INSTITUTE OF OCEANOGRAPHIC SCIENCES
DEACON LABORATORY
CRUISE REPORT NO. 221

RRS CHARLES DARWIN
Cruise 50
29 Jun - 22 Jul 1990

Oceanography of the Iceland Basin
The fate of Iceland Scotland Overflow Water

Principal Scientist
W J Gould

1991

The report provides a narrative and science project reports of a cruise to the Iceland Basin of the NE Atlantic in summer of 1990. Work carried out included the working of CTD and XBT sections, underway ADCP and Echo Sounding, the deployment of moored current meters and the determination of nutrient and dissolved oxygen caracteristics.

CONTENTS PAGE

SCIENTIFIC PERSONNEL
GOULD, W.John. IOSDL Principal Scientist
BACON, Sheldon IOSDL
BRANDON, Mark IOSDL
CHIPPINDALE, Marc Univ. East Anglia
DAVIES, Mike RVS
GOY, Keith M IOSDL

HYDES, David J. IOSDL
LLOYD, Rob. B RVS
MOSS, Karen IOSDL (Industrial Year Student)
PHILLIPS, Greg, R.J. IOSDL
RYMER, Chris RVS
SMITHERS, Mrs Jill IOSDL
SMITHERS, John IOSDL
WOOLLEY, Marie IOSDL (Industrial Year Student)
WYNAR, John RVS (To Wallsend only)

SHIPS PERSONNEL
AVERY, K.D. Master
LOUCH, A.R. Chief Officer
JACKSON, J.P. 2nd Officer
ATKINSON, R.M. 3rd Officer
ROWLANDS, D.C. Chief Engineer
ROBERTSON, G.A. 2nd Engineer
DEAN, S.F. 3rd Engineer
EDGELL, P.E. Electrician
BAKER, J.G.L. Radio Officer
TREVASKIS, M. CPO(Deck)

CRUISE OBJECTIVES
The cruise is one of a series (*Challenger 15/87 (1987), Discovery 174 (1988), Charles Darwin 42* (1989), on which the magnitude and fate of the Overflow water from the Norwegian Sea crossing the series of ridges and channels between Scotland and Greenland have been studied.
On *Charles Darwin 50 (1990)* the objectives were
1) To observe the path of the overflow water in the Iceland Basin on the south side of the Iceland Faroes Ridge, using a lowered CTD, XBTs and ship mounted ADCP (Acoustic Doppler Current Profiler).
2) To determine the chemical properties (nutrients, dissolved oxygen and aluminium concentration) of the Overflow and Atlantic water masses.
3) To deploy an array of moored current and temperature recorders south of Iceland.
4) To deploy a moored ADCP on the Iceland-Faroes Ridge in support of *Charles Darwin Cr 51.*
The cruise track is shown in Figure 3

NARRATIVE
The scientific party joined the vessel in the Pool of London alongside HMS Belfast at 1430A 28-VI-90 (179). There was little in the way of equipment preparation that could be done since most gear was to be loaded the following day in Gt Yarmouth.
A photographer from the Guardian came to take pictures to accompany an article about the cruise (Guardian, 29-VI-90).

The vessel sailed at 1900A and made an uneventful passage overnight to Great Yarmouth where she berthed at 0930A (29th,180)
Equipment from IOSDL was loaded, as were a number of items including the moored ADCP and its mooring hardware from RVS. Two staff from Hydrographic Dept Taunton were on hand to complete installation of the new automated XBT recorder supplied by the Hydrographic Dept.
Equipment was installed in the labs and a base plate for the CTD unit modified and bolted to the deck. Morag Stirling assembled and installed the fluorometer for Cruise 51 and Steve Alderson helped to install the P STAR data processing system. GPS position data were recorded throughout the port call in Gt Yarmouth in order to try to assess the effects of the deliberate downgrading of positional accuracy which had recently been imposed by the US Department of Defense.
It was clear by mid afternoon that we would not be able to catch the afternoon tide and sailing was therefore scheduled for 2300A.
A reporter from the Eastern Daily press who had seen the Guardian article visited the vessel in the afternoon.

The vessel sailed at 2330A, after a delay due to pilots being busy. No scientific watches were kept overnight but navigation data were logged.
June 30th (181) opened overcast with a falling barometer and with the vessel making 12 kts northwards in a light sea. The scientific party continued preparing equipment. Thermosalinograph logging was started and calibration water samples from the non toxic seawater supply were taken at 4 hr intervals. ADCP logging was started at mid morning.
The vessel passed through Pentland Firth between 1030-1100A (July 1,182) in clear conditions but the weather worsened as we progressed northwestwards.
The vessel stopped at 1430A to deploy the PES fish and to test handling of the new CTD and multisampler package. The unit was deployed without bottles and with two 40 kg lead weights strapped to the bottom ring. The frame handled well and showed that it could be deployed and recovered with the ship's guard rails in place. The cantilever arm on the midships A frame seemed to steady the package quite well.
Course was resumed towards 60 15N 06 00W but with speed reduced to 7-8 kts due to weather.
At ca 1600A the ship stopped so that severe noise and vibration in area of steering gear which had become apparent as the sea state had increased could be investigated.. After considerable deliberation it was decided that there was a serious problem, (probably with the rudder), and we set course at reduced revs for Aberdeen.

The vessel arrived in Aberdeen by mid morning July 2nd (183). Divers were on hand to inspect the rudder and propeller but nothing obvious was found. The vessel remained in Aberdeen overnight for consultation with RVS. The divers returned at 0800A (3rd) to inspect the bilge keels but again nothing untoward was found. The vessel sailed at 1030A and conducted sea trials off Aberdeen. The severe vibration and noise reappeared when the rudder was put hard over at 12kts. RVS were informed and the vessel headed south towards Leith which was the nearest available drydock. We were informed in the afternoon that the Leith drydock was not available and that we should head for the Tyne.
The Tyne pilot boarded at 1000A 3rd (184) and the vessel arrived in dry dock in Wallsend at noon. The dock was pumped out by 1600 and tests on the rudder were carried out. These identified slack in the lower pintle bush and work was commenced to rectify the matter.
The vessel remained in dock throughout the 4th and 5th with the ship's personnel remaining on board. Repairs to the rudder were almost completed by evening of 6th. The vessel sailed at 1400A 7th (188) but took a long time to clear dock as she became stuck across the dock entrance on the flooding tide. We cleared the mouth of Tyne by 1545A and retried the same helm- hard- over manoeuvres as before. The noise and vibration were still present.
The vessel returned to dry dock after Paul Stone (RVS Engineering Superintendent) and the dock manager had joined the ship by pilot boat to witness the problem at first hand.
Suspicion now fell on the skeg which attaches the propeller rope guard to the shell plating. Some minor cracking and rust streaks had been noticed around that area. The vessel returned to port and was alongside the drydock by 2330A.
The vessel entered drydock again at 1500A 8th (189) and when the dock had been drained it was found that the rope guard could indeed vibrate and hit rudder. Work was commenced to remove the guard and repair the cracks.

