Cruise Report
Challenger 123B/SES4B

by

K. J. Jones
Principal Scientist

Centre for Coastal and Marine Sciences
Dunstaffnage Marine Laboratory
PO Box 3
Oban, Argyll, PA34 4AD
Scotland

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1. Objectives

1.1 General Objectives of SES

The LOIS Shelf Edge Study (SES) Objectives are:

a) to identify the time and space scales of ocean -shelf momentum transmission and to quantify the contributions to ocean-shelf water exchange by physical processes;

b) to estimate fluxes of water, heat and certain dissolved and suspended constituents across a section of shelf edge with special emphasis on net organic carbon export from and nutrient import to, the shelf;

c) to relate sediment properties and fluxes to the physical context;

d) to quantify organic carbon cycling in shelf edge sediments;
to incorporate process understanding into models which will be tested by comparison with observations and provide a basis for estimation of fluxes integrated over time and the length of the shelf edge.

These SES objectives are being pursued by measurements at the shelf edge west of Scotland, and by the development of numerical models representing physical processes and microbiology. The overall plan for measurements includes an initial seabed survey, maintenance of moorings from spring 1995 to summer 1996, seasonal measurements of distributions , coring tracking of drogued buoys and remote sensing.. RRS Challenger cruise 123 is the fourth of a sequence of seven planned SES cruises at intervals of 13 months.

1.2 Specific Objectives for Challenger 123B/95

a) To measure (i) the variation in concentration of suspended particulate matter (SPM) at the shelf edge over a range of spatial and temporal scales using a CTD-mounted optical beam transmissometer (ii) to determine the settling velocity SPM using the UWB sediment velocity tube samplers and (iii) determine the composition, size and by analysis of water samples.

b) To determine long- and cross-slope variability in the vertical distribution of dissolved inorganic nutrients in the SES area.

c) (i) To determine dissolved organic carbon distributions from the LOIS (SES) South and North transects across the Hebridean Shelf using a high temperature catalytic oxidation technique (HTOC). (ii) To field test the coupled *Shimadzu 5000 - Antek 705D* system for the simultaneous determination of HTCO-DOC & total dissolved nitrogen (TDN).

(iii) To preserve water samples from the LOIS (SES) South transect, to compare determinations of HTCO DOC & TDN made in the laboratory and the field. (iv) To collect and preserve surface and bottom waters from a deep station(>1500 m) to be used as running standard in the laboratory.

c) (i) To determine the vertical and horizontal distribution of phytoplankton chlorophyll *a* in the SES area using CTD-mounted fluorometers and continuous fluorometric monitoring of surface waters. (ii) To determine the composition of phytoplankton communities by means of taxonomic analysis and size-fractionation. (iii) To determine parameters describing the photosynthesis v irradiance (P:I) characteristics of algal populations in the surface mixed layer using ^{14}C assimilation experiments in a light-gradient incubator

d) To determine variation in the distribution of trace metals across the shelf break in the SES area.

e) To measure naturally-occurring, particle reactive radionuclides in the water column and shelf sediments to determine the fate of particles, and in particular those of biogenic origin.

f) (i) To measure rates of sediment oxygen consumption and anaerobic sulphate reduction in sediments from the Hebridean slope. (ii) To obtain samples for investigation of sediment biogeochemical properties, radio- and stable isotope distributions. (iii) To determine meiofaunal content of sediment cores.

g) To obtain photographs of the sea-bed at all coring stations using the Bed-Hop Camera system.

h) To release 21 instrumented drogues in the SES area to investigate dispersion processes at the shelf break.

i) (i) To deploy a bottom mounted ADCP at S400 and recover a surface marker buoy from S700. (ii) To recover a meteorological buoy from S140.

