchester disc DP3 got mildly corrupted one night in Gibraltar, probably when the power to the machine was switched

off, and had to be resurrected from the last backup of the previous leg. The program used to inject navigation data into FINAL, GETNAV, refused to work, throwing out a 'dread-604' error for which no documentation coud be found. At first the change in the file data rate was thought to be the cause but experiments using a 30s data rate file proved negative. The problem disappeared when the task was removed and re-installed.

A data rate problem did appear when it came to running DEPTH, a Carter correction program. This had been set to accept nothing except a 30 second rate and so a new temporary version was built (in directory DP2: [7,31]. While doing this, some discrepancies in some of the source files on the LABSOURCE disc were noticed. The source code for part of DEPTH, a function call dcorr, contained several bugs. There was however a baud listing of dcorr in which the bugs had been eliminated but it was not on any of the discs or tapes on board so the source code on disc was replaced by a typed in version from the listing. It is possible that there may be other, inconsistencies relating to source files.

Current Meter Tapes

Six Aanderaa current meter tapes were transferred to 1/2 inch tape though with a surprising number of errors in some cases. Maybe the Aanderaa reader does not like stop/start way that AARDVARK the reading program, drives it. Later the Aanderaa tapes were transferred to 1/2 inch tape using a custom-built interface between the reader and a Digidata drive. The error count dropped considerably.

Data from several VACM casettes were also processed.

E. Lawson
E. Cooper
R. Pollard

CTD Performance

A total of 29 CTD stations were worked, the majority of them to within about 10m of the sea bed as revealed by the near

bottom echo sounder. For the most part the new CTD unit was used with the addition of the oxygen sensor and tansmissometer. On a few stations near the middle of the cruise (see Station list) the new unit was replaced by the old one (without oxygen and transmittance). On Station 10803 both units were attached to the CTD wire and an intercomparison of the temperature sensors made. (Pressure did not work on the old unit and so the intercomparison of the other sensors could not be performed). On Stn. 10809 the new CTD conductivity sensor was replaced. It had started to drift after being fouled by a large mass of red biological matter. By the end of the cruise the new sensor had stabilised and a new calibration was established.

The multisampler was used extensively for calibration values as were 10m IOS water bottles. After initial problems with lanyards tangling the multisampler worked well. The new bottles have greatly improved the ease of obtaining good calibrations.

J. Smithers,
P. Saunders
W.J. Gould

Mooring operations

A total of 18 recoveries or deployments were carried out with 100% success.

Discovery Gap array

All moorings (6) were recovered with complete data records in every instrument. There were no problems with the acoustic releases (all of which had titanium hardware) nor with any of the mooring components. The use of a 16" glass sphere at the end of the recovery line seems to keep it from tangling with the other buoyancy and this technique was used on all moorings set on this cruise.

ALS moorings

The ALS moorings were set buoy first from the poop, a technique that proved remarkably easy. The rope lengths had been flaked down into boxes and so could be paid out without kinking. The rope was run out over a block on the crane davit which was ideally situated for the work. The rope was slipped round the capstan. (Some rope lengths had previously been tensioned and their lengths measured since on deployment low tension caused some slip on the meter wheel). The hydrophones and ALS recording packages proved easy to handle.

On the second ALS (mooring 340) the acoustic release pretripped before the mooring was in place. On recovery it was found that one pyro had come apart at a glued joint. Subsequently all pyros used on moorings were pinned. This procedure has been used for some while by SMBA.

The recovery of the ALS and hydrophone is somewhat difficult since the complete unit has a length only slightly less than the lift of the forward crane. In future recoveries the hydrophone and recording-package will be separated on recovery.

Moored sound source (float)

A similar deployment technique to that used for the ALSs was used but the 10 ft. length of the unit proved a little difficult to handle. A second float will be moored on Cr. 139.