After telephone discussions on the morning of the 9th with Trevor Guymer (Acting Head Marine Physics), Peter Saunders and Colin Summerhayes it was agreed that a cruise extension would be impracticable due to fact that most of officers were due to change at end of the present cruise.
Repair work continued throughout the night and the vessel sailed at 1630A after a number of pinhole leaks in the skeg had been welded and the skeg integrity tested. The breakwater was cleared by 1800A and course set northwards. High speed manoeuvres produced some noise but the previous problems appeared to have been largely solved. Passage continued northwards at 12.5 kts.
An Inmarsat message was received from Hendrik van Aken on *R/V Tyro*. They had been delayed through bad weather and would not complete WOCE section AR7 to Greenland.
Passage continued northwards throughout July 10th (191) in stiff northerly winds. The vessel arrived in the Pentland Firth 1630A and encountered heavy swell. This rapidly abated. At 1800A the PES fish was deployed. At 1820A an ADCP calibration run at 10 kts was started on courses 000 and 270. This continued until 2100A when the GPS satellite constellation reduced from 4 to 2.

The wind increased to F8 overnight 10th/11th with a heavy beam sea. Clocks were retarded 1hr to GMT at

midnight. The vessel arrived on station 0500Z/11th (192) and after a wire test of two double acoustic release units, CTD CD50001 was worked to 1170m in centre of Faroe Shetland Channel. All 12 multisampler bottles were fired at the bottom. All closed but two thermometer lanyards caught up. (We later discovered that we were fixing the thermometer lanyards in the wrong place).
The CTD package handled well despite the heavy sea and swell and 35kt winds. We remained on station while the water sampling was completed. The CTD conductivity sensor seemed very noisy and with a large offset and so it was changed before the next station.
An attempt was made to get the XBT system working but there appeared to be water in the launcher cable and in any case it was at that stage too dangerous to go out on deck and launch probes.

Course was set towards the start of a section across the Iceland Basin but the heavy seas prevented speeds in excess of 5 kts.
The wind abated overnight 11/12th but the heavy swell kept speeds to 8kts. The vessel stopped at 1130Z to do wire tests of releases (2 dips) in the gap between Bailey and Lousy Banks. These were completed by 1530 and course set for start of CTD section.
The CTD section (CD50002-020) was started at 1900Z. The CTD package proved easy to handle with the new steadying roller on the A frame. On CD50007 the PS2 data stream hung up on the down cast. The CTD was raised and lowered again to cover the missing data.
The PSO talked to Tom Hopkins on *R/V Alliance* at 1645Z 13th (194). *Alliance* had deployed two moorings on the Iceland Faroes Ridge. A regular radio schedule was then established with *Alliance* at 1100Z each day.

In working up the ADCP calibration run a fault was found with the gyro interface box. It was found to miss a bit and put directions passing through north as 180.
On 14th (195) the vessel stopped at 0030Z for wire tests of releases in 2200m of water at the position of CD50012. Two lowerings were completed by 0530Z.
On station CD50014 the CTD connecting wire snagged under the shackle pin as the CTD was being lifted from the deck and broke the conductor. While the termination was being remade four more acoustic releases were tested to 1200m.

The section continued up the slope south of Iceland. Station CD50018 (in about 1300m) was found to be downslope of a 50m deep channel. It was decided to do CD50019 in the channel but no anomalously cold water was found. The final CTD of the section, CD50020, in 700m was worked on the morning of 15th (196).
During the day of the 15th moorings B,C,D,E and F were deployed along the CTD line just occupied. (Details are in the mooring section and table.) Passage between moorings was slow (7kts) due to fog. The fog cleared at 1330 leaving a bright clear sunny day with southerly winds. Mooring deployment continued through the day until 2200Z with the deployment of mooring F. This last station was delayed somewhat by a hydraulic hose blowing out on the reeler of the double barrelled mooring capstan. Overnight 15th/16th the first station CD50021 of a line across the Iceland -Faroes Ridge was worked.
By 0500Z/16th the ship was in position to deploy mooring A. The vessel remained at this position to record a longer series of ADCP data and mooring deployment started at 0800Z. Mooring G, the last one was completed by 1100Z.

Course was then set for the next CTD of the line (CD50022). CTDs then continued with XBT probes inbetween. The termination of the CTD wire failed at CD50023 and had to be replaced before we proceeded. CTD stations continued throughout 16th(197) and into 17th (198).
The surface expression of the Iceland-Faroes front was crossed ca 1500z 17th. We encountered fog as we got towards the front.
The CTD section continued with adjustment of positions on the last two stations to get a better distribution of depths.
On completion of the CTDs the vessel ran south to the position on the Iceland Faroes ridge for the deployment of the ADCP mooring. The vessel arrived there at 1530Z/18th (199) in thick fog. The sea surface temperature there was very cold (5.5C). The mooring was deployed uneventfully by 1600Z. The vessel then remained in position to see the acoustic releases time out and to await good GPS coverage for fixing.

At 1700Z radio contact was made with Hopkins on *Alliance* and arranged a rendezvous arranged for a CTD

intercomparison on 64N. Prior to this a short CTD section of 5 stations CD50038-042 was worked to look for water which might have overtopped the ridge close to the ADCP mooring. The section was completed by 2330Z/18th (199) and course set to rendezvous with *Alliance*.
We worked a station within 3 cables of *Alliance* (CTD50043) 0140-0200Z/19th(200) in 490m of water. Visibility was poor (0.5 miles) and deteriorated further as we set course for the next CTD section. The fog eventually cleared and the CTD section across the continental slope south of Iceland was started at 0830Z/19th with XBTs between the first three stations. The section continued through the day in good clear weather. Some problems were encountered with the CTD deck unit hanging up when bottles were fired at the bottom of the cast. The section was completed by midnight
A series of T7 XBT drops at half-hourly intervals was then started along the 700m depth contour on the south slope of the Iceland Faroes Ridge running towards the Faroe Bank Channel. This was completed by mid morning 20th (201) and then course was set towards a repeat of Saunders line Q from Charles Darwin Cr42.

Time was by now running short and the shallowest station of the line was omitted. There was insufficient time also for the last/deepest station and instead of this the last two T5 XBTs were deployed. The section was completed by 2000Z 20th (201) and course set for the Pentland Firth.
Passage continued throughout the 21st in good weather. A further ADCP calibration run was performed west of Orkney during a period of good GPS data. The PES was recovered and course resumed towards Aberdeen.

The vessel docked in Aberdeen 0930A/22nd(203). The following day was spent with a film crew from Shell producing footage for a film on Climate Change.
WJG

REPORTS OF SCIENTIFIC WORK.
CTD Operations
During *RRS Charles Darwin* Cr 50, a total of 57 CTD stations were worked.

This was the first cruise on which the new Neil Brown CTD deck units and Rosette Multisampler deck units were used. A new 10 litre 24 bottle Rosette Multisampler was employed throughout the cruise but with only 12 bottles in alternate positions around the rosette.
The total package was made up of a NBIS MkIII CTD with dissolved oxygen sensor and a 1m path length transmissometer. These were mounted horizontally in a protective frame below the rosette. A 10kHz pinger with tilt indicator was mounted in the CTD frame.
The horizontal attitude of the CTD made it extremely easy to mount and service. Two lead weights of approximately 40kgs each were secured to the frame to help overcome the drag of the rather large package. Although the package is large, in use it proved very easy to handle. The 12 10 litre water bottles were used for most of the casts. These were mounted at alternate positions around the frame to provide a balanced package.