2. Narrative

30/11/95 After delayed docking of RRS Challenger, due to engine power failure at the end of Leg A, unloading of equipment from the previous leg did not commence until 0800, 24 h later than scheduled . All gear from Leg A had been unloaded by midday and by 1700 gear for Leg B was on board. Faced with a poor forecast for the next 3 days with an unlikely prospect of being able to steam directly to the working area the decision was taken to delay sailing until 0800 the next day giving the opportunity for installation of the autoanalyzer, DOC analyzer and other equipment in calm conditions. All gear was secured by 2045.

1/12/95 RRS Challenger sailed from Ardrossan at 0800 and the pilot disembarked at 0912. Course was made for a position in the outer part of Loch Foyle. The non-toxic system was

switched on at 0925 and underway sampling commenced shortly after at 1010. A general cruise briefing meeting and emergency drill took place on route. The ship hove to in the entrance to Loch Foyle at 2020.

2/12/95 The morning forecast for Malin and Rockall remained poor (S or SW gales, force 7-9), the ship therefore remained in Loch Foyle for the day. The Neil Brown oxygen sensor supplied on the CTD was fitted with Seabird pump and fittings during the morning and a test deployment of the CTD was made in the entrance to Loch Foyle at 1308. Erratic functioning of the fluorometer on this CTD dip was traced to the power supply providing insufficient current to power both the oxygen electrode pump and fluorometer. A second test deployment after changing the power supply showed the CTD, fluorometer and oxygen probe to be functioning satisfactorily. The UWB sedimentation velocity tubes failed to close properly under test and were found to require adjustments to the spring closing mechanism. With continuing strong winds the ship remained hove to in Loch Foyle for the remainder of the day.

3/12/95 The morning forecast predicted SE winds force 6-8 veering NW 4-5 later. A rapid change in wind direction around 8 am to the NW forced the ship to leave Loch Foyle and in the light of an improved outlook, the decision was taken to progress slowly towards the SES box to assess conditions. Winds moderated during the day and, with a passage speed of about 6 knots, Challenger arrived at S140 at 2211. Although the swell was still large, conditions were considered workable. CTD stations were therefore worked westward along the S line during the night.

4/12/95 In constantly improving sea conditions CTD dips were carried out at S200, S300, S500 S700 and S850. Nutrient and DOC samples were collected and analysed en route. Extra CTD dips were executed at S700 to collect water for radionuclide studies and following a change of bottles to lever-arm Niskins , for trace metals studies. The S850 CTD cast was complete at 1200 and the decision was taken to break from the S line to move to the shelf deployment position for the drogued buoys (Circle 1; 56.2477°N 9.0685°W). Drogue deployments in Circle 1 were complete ed at 1607 and the ship then steamed for Circle 2 (56.2455°N 9.2202°W) over the mid region of the slope. Drogued deployments in Circle 2 were completed at 1930. The ship then steamed to rejoin the S line at S1000 to continue CTD's. Plans to break from the CTD line in the early hours of the morning to steam for the N2000 coring station were revised in the light of forecasts of strong to gale-force winds for the Malin and Rockall areas and the decision was taken to complete the S line CTD stations during the night overnight and postpone coring operations for 24 h. The S1000 CTD station was completed at 2215.

5/12/95 Weather and swell conditions worsened during the S1150 CTD dip and difficulty was experienced in maintaining a vertical CTD wire. On completion of the dip the decision was taken to suspend CTD operations . The ship hove to and preparations were made to deploy the S400 ADCP at 0800 the next day subject to improved weather conditions. A warning message was received at 1800 from ARGOS to indicate that the S140 toroid buoy had strayed outside its watch circle with the reported position being 56 29 N; 8 57'52" W.