Madeira Array

All moorings (8) were set from the foredeck using the double barrelled winch. The first mooring attempted was the most difficult since it carried eight vector averaging current meters. The present "A" frame has limited height clearance and in each case the current meter and its associated buoyancy package had to be lifted into place by crane, It is to be hoped that the new forward A frame will simplify this procedure.

During deployment of the VACM mooring the anchor, still above the water when the release and deepest current meter were

attached, swung with the roll of the ship and caused the release (a double unit) to strike the A frame and fire the pyros. No damage to personnel or equipment resulted and the mooring was relaid using steadying lines on the anchor. In future a two stage anchor should be used so that the pilot weight will reach the water and steady the mooring line.

The array was aligned with its major axis parallel to the large scale trend of the topography as revealed by a preliminary bathymetric survey. A three day float track at a depth of 4200m had a mean direction within 3 degrees of the array axis and a mean speed of 7cm/sec.

Test Mooring

A mooring was set near to the westernmost mooring of the Madeira array. It carried concrete samples for the Building Research Establishment. The 10 cm cubes were held in a plastic frame enclosed in two 16" Corning Sphere hard hats.

J. Cherriman
I. Waddington
M. Sawkins
W.J. Gould

TABLE 1. HYDROGRAPHIC STATION LIST

Station No	Time Down	Date 1983	Lat. N	Long. W	Water Depth m	CTD Ht. above bottom m	Salinity Samples	Therm. frames	Oxygen samples	Comments
10784	1630	19-VI	37 38 3	13 48.2	4506	9	11 (A)	3	11	Therm. frame tangle
10785	2249	20-VI	37 20.4	15 49.9	5056	12	12 (A)	5	12	Therm. frame tangle
19786	1702	21-VI	37 09.6	16 42.6	4174	13	11 (A)	4	0	
10787	2244	21-VI	36 51.1	16 40.5	4654	7	9 (A)	6	9	
10788	0402	22-VI	36 56.8	16 40.2	4721	9	8 (A)	4	0	
10789	1225	22-VI	37 04.8	16 42.1	4485	10	10 (A)	4	1	
10790	1942	22-VI	36 44.7	16 37.1	4056	9	6 (A)	4	0	
10791	2100	23-VI	36 36.2	16 49.1	*	13	0	0	0	Yo-yo First Down
	0216	24-VI	36 37.0	16 52.5	5105	9	0	0	0	Yo-yo Sixth Down
10792	0839	24-VI	36 30.0	17 26.1	5087	10	12 (A)	5	0	
10793	1822	24-VI	36 29.7	18 31.8	5544	10	1	5	0	All therms. at 14m
10795	1630	25-VI	35 00.7	20 59.9	5196	-	0	0	0	2 miles E of ALS10. Cond. fail at ~2500 m. Biolog. fouling.
10796	1912	25-VI	35 00.41	21 05.1	5040	-	1	5	0	All therms. at 19m. Cond. fail at 740 db.
10797	2259	25-VI	34 59.6	21 19.4	5168	9	1	5	0	All therms at 25.m +
10798	1208	26-VI	34 37.3	23 01.3	5190	9	7	6	0	+
10799	2302	26-VI	34 39.9	24 19.7	5257	9	11(A)	6	0	New CTD. Problems on O_2. "Meddy" Stn.
10800	2056	27-VI	34 27.5	26 01.3	5037	-	0	0	0	Station abandoned
10802	1145	29-VI	34 27.2	26 01.5	5006		1(A)	1	0	Attempted intercomp. new & old units. Old unit failed. Biological fouling as 10795.
10803	0136	30-VI	33 00.5	25 16.4	5366	25	2(A)	2	0	Intercomp.of old & new CTD. Old pressure u/s salin. shift on new unit.
10804	1902	30-VI	31 30.1	24 22.1	5428	8	11(A)	6	11	New unit. T & S still unstable.
10805	1002	1-VII	30 00.2	23 30.8	5271	10	12(A)	7	0	

Hydrographic Station List Cont.