7 SIS digital reversing thermometers and 2 reversing pressure meters were used with the bottles.
The pairing of thermometers was changed on a number of occasions, in order to determine calibration errors. (See separate section)
Water sampling was carried out on deck with the bottles mounted permanently on the Multisampler.
During the first cast it became apparent that there was a serious problem with the conductivity cell. It was not clear if the problem was one of fouling or just failure. A new cell was fitted for the remaining casts.

The new deck units and acquisition software generally worked extremely well and were easy to use. However there was a problem on a number of occasions with the system crashing after the start of an upcast when trying to fire the first water bottle. It was believed to occur when bottles were fired too soon after the end of the down cast. Due to the method used to save the raw data, none was lost on these occasions.
The CTD and transmissometer worked throughout the cruise without fault. The pinger tilt indicators showed that the package rotates slowly during the cast but this did not create any problems.

The new articulated arrangement of the CTD A frame made handling the package both easy and safe, although weather conditions were never bad enough to really test the system. Cable loading on the 8 mm CTD wire could be a problem with the ship heaving in heavy seas.

The sea cable had to be reterminated twice during the cruise due to its snagging on the shackle at the top of the CTD.
The bottle files generated by the PS2 system were copied to disk and merged with sampled salinity and nutirient data on the Sun workstation.
After problems on the first station the stability of the replacement conductivity cell was found to be very good, providing an excellent set of data for the cruise. The high quality of the calibrations obtained were believed to be due to a combination of good sampling technique, the use of new salinity sample bottles and the new 10 litre water bottles.

CTD stations are listed on Table 1.
JS

Water sampling and salinities

Both IOS Guildline salinometers, the new and the old, were carried on this cruise in the *Charles Darwin's* constant temperature laboratory set at 20C with salinometers set to run at 21C. Both were kept up and running, but almost all sample processing was carried out on the old one, as the new one gave indications of instability at the start of the cruise. When work commenced, time did not permit the further investigation of this indication. A few checks suggested that the new one was working at least adequately, but I am not yet confident that it is as reliable as the old machine, which performed excellently, being in nearly continuous use for ten days and only wandering twice.

A total of 981 samples were processed, comprising 430 duplicate pairs of bottle samples, 72 single bottle samples and 49 surface samples from the non-toxic supply. Reproducibility between duplicates was of a high standard, with 202 pairs 0.000 different in salinity, 195 pairs 0.001 different, 24 pairs 0.002 different and 1 pair each at 0.003, 4, 5 and 6. The two worst pairs result from the salinometer's two wanderings.

I believe the quality of these results to be due to three things. Firstly, the increased frequency of standardisation: once every twelve samples (start, middle and end for a crate of 24 samples); secondly, the ten-litre GO bottles, being of large volume, make the sample water less susceptible to contamination from leaks; and thirdly, the new sample bottles. It is surprising that, considering their cheapness (79 pence per bottle), they have not been replaced earlier and more often. The old bottles with their one-piece tops were contaminated and deteriorating. The new bottles are of fine clear glass with disposable stoppers (3 pence each), ensuring a clean seal with no need to worry about cap contamination from previous samples. Unfortunately some stoppers had to be re-used, as adequate supplies were not available for this cruise. None was used more than twice on this cruise. They should be disposed of upon return and a large (ca 10,000) supply purchased soon.

Sampling was carried out on deck. A bonus from this which excluded further contamination was that the sample bottles were kept in the wet lab, separate from the GO bottles, so that they were not swimming in the spill water from the GO bottles as they would have been had the old fiddle been used. Sample bottles should be kept separate from GO bottles at all times to improve cleanliness. Furthermore, upon return, all used sample bottles will be washed clean and dried. Storing them with seawater inside for the best part of each year can only hasten deterioration and increase the risk of contamination.

With regard to standardisation, 130 ampoules of Standard Seawater batch P113 were consumed on this cruise. Some defects in the SSW must be noted here.

i. Three ampoules were seen to contain 'floaters', small specks of foreign matter, one seen after opening but two before.

ii. One ampoule had not been sealed correctly; upon opening one end, the water poured out of the other.

iii. Most worryingly, two standards were found which were way off salinity. P113 has K_{15} = 0.99984, ie a Guildline ratio of 1.99968. The old salinometer was set to read SSW at or about this value, with drifts typically of +/- 0.00010. The two suspect ampoules gave ratios of 1.99999 and 2.00050, both confirmed as wrong by immediate re-standardisation.

The changes in standardisation throughout the cruise are presented in Figure 1.
It is to be hoped that noted drifts were due to the salinometers, and not to less extremely erroneous SSW. It may be possible to use the duplicates as a check on the standardisation. This will be attempted in the near future.
Salinity determination from Guildine ratio was performed on the cruise using Ocean Scientific International's software package "Salinity". An IBM PS/2 was used to run the package.

SB

Nutrient determinations

Analyses for silicate, nitrate and phosphate were carried out on CTD water bottle samples from Stations CD50001 to CD50053 on the Alpkem RFA 300 autoanalyser and Stations CD50001 to CD50057 on the IOSDL autoanalyser. Some samples were frozen for later comparison in the Lab.

The IOSDL system worked well throughout the cruise, and we expect the primary nutrient data to be from this system. The majority of problems experienced using the Alpkem were caused by the lack of a manual for the software. Using the Help screens it was finally possible to process the data collected.

Nitrate: comparing the two systems the results agreed to within 1%. The Alpkem system worked well, especially the new type of open tube cadmium reducing reactor which needed very little attention.

Silicate: Comparing results between the two analysers the results were 3-5% different.

Phosphate: The phosphate channel on the Alpkem was not satisfactory due to problems with noise on the signal, possibly caused by the tubing or bubbles, the latter could be improved by inserting a de-bubbler before the flow-cell. The other main problem with the phosphate was drift in the baseline.

There are still some features of the system not tried out, eg. carry over corrections from one sample to the next. The phosphate channel needs to be improved and then the Alpkem will be a good system to use at sea, as each sample uses 2ml of seawater and only takes 70s to sample.

Jill S

Oxygen Determinations

During Cruise 50 it was intended to perform an intercomparison study between oxygen titration equipment supplied by UCNW Bangor and a new fully automatic unit recently purchased by IOSDL Marine Physics. Due to a fault with the stabilised power unit, it was not possible to obtain results from the UCNW equipment.

The results obtained from the Marine Physics unit were on the whole good. Some

problems were experienced with air locks trapped in the burette system which appeared to be due to a faulty seal. With practice it should be possible to reproduce results to a precision of 0.05%,which would be adequate to meet WOCE standards and allow comparison between data sets.

The equipment accuracy has also been improved since, supplied with a standard of known concentration, the unit will calculate the titre normality and so eliminate inaccuracies in calculation due to preparation of solutions.