6/12/95 Further updated positions of the S140 toroid from ARGOS through the night indicated that the buoy was moving NNW at a speed of about 1 knot. With much improved wind and swell

conditions the decision was made to try to locate the buoy and recover it after the deployment of the ADCP. The ADCP was successfully launched at S400 at 0905 in 398 m of water and a course was set to intercept the drifting buoy, based on the most recent position fix and direction of drift. The drifting toroid was sighted and successfully grappled at 1159 at 56° 42.64'N 09° 06.16'W. All instruments were intact. Inspection of the mooring line showed that the the nylon section of the mooring line had failed or had been damaged at the upper hard -eye, the thimble was all that remained. The instruments, a fluorometer and transmissometer were removed from the buoy. *En route* back to S200 the positions of the met-buoy and U mooring surface toroid at S140 were confirmed and ARGOS transmissions detected from both moorings.

The ship was on station at S200 at 1504. Water samples were collected for trace metals, radionuclide studies and primary production measurements. Between CTD dips, a further trial of the UWB sedimentation velocity tubes was carried out but the trial was abandoned once again due to premature closure of the tubes. On completion of the work at S200 the ship steamed to S1300, arriving at 2104 to resume the S line CTD section. The CTD failed at S1400 shortly after it had been deployed. The CTD was recovered and checks revealed breaks in the CTD cable conductors at the tail. Because of the requirement to be on R1000 for coring at 0800 S1400 was aborted and retermination of the CTD carried out on passage to S1500.

After completing the CTD dip at S1500 the ship sailed for R1000, arriving at 0534. Two CTD dips were carried out to collect the standard water samples and also to collect a large volume of near-bottom water for sediment core incubation experiments. Coring commenced at 0847 and after 3 multicorer deployments 21 good cores had been collected (100% success rate) by 1140. Cores were processed for microbial flux studies and stable isotope, lipid and meiofaunal studies soon after collection. The bed hop camera was deployed at R1000 at 1216 in 1002 m. A final CTD cast to 250 m, with irradiance sensors fitted, was carried out at R1000 at 1429 to obtain a downwelling irradiance profile and water for productivity studies.

An eastward CTD and water sampling transect along the R line began at R700 at 1517. R140 was reached at 2132 and after completing the CTD cast a westerly transect along the N line begun. CTD's completed at N140, N200 and N300 before midnight.

8/12/95 CTD's continued through the night completing N500, N700, N850, N1000, N1150, N1300 arriving at N1500 at 1029. 5 CTD casts were completed at this station to collect samples for nutrients, productivity measurements, trace metals and radionuclides. A failure in the ship's clean power supply to the labs caused the fourth cast to be interrupted on the upcast. However this was completed without problem when the power was restored. Early in the fifth cast a the CTD again failed. The fault was eventually traced to a blown fuse in the deck unit power supply. A reserve power supply was connected and the CTD cast to collect samples for trace metal studies was completed without further problem. With a reasonable forecast for the next 24h a decision was made to steam westwards to N2300 to collect samples from the deep water of the Rockall Trough during the night arriving at N2000 station to collect sediment cores early next morning.

9/12/95 N2300 was reached at 0422 and the CTD cast completed by 0651 in conditions of increasing wind and swell. On arrival at N2000 at 1100 the winds had increased to force 7 and

swell conditions rendered any overside deployments unsafe. With no promise of improvement in conditions in the medium term plans to core at S2000 were cancelled and the ship made slow progress back to the SES box hopeful of finding more amenable working conditions further east.

The ship arrived at S140 at 1815. The swell was still large but conditions were better than at the westerly stations and considered workable. Lever -arm Niskin bottles were fitted to the CTD for collection of trace metal samples. Just prior to deployment power to the CTD failed once again. The fault, traced to water ingress to the cable, was rectified by retermination of the CTD. Samples for trace metals, radionuclides and nutrients were taken from 3 casts at S140 before steaming to P140 to begin a westerly transect along the P line. Wind and swell conditions again began to worsen and after recovery of the CTD at P140 work was suspended at 2255, pending improvement in conditions.