Station No	Time Down	Date 1983	Lat. N	Long. W	Water Depth m	CTD Ht. above bottom m	Salinity Samples	Therm. frames	Oxygen Samples	Comments
10807	1152	2-VII	31 40.8	22 34.8	5205	8	12(A)	7	0	Salinity jumped
10809	0707	3-VII	32 59.9	23 30.1	5412	9	11(A)	5	0	Conductivity sensor 941 changed.
10810	0752	4-VII	33 19.4	21 49.6	5314	9	12(A)	7	0	
10813	1937	5-VII	32 35.8	20 06.6	4667	12	12(A)	7	0	Near A6 Maderia Array
10820	0625	7-VII	32 26.7	20 08.6	4639	9	12(A)	7	0	Near A5
10821	1312	7-VII	32 21.6	20 11.4	4670	8	12(A)	7	0	Near V
10822	2023	7-VII	32 16.7	20 14.1	4682	7	12(A)	7	0	Near A4
10823	0145	8-VII	32 22.8	20 21.0	4731	8	12(A)	6	0	Near A1
10824	0925	8-VII	32 21.5	20 14.7	4705	9	12(A)	7	0	Near A2

A Near surface samples taken with IOS water bottle
* Not observed
\+ Old CTD No O_2 or transmittance

TABLE 2. MOORING LIST

Mooring No	Discovery Stn	Date	Time*	Lat.	Long.	Water Depth	Instruments	Comments
321	10577	20-VI	1829	37 20.7	15 41.4	4686	1 Aa. 1 VACM	Recovery
322	10578	20-VI	1623	37 21.6	15 43.3	4947	2 Aa. 1 VACM	"
323	10579	20-VI	1355	37 23.9	15 47.2	5009	1 Aa. 1 VACM	"
324	10580	20-VI	1148	37 25.1	15 50.8	4429	1 Aa. 1 VACM	"
326	10589	20-VI	0900	37 30.8	15 40.3	4613	1 VACM	"
327	10590	20-VI	0512	37 27.5	15 25.3	4820	1 Aa.	"
339	10794	25-VI	1506	35 01.3	21 01.4	5198	ALS "IOS 10" + 1 Aa	Deployed
340	10800	27-VI	1937	34 29.0	26 02.4	5050	ALS "IOS 11" + 1 Aa	Deployed
341	10806	1-VII	1603	30 00.6	23 31.5	5268	ALS "IOS 12" + 1 Aa	Deployed
342	10808	3-VII	0006	32 30.9	23 30.9	5410	FLOAT 4	Deployed (4000m)
343	10811	5-VII	1428	32 20.5	20 11.1	4676	8 VACM	Deployed V
344	10812	5-VII	1804	32 35.6	20 06.0	4661	2 Aa	Deployed A6
345	10814	6-VII	1152	32 15.9	20 13.3	4669	2 Aa	Deployed A4
346	10815	6-VII	1455	32 25.9	20 09.5	4664	2 Aa	Deployed A5
347	10816	6-VII	1708	32 23.0	20 20.8	4728	2 Aa	Deployed A1
348	10817	6-VII	1752	32 23.9	20 20.9	4723	Concrete samples	Deployed BRE mooring
349	10818	6-VII	1937	32 21.7	20 14.8	4711	2 Aa	Deployed A2
350	10819	6-VII	2127	32 19.4	20 08.3	4626	2 Aa	Deployed A3