500 samples were taken during the cruise and analysed in duplicate. The preparation and analysis time is rather long and the software supplied with the unit has space for only 100 sample bottle volumes. It was therefore only possible to have four sets of samples awaiting analysis. With the high frequency of CTD sampling it was difficult to maintain a supply of clean bottles.

The procedure should be improved by adjusting the software to accommodate a larger bottle bank and obtaining more sample bottles.

RP

Aluminium determinations

Dissolved aluminium concentrations are higher in deep waters than in intermediate waters. The source of this aluminium has not yet been identified. One proposed mechanism has been the dissolution of aluminium from particulate aluminosilicate material resuspended into waters containing low concentrations of dissolved silica in areas of strong bottom currents such as those encountered on this cruise. Aluminium has also been suggested to be a useful identifier of water masses giving additional information to that which can be gained from the traditional measurements of temperature and salinity and from nutrient determinations. The analysis of the results from the detailed sampling carried out on this cruise will allow us to determine if aluminium is a useful tracer of high latitude water masses.

Aluminium determinations were made on 357 samples of unfiltered water out of a total of 499 water samples collected on the cruise. 65 determinations were also made on samples filtered through 0.2 micron pore size filters.

The concentrations measured ranged from 75nM in unfiltered deep waters with high particle concentrations to 2nM in biologically depleted surface waters. The precision of the analyses was good on this cruise being consistently better than 0.5nM.

Concentrations are higher in the Norwegian Sea than in the Iceland Basin at 1000m water depth. Contouring of the concentrations shows a distribution that follows the density distribution across the Iceland-faroes Ridge. Concentrations in the Iceland Basin correspond closely with those determined at the Southern end of this basin on the BOFS-3 cruise in 1989. Dissolved concentrations are markedly higher in waters with high suspended matter concentrations in deep water. However the suspended matter in these waters contains aluminium which is detected by the fluorometric determination used. (This is not the case in surface waters with high suspended matter concentrations, and most previously reported determinations of aluminium in deep sea waters have been done on unfiltered samples). The aluminium concentration increases more rapidly close to the bottom than does the silica concentration. This suggests that there is some dissolution of aluminium taking place in the nepheloid layer rather than the increase being due to a change in the identity of the water mass.

DJH

Digital reversing thermometers

The SIS digital reversing thermometers and pressure meters were paired on four of the twelve bottles used. For the most part there were pressure determinations at the maximum depths reached and temperatures determined at the top, bottom and two intermediate depths. Pairings of thermometers were changed throughout the cruise to enable intercomparisons to be made. The levels chosen for firing the bottles tended to be selected on the basis of providing good vertical distributions of nutrient data rather than for being in areas of low vertical temperature gradient.

Table 2 shows difference between pairs of digital thermometers, corrected using the manufacturer's calibration data. Only 3 pairings show offsets significantly different from zero (401-220, 400-220, 238-204). Comparisons with data from other pairs does not allow one to conclude that any particular thermometer calibration is in error but suspicion falls on 220 and 204.

Table 4 shows the difference between the pressure meters and the CTD. 204 shows a large but not statistically significant offset, as also do 398 and 401. Again thermometer errors cannot be unambiguously identified.

Table 4 shows the difference between the pressure meters and the CTD. These in each case demonstrate a pressure (or possibly temperature) dependence.

WJG, MW

XBT measurements

The cruise was the first on which the Hydrographic department's XBT system was used. It consists of a Bathysystems SA-810 XBT unit interfaced to a Zenith personal computer and with a satellite data link to the Meteosat satellite.

The recording unit was installed in the plot, abaft the bridge, and communication between the plot and the afterdeck was by means of portable VHF sets. This proved less than satisfactory since there were a number of "dead" spots in the plot from which communication was difficult. The recorder was connected to a Plessey plug mounted on the after external bulkhead of the main lab. Initially there were a number of probes which failed to record good data due to an apparent earth leak on the hand held launcher. After this had been replaced there were few failures. We noted an number of problems with the XBT software:

The timeout period between setting up the recording unit and having to launch a probe is too short for a vessel on which the recorder and launcher are so far from oneanother.

More seriously the algorithm for coding the JJXX satellite message ignores information input to the program which specifies a depth at which the probe hit bottom and below which date are in error. This resulted in apparently subbottom data with spurious temperatures being transmitted.

Towards the end of the cruise a considerable number of probes were dropped close to the 700m contour on the south side of the Iceland Faroes Ridge. A comparison of indicated bottom depth from the XBTs (Plessey T7s) and the corrected depth determined from the echo sounder showed that the XBT depths were shallow by 37.4±6.6m. An analysis of the data for probes used in shallower water depths suggests that a linear relationship between zero error at the surface and 40m at 700m would nowhere be in error by more than ±10m. In all cases probes were dropped with the ship speed between 8 and 12 kts.

Details of all XBT drops are given in Table 5: Fig. 2 shows the observed depth errors (True depth - XBT depth) .

WJG

Ship mounted ADCP

A vessel mounted ADCP (RDI, 150kHz) was run between 1800Z/181 and 1900Z/182 prior to the rudder repairs and from 1753A/190 until 2359Z/202. Three configurations were used
a) bottom tracking in depths less than 200m
b) bottom tracking in depths to 800m
c) water tracking

During the cruise regular notes were made of clock error with respect to the vessel's master clock. The ADCP clock was reset every 2.5 days (approx) when the error reached of order 1 minute. Checks of the ADCP temperature against the ship's hull temperature sensor showed there to be good agreement. Checks were also made against the ship's gyro-compass. Heading differences of 1 or 2 degrees were seen at times .

Data were collected in 2 minute ensembles, transferred in 24 hr segments to RVS data files and thence into the Sun Pstar system. At this stage a number of operations were carried out on the data:-

a) water track and bottom track segments were separated
b) velocity units were converted to cm/s
c) header information was input
d) times were corrected for clock error and converted to seconds
e) missing data values were converted from 1999 to -999
f) data with % good less than 25% were set to absent data
g) the data were corrected with a pointing angle and scaling factor.

These last corrections were derived fom calibration runs carried out using the method of Read and Pollard (see narrative section). The two calibration exercises produced rather different and noisy values for A and phi as follows :-

Day 191 A = 1.011 Phi = 0.652
Day 202 A = 1.122 Phi = 0.016
When the vessel was on station during CTDs, wire tests and mooring deployments, time series of data were identified and plotted. It had been hoped to collect ADCP data on station and over complete tidal cycles near temporarily deployed current meter moorings but the loss of time with rudder problems precluded this. All data files were archived for later processing at IOSDL.

KM

Mooring Operations

Seven current meter moorings with 13 Aanderaa current meters were deployed S.E of Iceland for a period of one year in water depths ranging from 1027-2305m. The mooring positions were in deeper water than had been planned in light of the results from a CTD survey to detect the cold water overflow.

An Acoustic Doppler Current Profiler (ADCP) mooring was deployed at 64 23.8N ,11 55.7W which is to be recovered on Charles Darwin 51.

All Aanderaa current meters had been overhauled and calibrated at IOSDL prior to the cruise and cold tests carried out to ensure correct operation at expected working temperatures. Fins were overhauled and fitted with titanium spindle assemblies in an attempt to overcome corrosion problems experienced during previous one year-long deployments. The ADCP and S4 current meter were provided by RVS and were already prepared and working when received.