10/12/95 With a slight improvement in swell the CTD was deployed at S200 at 0050 but problems in getting the instrument overboard and inboard again prompted suspension of operations until 0600. Although only a slight improvement in conditions had occurred, safer deployment and recovery conditions were achieved at S300, at 0605, by turning the ship's head to the swell whilst getting the instrument outboard and inboard. Using this strategy it was possible to continue the CTD survey along the P line for the remainder of the day. Station P1500 was completed at 2202 and R1500, previously unvisited on the R line survey was completed at 2236. During the CTD cast at R1500 (Cast 58) a deterioration in the quality of the oxygen signal was observed although there was no obvious fault to be found the problem appeared to be symptomatic of poor flow through the O_2 sensor.

11/12/95 With reduced wind and an easing swell, the ship slowly steamed to N1500 for sediment studies. A standard CTD cast was carried out at 0400 followed by a second cast to collect near bottom water for sediment incubation experiments. Deployments of the multicorer began at 0825. Three multicorer deployments yielded 21 (100%) good quality cores which were used to determine sediment oxygen consumption and sulphate reduction in shipboard experiments, and sectioned stable isotope composition. The bed hop camera was deployed at S700 at 1206 and 25 frames of film were exposed.

Two settling velocity tubes were filled at 1405. One tube fired prematurely near the surface but the other closed satisfactorily at the desired depth of 30m. The tubes were recovered an set up on deck to determine the sinking rate of the contained particulate material by subsampling throughout the rest of the day. After a short steam to R1000, a standard CTD cast was carried out followed by 3 further casts for radionuclide and trace metal studies. The ship left station R1000 at 2217 and headed north to begin a cross slope CTD section to the north of the SES area on the DML WOCE survey line.

Further attempts were made to trace the oxygen detector problem during the passage to station WP1. Careful examination revealed a break in the power conductor to the Seabird pump which was only revealed when the cable was under tension. A new power lead was made up and fitted.

12/12/95 The CTD section along the shelf edge part of the WOCE survey line began at 0230 at station WP1 (equivalent to the DML WOCE station P1). No improvement in the oxygen signal

was observed during this cast and consequently the Seabird pump system was removed and oxygen sensor run without pump supply. CTD's continued south eastward on to the shelf in good conditions. The oxygen trace showed a marked improvement after removal of the pump system, suggesting that pump failure was the likely cause for the deterioration in oxygen signal, although the signal was slightly noisier than that obtained when the pump had been working properly earlier in the cruise. Water for a primary production experiment was taken from 7 m at WQ3. Station WR was completed at 1536 and a new section heading due south was begun with stations (NSA 1-7) spaced at 5' intervals being worked back to the S line in the SES box.

13/12/95 the CTD cast at NSA7 was completed at 0050. Station S200 was revisited at 0206 to collect water principally for POC/PON determinations, the ship then continued to S700. A standard CTD cast was carried out at S700 at 0530. A second cast was deployed at 0652 to collect near-bottom water for the core incubation experiments. On recovery of the CTD was raised clear of the water with the gantry too far extended and the instrument swung into the side of the ship with considerable force, causing the loss of one water sampling bottle and reversing thermometer and severe damage to 4 other bottles which remained on the rosette frame. A formal report of the incident and damage is given in Appendix 1. The cast was repeated with 5 bottles on the rosette and water for core incubations was collected successfully. Multicoring operations began at 0917. The first drop yielded 7 good quality cores, the second yielded only 6, the third only 3. A final fourth drop produced the 3 cores which were sufficient to make up the remaining requirements. The poorer success rate (52%) compared with the 100% success rates of drops at the other two stations samples is attributed to the sandier sediment composition.