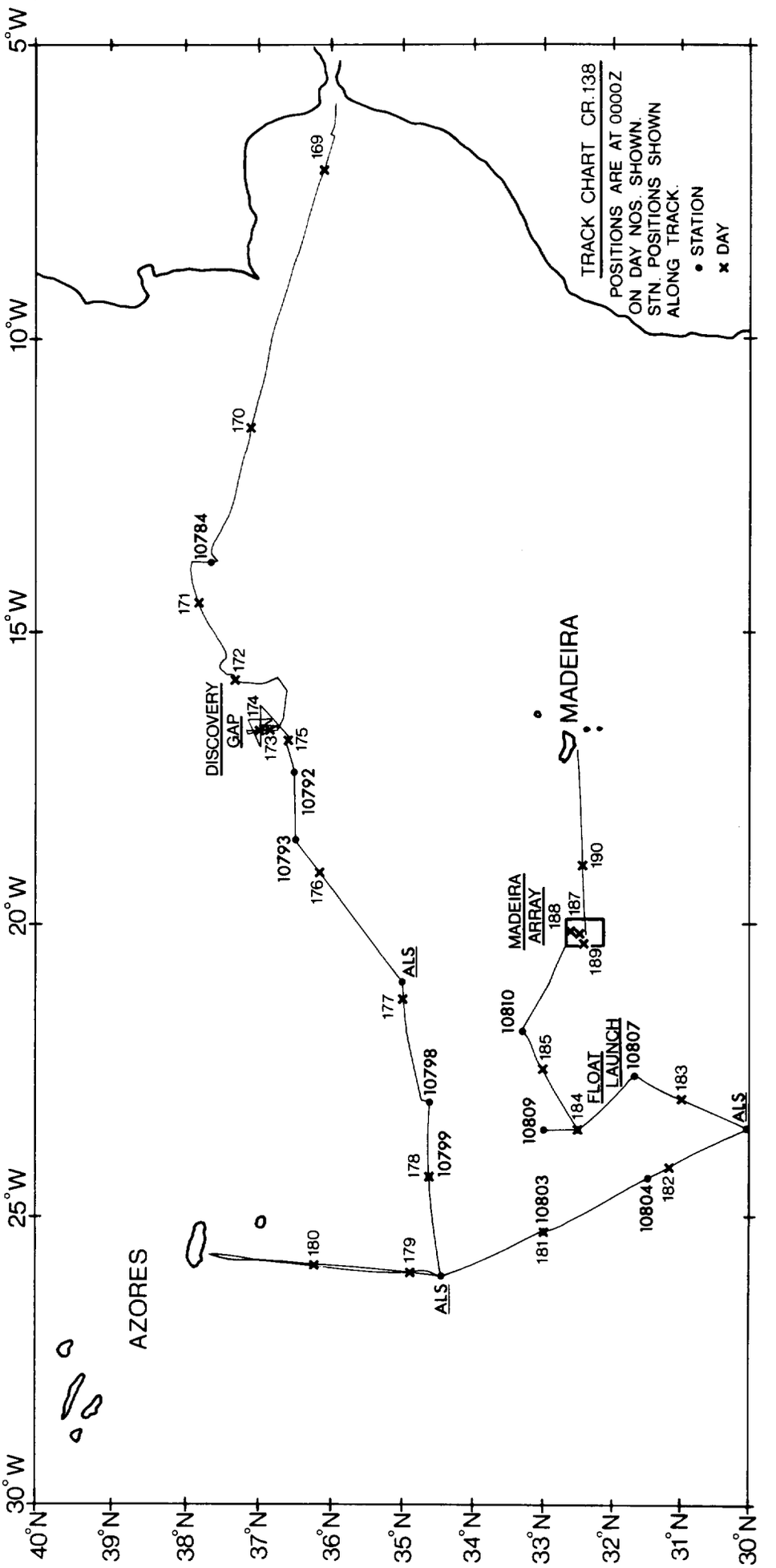
TRACK CHART CR.138
POSITIONS ARE AT 0000Z
ON DAY NOS. SHOWN.
STN. POSITIONS SHOWN
ALONG TRACK.
• STATION
× DAY
AZORES
MADEIRA
DISCOVERY GAP
MADEIRA ARRAY
FLOAT LAUNCH
ALS
10784
10792
10793
10798
10799
10803
10804
10807
10809
10810
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
187
188
189
190
5°W
10°W
15°W
20°W
25°W
30°W
40°N
39°N
38°N
37°N
36°N
35°N
34°N
33°N
32°N
31°N
30°N

Figure 1.