Mooring deployments were carried out using the RVS portable double barrel capstan (DBC) winch with the line leading over a snatch block attached to the hook on the starboard Effer crane. The Effer cranes on the stern are a recent addition to the Charles Darwin and provide an excellent alternative to the A frame for mooring deployment/recoveries. A length of 13mm chain was also attached to the hook to "stop off" the mooring line as required.

The Aanderaa current meter moorings were all deployed anchor first and the line stopped off as required for instrument insertion. Difficulties were experienced with the haul/veer control on the DBC when minor adjustments were required but generally all deployments were straightforward. It is recommended that in future the DBC drums should not be painted so as to improve traction.

The ADCP mooring was deployed ADCP first, the method dictated by the construction of the buoyancy package. All lines and instruments were preassembled on deck prior to deployment, with the release and Aanderaa current meter suspended from the block and secured by the line to the DBC. The ADCP and S4 current meter were lowered to the waterline on the port Rexroth winch, cut away and allowed to drift astern as the ship increased speed to 1.5-2 knots. The glass spheres were lowered by hand as the line tightened and the tension was finally taken by the DBC, allowing the release and current meter to be lowered away. Finally the anchor was fitted and cut away at the waterline.

Mooring details are given in table 6.

KG

Mooring Acoustics

Seven moorings were to be deployed for at least one year. Over the last fifteen years about one long term mooring a year has `vanished', that is, no acoustic contact has been made with the acoustic release and relocation unit. In view of this and the age of current release stocks, one third over eight years old and one third brand new, I decided to double up acoustic units on each mooring. The proposed mooring depths ranged smoothly from 200 metres to 2350 metres and so I planned to deploy four pairs using `shallow ceramic ring' acoustic transducers and three pairs using `deep mushroom' acoustic tansducers. The physical oceanography of the area dictated a last minute change of plan to a deeper deployment pattern. With no time to prepare extra deep units I altered the pairings so that two of the moorings that were marginal for shallow transducers were covered by a transducer of each type.

My original intention of using transponders to mark two of the moorings was frustrated by the destruction of one set of electronics by a faulty Lithium cell. This is the second known failure of a cell of this type (Crompton Parkinson G20) in recent months. It is particularly worrying as this cell is used in the acoustic release battery pack although no known failures have occurred in the ten years we have been using them in that application.

A short term (four to six weeks) deployment of a mooring carrying an acoustic doppler current meter, an electromagnetic current meter, and a conventional rotor current meter was proposed. As the total value of this rig was about [[sterling]]100,000 I decided to pair both the IOS type acoustic units provided by RVS for this mooring. On inspection of the electronics it was obvious that neither unit had been adjusted from new. Both units required significant adjustment before I was happy to deploy them.

A very short term mooring (multiple deployments of 12 to 14 hours) was proposed .This was covered by the spare units prepared and tested for the long term moorings.

The acoustic units were wire tested at about their proposed operating depth and temperature in groups of four on six deployments. One new unit required three tests before I was happy with it, five other units required a second test after adjustment.

All Releases were fitted with two pyroleases.

GP

Simrad Precision Echosounder

This unit was run throughout the cruise mainly in a passive `Pinger' mode using the hull mounted acoustic transducer. I will be reviewing the system further on Discovery Cruise 194; these are my impressions so far.

Generally the three parameters controlling receiver gain are far too complex; two of them could be locked to maximum values for most cruises and gain controlled in simple 3db steps using the third. I have not yet played with the external triggering mode.

1. As a passive monitor it worked well. The ability to use either the VDU or the printer as an expanded window is potentially very useful.
There are two major drawbacks.

a) The scale the output is drawn on both VDU and printer is not controlled by the input sound velocity profile as far as I can see. They both appear to be scaled to the default 1472 metres per second - this is not acceptable.
b) The signal appears to be sampled only one in seven sweeps; that is two seconds in every fourteen. This is unacceptable for most monitoring work, particularly close bottom approach work.

2. As an echosounder also monitoring pingers - essential for all bottom and near bottom approach work - it's sophistication is it's downfall.

a) It can be made to repeat at a precision rate but this involves setting a rate longer than the expected bottom reply. In deep water this can be ten seconds so setting a two second window to monitor a pinger with reasonable resolution involves only sampling one sweep in five - this is unacceptable.
b) If the software detects a signal of similar amplitude to the expected bottom echo it spends time analysing it and then locks on to it's preferred source. During this time it loses it's precision timing and so all signals are scrambled - this is unacceptable. When it relocks it starts a new sequence so all pinger signals are displaced. It will also then track the pinger signal as the depth so the digital reading will be wrong although the true bottom echo will be obvious to the observer and readable from the scale lines. The resolution readable to the unaided eye on a 1500 metre display is 10 metres at best - this is not really acceptable.
c) Removal of TVG from echosounding mode appears to have resulted in a monochrome (red) display. This reduces the dynamic range of the display and therefore an easy to use gain control is required.

GP

Level A/B/C computing

Data was logged from the following systems:-
Em log - no problems.
Gyro - when sailing north the synchro output from the gyro produced spurious readings when swinging from 0 to 360 degrees and back. It is thought that the stators need adjusting or cleaning. This will have to wait until suitably skilled staff can attend the vessel.
MX1107 - no problems although it was noticed that the bridge officers frequently relied on the MX1107 in preference to the GPS. The provision of a Navigation Display Unit for the GPS is needed particularly now cover is improving.
GPS - North of about 60N GPS gives almost continuous cover with 3 or more satellites in view for all but two short periods each day. Statistical analysis of GPS data from periods in port have revealed that despite the rubidium frequency standard, fixes derived from 2 satellites are significantly worse than those derived from 3 or more satellites. The degradation now applied to the GPS data gives typical errors of about 45m. in latitude and 95m. in longitude.
The Level A itself developed a fault on the local terminal output and this, together with the occasional spontaneous reset, may mean it is prudent to replace the hardware for the next cruise.
TSG103-no problems.
CTD-no problems.
ADCP - Logged directly into the parser SUN 3/60. This suffered from the same synchro gyro problem mentioned above.
Plot Network (Cambridge Ring) Server.
This has an intermittent fault that has as yet not been traced. There is a spare available for the next cruise.
Level B performed well with no crashes.
There were no problems with the level C but some of the ASCII terminals are showing symptoms of age. The bulk of the processing was done in Pstar. The transfer between RVS data file and Pstar (datapup) was initially a problem but advice from colleagues on Discovery during a routine radio schedule solved most of the difficulties.

RBL

PSTAR Data Processing

The on board Sun Microsystem network was loaded with the Pstar library which was compiled and used successfully throughout the cruise.
The problems encountered on Discovery 189 with tape archiving were not present and around 200Mb of data have been archived to tape and brought back to IOSDL.

The RVS program DATAPUP caused some difficulties. The program transfers data from RVS level C to IOSDL Pstar format. The problem arose when a file was left open after being written to by an instrument. It was assumed that in leaving the file open the file pointer was not sure of its exact position and so transferred no data. When files were closed after being written to the problem disappeared.
The processing of CTD data from the 57 stations on Darwin 50 was similar to that used on Discovery 189. Differences in processing were mainly caused by the introduction of the new CTD deck unit which made part of the old data route redundant.