After finishing coring at 1203, the ship positioned to recover the marker toroid buoy at S700. The mooring was grappled without difficulty and was on board by 1312. The ship repositioned on S700 for deployment of sediment velocity tubes but after a misfire of one tube at the surface and failure of the other to fire at the required depth the attempt was aborted and preparations made for deployment of the bed-hop camera. The camera was in the water at 1500 and was recovered at 1600 after exposing 25 frames of film. Water samples for trace metal analysis and samples for radionuclide determinations were taken from 2 CTD dips at S300 between 1700 and 1830. Since this was the last dip of the cruise to used for trace metal sample collection it was agreed that some of the lever arm Niskin bottles would be brought into use for standard casts to alleviate the shortage of standard Niskin bottles..

After completing sampling at S300 the ship steamed north to begin the second north- south CTD transect at NSB1 (56° 57.24' N 09° 02.88'W) at 2157.

14/12/95. CTD's stations were occupied through the night and the line was completed at 0630 The ship hove-to to await daylight to begin recovery of the POL meteorological buoy at S140. The buoy was successfully grappled in calm seas with light swell at 0911 and was inboard by 0938. Serious damage was noted in the nylon rope section of the mooring at the hard eye. It would appear that had the buoy not been recovered it would probably have broken loose during the next storm. The ship then repositioned on S140 to carry out a CTD cast for collection of a sample for productivity studies before steaming northwards once again at 1043, to begin the third N-S CTD transect line at NSC1 (56° 57.0'N 9 05° 00'W). However soon after leaving S140, serious loss of oil through the stern gland was reported at 1123 and at the request of the Master,

further activities within the SES area were terminated and the ship set course for Greenock.

15/12/95 The ship docked at Greenock during mid-morning and unloading of DML and UWB equipment was completed by mid-afternoon.

3. Achievements

3. 1 Operational Achievements

Operationally the cruise was extremely successful in that most of the targeted aims were satisfied. The principal CTD sections (N, P, R, S) were all surveyed once during the cruise (see Fig.1). Several stations on these lines were visited on a number occasions through the cruise. 2 long-slope CTD surveys were also completed but two further planned transects had to be aborted due to the ship's stern gland problems. Nutrient profiles were determined at all CTD stations. Adequate sampling for calibration of CTD and deck tank instruments was carried out throughout the cruise but because of shortage of personnel, calibration of the CTD oxygen sensor was less than optimal and experimental estimates of pelagic community respiration could not be made. Three of the four targeted coring sites were visited and successfully sampled. Similar success was also obtained in the trace metal and radionuclide objectives. The coupled *Shimadzu-Antek* analytical system for DOC-DON determinations worked properly during the cruise, even in inclement weather conditions, allowing comprehensive vertical sections of DOC and DON along the N and the S lines to be determined. Instrument deployments made during the cruise were completed without any serious problems and the released drouged buoys were tracked using ARGOS during the cruise. It was possible to make mooring recoveries at S140 and S700 which were prevented by adverse weather during Challenger 123A. In addition it was possible to locate and successfully recover an instrumented toroid buoy which had broken free from S140.

3.2 Scientific Achievements

The achievements of this cruise will not fully become apparent after further analysis of samples and data. Preliminary reports, by the scientists involved, of scientific achievements are given below.

3.2.1 Water Column Measurements

3.2.1.1 CTD Deployments

A total of 93 CTD casts were completed with salinity and temperature measurements taken for calibration purposes (Table 2). The general oceanographic situation was similar to that described by Huthnance (1995). during Challenger 123B. Temperature, salinity and uncalibrated oxygen sections along the N and S lines are given in Figures 2 and 3. CTD fluorescence measurements suggested a low phytoplankton chlorophyll biomass in the upper 100m and insignificant chlorophyll concentrations below this depth

3.2.1.2 Dissolved Inorganic Nutrients *(Brian Grantham)*

Nutrient measurements of ammonium, nitrate, phosphate and silicate were made using a Lachat QuikChem 2000 flow injection analyser. The instrument worked well throughout the cruise with no major problems. Analyses were carried out on water samples from 74 stations in the SES area covering the standard S, R, P and N survey lines and additional intermediate lines. Measurements of nutrient concentrations in water overlying sediment cores taken at stations S700, R100 and N1500, both before and after several hours incubation(see 4.2) , were also taken to estimate sediment nutrient fluxes.

3.2.1.3 Dissolved Organic Carbon & Total Dissolved Nitrogen Using High Temperature Catalytic Oxidation *(Xosé Antón Alvarez Salgado)*

Introduction

Rapid and precise techniques are now available for the determination of dissolved organic carbon (DOC) and total dissolved nitrogen (TDN), i.e. dissolved organic nitrogen (DON) plus inorganic nitrogen salts (DIN). Increasingly used for this purpose is high temperature catalytic oxidation (HTCO), results from which have profound implications for mass-balancing carbon and nitrogen budgets and material fluxes across estuarine and shelf interfaces and within oceanic systems. Ocean margins are key areas for investigating impacts of DOC on the carbon cycle, since both the export of terrestrial DOC and the import of oceanic DOC occur at this boundary. In addition to the physical forcing, biogeochemical processes at these ocean margins will determine the dissolved organic matter budget.

LOIS (SES) studies in the Hebridean Shelf will provide data covering contrasting seasons. Comparison with data from the Celtic Sea (OMEX programme) allow us to study the effect of contrasting transitional zones.

Methodology

HTCO techniques involve the direct injection of acidified and decarbonated sea water onto a platinised alumina catalyst, at high temperature (680 °C), under an atmosphere of high purity oxygen. Quantitative production of CO_2 and NO• gases occurs under these oxidative conditions.

$$DOC + DON + DIN + O_2 \rightarrow CO_2 + NO\bullet + H_2O + ...$$

DOC concentration is directly related to the amount of CO_2 produced, which is determined using a CO_2-specific infrared gas analyser (IRGA). Total Dissolved Nitrogen (TDN) is determined by a nitrogen-specific chemiluminescence reaction. The quantitatively produced nitric oxide radical, reacts with ozone producing excited nitrogen dioxide (NO_2*). NO_2* emits quantifiable light energy upon decay to their ground state:

$$NO\bullet + O_3 \rightarrow NO_2^* + O_2 \rightarrow NO_2^\circ + h\nu$$

When finalised N-based nutrient data are available, the TDN concentrations can be corrected, giving a measure of DON, complementary to HTCO-DOC measurements.

Plymouth Marine Laboratory performs these measurements with a *Shimadzu TOC 5000* analyser coupled with an *ANTEK 705 D* chemiluminescent nitrogen-specific detector. Incorporation of a *Licor 6252*, solid-state IRGA, and a PC-based integration system (ATi Unicam, *4880*) allows high precision measurements to be made against the noisy background of an ocean-going research platform.

Samples Collected

A total of 71 samples in the LOIS (SES) South Section and 40 in the North Section. were collected and successfully measured aboard ship. In addition, a total of 26 samples were taken in three stations along the DML WOCE section, to observe latitudinal differences (Table 3). Unexpected failure in the injection system of the *Shimadzu TOC-5000* prevented the analysis of these samples aboard. They were acidified, heat-sealed and preserved in the dark at 4 °C for later analysis in the laboratory. Finally water from 7m (12 ampoules) and 1497 m (12 ampoules) was collected at station N1500, when reoccupied on 11 December.

Summary of achievements

Shipboard measurements of HTCO-DOC & TDN were made on all the samples collected from the North and South Sections. The coupled *Shimadzu-Antek* analytical system worked properly at sea, even in inclement weather conditions. An injection cycle took 5 ½ minutes. As each sample was injected 4 times, ~22 minutes were necessary for completion of each sample.

A mixed standard of potassium hydrogen phatalate and glycine was used to calibrate the system daily. The slope of the calibration curves for DOC remained constant over the cruise. The C.V. for the 8 calibrations performed <1.5% (see Figure 4). The slope of the calibration curves for TDN increased with time during the cruise, as observed in the laboratory. However, the C.V. for the eight calibrations was 2.5 % (see Figure 5). The system blank was 10 μM-C and < 0.3 μM-N for DOC and TDN, respectively. The C.V. for the 4 replicate analysis of each sample was usually < 2% for both DOC and TDN measurements.