The processing was therefore mainly accomplished using the existing execs (an exec is a collection of Pstar programs that run together in sequence).
CTDEXEC0 reads in the data from an RVS file. This sometimes caused problems from the program datapup.
CTDEXEC1 performed a calibration on the data. Three calibration files were used throughout the cruise with modifications being made to the pressure and conductivity calibration values
CTDEXEC2 was used to extract the down cast from the ctd station.
CTDEXEC5 was modified to produce less derived variables and averaged the data on 2db intervals.

Considerable time was spent on working through the method used on Discovery 189 (CTDEXEC4) to correct the salinity values but because of time restrictions this was left until the return to IOSDL. Potential temperature against salinity was plotted for each CTD station. The data was gridded and plotted in sections for temperature, salinity and sigma. The sections were plotted out as below.

Stations	Calibration file no.	No of stations
CD50001	1	1
002-020	1	19
021-037	1	17
038-042	2	5
043	2	1
044-053	3	10
054-057	3	4

The data was archived all the way through the process. The full data processing route for each station is as below :-

CTDEXEC0- archived copy- CTDEXEC1- archived copy- CTDEXEC2- archived copy- CTDEXEC5- archived copy- griddded into sections

The method used on Darwin 50 for the display of nutrient data is different to that used on any previous cruise mainly because of the introduction of the new CTD deck unit.

For each CTD cast the deck unit creates a "bottle" file. This file contains a header. The header contains a unique label for each CTD station, the geographical position and the time of the cast. The file also contains CTD data from each of the sensors averaged about the time at which a bottle was fired. It has one such line for each bottle firing. For example in normal use the bottle file had 24 lines, one for each space in the rosette whether it had a bottle in it or not. A misfire when trying to close a bottle would appear as an extra line of data in the bottle file.
Each bottle file was edited using the Sun microsystem screen editor. The header was deleted as were any lines of data that did not correspond to a bottle on the rosette sampler. The variables that were not used in Darwin 50 (eg fluorescence) were deleted. There then remained a bottle file that just consisted of the following 8 variables

Salinity- Bottle number- Oxygen Current- Pressure- Oxygen temperature- Temperature- Dissolved oxygen- Conductivity.

The next stage was to bring in the nutrient data, the bottle determined salinity and dissolved oxygen. Using the hydrographic log sheets and the unique sample number that was used on this cruise for each bottle, it was a simple matter to piece the correct sample data to the correct line in a bottle file using the basic Sun editor facilities (cut, copy,paste)
Each bottle file now contained 16 variables in an ASCII file:-

Bottle number- Sample Number- Pressure- Sample O2- Temperature- Sample salinity- Conductivity- Aluminium- Salinity- Filtered aluminium- Oxygen current- Nitrate- Oxygen temperature- Phosphate- Dissolved oxygen- Silicate

This file was read into Pstar format using the Pstar program PASCIN, thus creating one Pstar file for each CTD station. Once in this format it was easy to grid and plot the nutrient data in a similar form to that used in the CTD sections. Although this was a simple part of the processing it was extremely time consuming and hopefully the more experienced personnel on Darwin 51 will come up with a less time absorbing way of displaying nutrient data.

As the files created using the method above contained a raw conductivity value and a bottle salinity value (assumed to be correct), a new value for the conductivity could be calculated. This new conductivity value could then be divided by the old value to derive a ratio. This ratio is called the corrected conductivity ratio and is used in the CTD calibration files (see ctdexec1). A Pstar program was written to work out this corrected conductivity ratio (CRAT.F), and write the results to a file. The file was then analysed by calculating a mean and standard deviation of the conductivity ratios to see just how the conductivity ratio changes with time. At sea this was only done on the first 20 stations, but showed that the previously used conductivity ratio of 0.99987 was wrong and a much better value would in fact have been 1.0002. The calibration file in CTDEXEC1 was changed on the basis of this result. It was felt that the results showed promise but as with the nutrient data the main problem was a time consuming method of getting to them.

MAB

ACKNOWLEDGMENTS

This cruise was severely disrupted by problems with the vessel's rudder which necessitated three unscheduled port calls and two periods in dry dock; all this before any work had been done. It says much for the forbearance of all the ship's personnel, scientists, officers and crew that so much was achieved in the remaining ten working days.

TABLE 1
CTD Station list

Consecutive Number	Time Down z	Day/ Date 1990	Lat N	Lon W	Water depth m	Closest Approach m	Comments
1	0845	192(11-7)	60 10.5	6 03.8	1212	33	FS1 All bottles fire
2	1940	193(12-7)	60 29.0	12 41.9	405	14	IB1
3	2118	193(12-7)	60 33.7	12 53.1	602	7	IB2
4	2319	193(12-7)	60 39.0	13 03.0	1045	16	IB3
5	0125	194(13-7)	60 44.2	13 13.2	1440	15	IB4
6	0351	194(13-7)	60 50.3	13 25.8	1667	18	IB5
7	0627	194(13-7)	60 55.1	13 36.2	1675	10	IB6
8	1001	194(13-7)	61 07.9	14 06.5	1759	7	IB7 Computer crash c
9	1355	194(13-7)	61 23.3	14 35.6	2070	15	IB8
10	1812	194(13-7)	61 36.3	15 6.8	2157	1	IB9
11	2158	194(13-7)	61 49.7	15 36.1	2290	14	IB10
12	0714	195(14-7)	62 03.7	16 03.6	2218	8	IB11
13	1033	195(14-7)	62 17.8	16 18.9	2120	13	IB12
14	1540	195(14-7)	62 30.0	16 33.7	2065	9	IB13
15	1825	195(14-7)	62 41.3	16 47.4	1830	8	IB14
16	2043	195(14-7)	62 48.3	16 54.1	1675	9	IB15
17	2312	195(14-7)	62 54.0	17 00.9	1550	9	IB16 depth approxima
18	0150	196(15-7)	63 00.4	17 08.1	1297	13	IB17
19	0432	196(15-7)	63 12.6	17 12.6	1322	8	IB18
20	0714	196(15-7)	63 12.0	17 22.1	660	10	IB19
21	0020	197(16-7)	62 10.4	15 31.8	2222	8	T1
22	1425	197(16-7)	62 19.2	15 04.0	2030	12	T2
23	1827	197(16-7)	62 28.0	14 38.9	1761	8	T3 Second attempt af
24	2132	197(16-7)	62 37.9	14 10.1	1465	8	T4
25	0026	198(17-7)	62 47.0	13 41.6	1120	15	T5
26	0302	198(17-7)	62 56.6	13 14.3	820	7	T6
27	0520	198(17-7)	63 05.6	12 46.6	535	6	T7
28	0723	198(17-7)	63 14.2	12 19.6	435	10	T8
29	0945	198(17-7)	63 23.1	11 52.0	410	5	T9
30	1210	198(17-7)	63 33.2	11 24.9	322	7	T10
31	1412	198(17-7)	63 42.1	10 55.8	385	5	T11
32	1621	198(17-7)	63 51.5	10 27.0	518	8	T12
33	1827	198(17-7)	63 59.9	10 00.5	646	8	T13
34	2043	198(17-7)	64 09.1	09 31.5	890	6	T14
35	2308	198(17-7)	64 18.3	09 02.6	1010	12	T15 Computer crash a
36	0143	199(18-7)	64 27.5	08 31.3	1040	12	T16
37	0415	199(18-7)	64 31.6	08 19.0	2380	10	T17
38	1840	199(18-7)	64 22.1	12 27.3	243	11	C1
39	1947	199(18-7)	64 19.3	12 18.7	465	8	C2
40	2057	199(18-7)	64 16.2	12 10.5	446	7	C3
41	2213	199(18-7)	64 13.0	12 02.8	425	7	C4
42	2319	199(18-7)	64 10.0	11 54.6	383	7	C5
43	0147	200(19-7)	64 01.4	12 24.7	490	7	Alliance intercompar
44	0837	200(19-7)	63 42.9	14 24.0	310	9	O1
45	0941	200(19-7)	63 42.2	14 22.1	700	10	O2
46	1121	200(19-7)	63 37.0	14 15.9	1180	14	O3
47	1315	200(19-7)	63 30.7	14 08.0	1415	10	O4 No O_2 samples
48	1512	200(19-7)	63 25.3	13 59.0	1337	7	O5
49	1706	200(19-7)	63 19.7	13 49.9	1305	7	O6
50	1903	200(19-7)	63 14.1	13 41.2	1190	7	O7

51	2044	200(19-7)	63 08.1	13 32.2	1005	9	O8	
52	2224	200(19-7)	63 02.4	13 23.2	890	8	O9	
53	2359	200(19-7)	62 56.5	13 15.0	825	10	O10	Repeat of T6
54	1333	201(20-7)	61 53.6	09 05.3	585	10	Q5	
55	1503	201(20-7)	61 48.8	09 16.7	730	12	Q4	
56	1708	201(20-7)	61 43.7	09 26.1	860	10	Q3	
57	1853	201(20-7)	61 38.7	09 36.9	1000	37	Q2	High shear near

Note depths are as recorded by the ship's PES. Sound speed is assumed at 1500m.sec^{-1}.
Designation T4 indicates 4th station on section T (see Figure 3).

TABLE 2

Differences between pairs of digital reversing thermometers (mK x 1000)

Pair of Thermometers	Number	mean	Standard deviation	Standard error
400-398	7	-0.83	3.4	1.29
401-238	9	-0.143	2.27	0.76
220-204	7	1	5.35	2.02
399-238	7	-1.29	3.73	1.4
398-238	14	2.36	2.3	0.61
401-220	4	6.25	0.96	0.48
401-400	23	1.43	4.98	1.04
400-220	15	6.6	3.29	0.85
238-204	8	6.25	3.5	1.24
399-398	8	0.375	1.92	0.68
399-204	8	3.75	10.95	3.87

TABLE 3

Differences between digital reversing thermometers and CTD (DRT-CTD) mK x 1000

Thermometer	Number of samples	mimimum	maximum	mean	Standard Deviation	Standard error
204	21	-50	8	-6.63	12.44	2.71
220	37	-44	43	-0.96	14.7	2.42
238	33	-60	54	-0.55	22.95	3.98
398	21	2	44	12.35	11.69	2.55
399	23	-32	21	-0.99	13.88	2.89
400	37	-31	31	3.73	10.26	1.69

TABLE 4

Differences between CTD and digital pressure meters

6132H	P<500	500<1000	1000<1500	P>1500	overall
mean	0.5	1.4	4.6	7.2	3.2
standard deviation	2.1	1.6	2.6	0.8	2.0
number	10	13	14	7	44
				(965 +/- 185)	

6075S	P<500	500<1000	1000<1500	P>1500	overall
mean	-3.6	-1.1	3.0	2.8	0.7
standard deivation	2.0	2.6	3.6	6.2	4.0
number	7	12	12	11	42
				(1135 +/- 185)	

TABLE 5
XBT Station list

Seq No	File No	Day/ Date	Time z	Lat N	Long W	Max Depth m	Water Depth m	Probe No
1	test							
2	test							
3	Weight dropped off probe						plx043441	
	73A	192(11-7)	2049	60 19.0	08 00.0	692	740	plx042444
4	74a	193(12-7)	0444	60 21.0	09 42.0	***	1060	plx043442
5	75a	193(12-7)	1511	60 26.0	11 27.0	***	1210	plx043445
6	56a	Failed, wire blew onto ship						
7	77a	Noisy						
	77b	Noisy						
	77c	Test probe	Changed launcher					
8	58a	197(16-7)	1600	62 23.9	14 51.9	***	1900	208178
9	59a	197(16-7)	2002	62 33.4	14 24.4	1645	1628	208185
10	510a	197(16-7)	2300	62 42.0	13 56.0	1305	1265	208180
11	511a	198(17-7)	0201	62 53.2	13 25.6	968	955	208188
12	712a	198(17-7)	0415	63 01.5	12 58.2	612	650	????
13	713a	198(17-7)	0622	63 10.3	12 33.2	440	470	plx043448
14	Failed at 50m							
15	u/s							
16	716a	198(17-7)	0838	63 18.9	12 02.8	381	410	plx04377?
17	Fouled ship							
18	718a	198(17-7)	1114	62 28.7	11 36.4	352	373	plx043484
19	719a	198(17-7)	1315	63 39.3	11 11.1	335	345	plx043483
20	720a	198(17-7)	1517	63 46.8	11 40.1	444	465	plx043481
21	721a	198(17-7)	1725	63 13.4	10 14.7	540	585	plx043482
22	722a	Suspect data					plx043478	
	722b	198(17-7)	1946	64 04.7	09 45.9	***	800	plx043478
23	523a	198(17-7)	2202	64 14.9	09 14.4	976	975	208189
24	724a	Noisy					plx043480	
	724b	199(18-7)	0024	64 23.1	08 46.9	***	1090	plx043485
25	725a	200(19-7)	0859	63 42.6	14 23.0	462	500	plx043704
26	526a	200(19-7)	1013	63 41.5	14 20.5	993	970	208182
27	727a	201(20-7)	0058	63 00.5	13 04.6	646	700	plx043703
28	728a	201(20-7)	0129	62 57.7	12 54.4	617	650	plx043698
29	729a	201(20-7)	0159	62 54.2	12 45.4	632	677	plx043702
30	730a	201(20-7)	0229	62 51.9	12 35.6	683	696	plx043701
31	731a	201(20-7)	0259	62 49.6	12 25.2	652	691	plx043700
32	732a	201(20-7)	0329	62 47.2	12 13.5	652	689	plx043699
33	733a	201(20-7)	0359	62 44.9	12 02.7	648	694	plx043690
34	734a	201(20-7)	0429	62 42.5	11 51.7	651	695	plx043694
35	735a	201(20-7)	0500	62 40.1	11 40.6	658	690	plx043693
36	736a	201(20-7)	0529	62 37.8	11 29.8	640	687	plx043443
37	737a	201(20-7)	0559	62 35.5	11 18.8	654	685	plx043697
38	738a	201(20-7)	0629	62 33.1	11 08.0	657	700	plx043695
39	739a	201(20-7)	0659	62 30.7	10 56.8	642	685	plx043562
40	740a	201(20-7)	0729	62 27.6	10 47.2	640	670	plx043563
41	741a	201(20-7)	0759	62 23.7	10 38.9	640	680	plx043564
42	742a	201(20-7)	0830	62 19.9	10 30.3	700	745	plx043572
43	743a	201(20-7)	0902	62 18.0	10 18.6	736	790	plx043571
44	744a	201(20-7)	0930	62 18.3	10 07.0	690	735	plx043565
45	745a	201(20-7)	1000	62 17.4	09 55.7	643	685	plx043568
46	746a	201(20-7)	1030	62 15.0	09 44.7	615	660	plx043569
47	547a	201(20-7)	1940	61 36.3	09 40.3	1060	1038	208181
48	548a	201(20-7)	2002	61 34.2	09 40.3	1085	1060	208183