A surface mixed layer, 100 meter deep, was found to be warmer and fresher than waters below. DOC concentrations, homogeneously distributed in this layer, are clearly higher than in deeper waters. DON will be calculated by subtracting the DIN from our TDN measurement. An example of a full water column profile of DOC (Figure 6) and TDN (Figure 7) is given for station S1500.

3.2.1.4 Primary Production Measurements and Chlorophyll Determinations *(Ken Jones)*

Experiments to determine photosynthesis-irradiance (P:I) curves of phytoplankton in the surface mixed layer were carried out at S140, S200, P850, R1000, N1500 and WR1. Samples (8ml) spiked with 300 μCi ^{14}C- $NaHCO_3$ were incubated for 1h at 24 irradiance levels at *in situ* temperatures, in an incubator based on the Photosynthetron design of Lewis and Smith (1985). Unfixed label was removed by acidification and shaking after incubation and the

samples were returned to the laboratory for scintillation counting. Samples of the same water were filtered sequentially through 18, 2 and 0.2 μm polycarbonate filters and these were returned to the laboratory, frozen for later analysis for chlorophyll *a*. Samples for phytoplankton taxonomic analysis were taken at all productivity stations, fixed with glutaraldehyde and returned to the laboratory for analysis.

3.2.1.5 Fluorometer Calibration *(Ken Jones)*

Samples for CTD fluorometer calibration were taken from 3 depths in the surface mixed layer at all CTD stations, filtered through GF/F filters and stored frozen for analysis ashore. Similarly samples were taken from the non-toxic seawater supply to calibrate the underway surface monitoring fluorometer in the deck tank (Table 4).

3.2.1.6 Dissolved oxygen calibrations *(Ken Jones)*

Water samples were taken from P850, P1500, WQ1 and NSB2 for calibration of the CTD dissolved oxygen sensor. Samples were transferred directly from rosette bottles to 125 m glass stoppered bottles and immediately fixed by adding manganous chloride and alkaline iodide solutions. Fixed samples were stored under water and returned to the laboratory for titration.

3.2.1.7 Trace metals *(Anne LeGall)*

The aim of the cruise was to repeat the sampling strategy adopted in the SES area in May 1995, during RRS Charles Darwin Cruise CD 93, in order to compare trace metal concentrations throughout the water column. All samples were processed in a specially prepared laboratory space isolated from external contamination by plastic sheeting. Total and dissolved aluminium were measured inboard by fluorometry. Additional water samples were filtered and stored for further analysis onshore.

Six of the 8 stations targeted were successfully sampled (S140, S200, S300, S700, N1500 and R1000) although rough sea conditions caused some equipment breakdown and there was some evidence of sample contamination at R1000. Despite this, the overall achievement is still quite satisfactory, taking into account the time of the year, the restrictions due to weather and the fact that the cruise was shortened at both ends due to ship breakdowns.

3.2.1.8 Radionuclides *(Jane Foster)*

^{210}Po-^{210}Pb analysis

20 litre water samples were collected at seven depths at S140, S200, S300, S700, R1000 and N1500. The samples were filtered through 0.45μm Asypor filters to remove particulate material. The dissolved fraction (<0.45μm) was then spiked with ^{208}Po and ^{206}Pb tracers and allowed to reach equilibrium. The tracers along with the intrinsic ^{210}Po and ^{210}Pb were

precipitated via cobalt nitrate and APDC and collected on a 0.3μm Asypor filters. The filters are to be processed back in the lab.