Water depth is measured by the ship's PES with an assumed velocity of 1500 m/s.
*** indicates probe did not hit bottom.

TABLE 6

Mooring Deployments

(Note... All depths are measured at 1500m/s and uncorrected for sound speed profile.

MOORING A   61 44.3N   15 23.9W   2290m

DEPLOYMENT	COMMENCED	0810Z	16/07/90
	COMPLETED	0823Z	16/07/90

ON BOTTOM 0837 16/07/90

CR2462 1.10 314-322/355-362
TRANSPONDER

ACM 7948	1 HR SAMPLE 8 RPC		
	1ST DATA	1200Z	09/07/90
	ROTOR FREE	O812Z	16/07/90
	IN WATER	0816Z	16/07/90

MOORING B 63 08.6N 17 17.8W 1027m

DEPLOYMENT	COMMENCED	0833Z	15/07 90
	COMPLETED	0848Z	15/07/90
	ON BOTTOM	0855Z	15/07/90

CR 2512 1.10 315-320/355-362
CR 2523 1.02 312-325/256-265

ACM 3727	1 HR SAMPLE 8 RPC		
	1ST DATA	1200Z	09/07/90
	ROTOR FREE	0841Z	15/07/90
	IN WATER	0841Z	15/07/90

MOORING C 62 59.91N 17 06.54W 1300m

DEPLOYMENT	COMMENCED	1044Z	15/07/90
	COMPLETED	1055Z	15/07/90
	ON BOTTOM	104Z	15/07/90

CR 2521 1.08 313-327/434-449
CR 2522 1.06 312-326/453-467

ACM 5205	1 HR SAMPLE 8 RPC		
	1ST DATA	1200Z	09/07/90
	ROTOR FREE	1047Z	15/07/90
	IN WATER	1047Z	15/07/90

MOORING D 62 43.1N 16 49.2W 1800m

DEPLOYMENT	COMMENCED	1405Z	15/07/90
	COMPLETED	1438Z	15/07/90
	ON BOTTOM	1449Z	15/07/90

CR 2520 1.12 316-323/415-424
CR 2400 0.94 312-322/333-343

ACM 6867	1 HR SAMPLE 8RPC		
	1ST DATA	1200Z	09/07/90
	ROTOR FREE	1430Z	15/07/90
	IN WATER	1433Z	15/07/90

ACM 3726	1 HR SAMPLE 8RPC		
	1ST DATA	1200Z	09/07/90
	ROTOR FREE	1417Z	15/07/90
	IN WATER	1433Z	15/07/90
ACM 2107	1 HR SAMPLE 8RPC		
	1ST DATA	1200Z	09/07/90
	ROTOR FREE	1406Z	5/07/90
	IN WATER	1410Z	15/07/90

MOORING E 62 26.38N 16 28.25W 2055m

DEPLOYMENT	COMMENCED	1723Z	15/07/90
	COMPLETED	1800Z	15/07/90
	ON BOTTOM	1815Z	15/07/90

CR 2519 1.14 314-325/295-305
CR 2385 1.04 314-322/336-345

ACM 6225	1 HR SAMPLE 8RPC		
	1ST DATA	1200Z	09/07/90
	ROTOR FREE	1752Z	15/07/90
	IN WATER	1755Z	15/07/90
ACM 2108	1 HR SAMPLE 8RPC		
	1ST DATA	1200Z	09/07/90
	ROTOR FREE	1738Z	15/07/90
	IN WATER	1740Z	15/07/90
ACM 7945	1 HR SAMPLE 8RPC		
	1ST DATA	1200Z	09/07/90
	ROTOR FREE	1724Z	15/07/90
	IN WATER	1725Z	15/07/90

MOORING F 62 03.8N 16 03.3W 2235m

DEPLOYMENT	COMMENCED	2113Z	15/07/90
	COMPLETED	2136Z	15/07/90
	ON BOTTOM	2154Z	5/07/90

CR 2557 1.00 316-323/453-467
CR 2499 1.12 315-324/374-386

ACM 8011	1 HR SAMPLE 8RPC		
	1ST DATA	1200Z	09/07/90
	ROTOR FREE	2118Z	15/07/90
	IN WATER	2132Z	15/07/90
ACM 3624	1 HR SAMPLE 8RPC		
	1ST DATA	1200Z	09/07/90
	ROTOR FREE	2115Z	15/07/90
	IN WATER	2118Z	15/07/90

MOORING G 61 49.9N 15 37.4W 2305m

DEPLOYMENT	COMMENCED	1000Z	16/07/90
	COMPLETED	1022Z	16/07/90
	ON BOTTOM	1043Z	16/07/90

CR 282 1.04 313-322/353-366
CR 2417 1.18 314-326/394-405

ACM 2109	1 HR SAMPLE 8RPC		
	1ST DATA	1200Z	09/07/90
	ROTOR FREE	1010Z	16/07/90
	IN WATER	1017Z	16/07/90

ACM 4738	1 HR SAMPLE 8 RPC		
	1ST DATA	1200Z	09/07/90
	ROTOR FREE	0958Z	16/07/90
	IN WATER	1005Z	16/07/90

ADCP MOORING 64 23.8N 11 55.7W 435m

DEPLOYMENT	COMMENCED	554Z	18/07/90
	COMPLETED	1600Z	18/07/90
	ON BOTTOM	1603Z	18/07/90

CR 2465 1.02.316-322/356-362
CR 2490 1.04 317-324/236-243

ACM 7401	10MIN SAMPLE 4 RPC		
	1ST DATA	1630Z	17/07/90
	ROTOR FREE	1547Z	18/07/90
	IN WATER	1600Z	18/07/90

Figure 1
Changes in Salinometer Standardisation during Cruise 50
SHOW FIG1
Figure 2
XBT depth errors (True-XBTdepth) on cruise 50
SHOW FIG2
Figure 3
Track chart showing positions of CTD sections
RRS Charles Darwin
Cruise 50 29 Jan - 22 Jul 1990
Track Chart showing positions of CTD sections: each section is designated with a letter or letter pair (see also table 1).
SHOW FIG3

END