XRF/POC Analyses on Suspended Particulate Matter

10 litre water samples were collected at eight depths at S140, S200, S700, R1000 and N1500. Approximately 4 litres from each sample were filtered through 0.4μm Nucleopore filters, destined for thin-film XRF analysis, the remainder of the water was filtered through GF/F filters for organic carbon and nitrogen analysis.

3.2.1.9 Suspended Particulate Concentrations and Particle Sedimentation rates *(Sarah Jones & Robin McCandliss)*

Calibration of CTD-mounted transmissometer

A total of 123 samples were collected from GO-FLO bottles during CTD surveys and filtered through pre-weighed 47 mm GF/C filters. Between 8 and 10 litres of water were filtered for each sample. These samples will be used to convert optical beam attenuation measured by the CTD-mounted transmissometer into total SPM concentration.

Particle size/shape distribution

It was not possible to perform any analysis of particle size or shape on this cruise, because the instrument developed a power supply fault which was not repairable before sailing.

Particle settling velocity

A total of 6 deployments of the UWB Settling velocity tube samplers were attempted. These had been modified so as to allow triggering at a specified depth in the water column using an acoustic release (only surface measurements have been possible before). However problems with premature triggering by swell waves on entering the water, and various mechanical failures of the new triggering system, resulted in only one useable sample being recovered, from the upper 30m of the water column (Table 5). This was set upright on a stand and sub-samples were withdrawn from the base of the tube at 1, 10, 20, 40, 80, 160, 320, 440 and 600 minutes. Sub-samples were filtered through pre-weighed Cyclopore 0.4 micron polycarbonate membrane filters for determination of settling velocity distribution of SPM.

3.2.2 Sediment Studies

3.2.2.1 Sediment microbial and geochemical processes *(Martyn Harvey and Lynda Mitchell)*

The multicorer was deployed at three stations (S700, R1000 and N1500) see Table 6. Cores

for sulphate reduction and oxygen uptake determinations were taken at each station as follows: sulphate reduction rate (1 core from each of three drops); oxygen uptake rate, (2 cores from each of three drops); pore water sulphate (1 core); porosity, (1 core). Oxygen uptake was measured by incubation experiments carried out in the CT room on board ship. Cores for sulphate reduction rate determination were processed on board; samples obtained from them were be frozen for analysis back at the laboratory. Sediment samples of known volume were taken and stored frozen for subsequent determination of porosity and organic matter content. Whole 5 cm sections were taken from one core for pore water sulphate determination.

Cores for biogeochemical and meiofaunal analyses were sliced into 1 cm sections immediately on recovery. One core from each drop was for the study of meiofauna in the top 1 cm of sediment. From these cores the top 1 cm was preserved in formalin. The rest of the sliced cores were stored in the freezer for various later analyses including determination of stable carbon isotope and various radioisotope ratios (to be carried out at SURRC, East Kilbride), CHN analysis, particle size analysis, inorganic carbonate contents and determination of porosity curves.

The sediment oxygen uptake rates determined on board ship are shown in Table 7.

3.2.2.2 Bed-hop Camera *(Jane Foster)*

The camera was deployed at stations S700, R1000 and N1500 (Table 8.). 25 photographs of the sea bed were taken at each site. (Exposed films were sent to John Humphery at POL for processing).

4. Instrumentation

4.1 Drifter Deployments *(Dave Meldrum)*

A total of 21 satellite-tracked drifting buoys were deployed during the cruise. The buoys are of a modified WOCE Surface Velocity Programme design, drogued at 50 m. Thermistors measure temperature at the sea surface and at the top of the drogue. Drogue depth is monitored by a pressure sensor. Two buoys contained GPS receivers to allow drift tracks to be reconstructed more accurately in space and time than is possible using the Argos system employed as the primary means of location. The deployments were designed to measure changes in dispersion across the shelf break, and took the form of three 2 km circles centred along 56° 14.7'N at 09° 04'W, 09 13 W and 09° 26' W. CTDs were performed at the centres of the two easterly circles, but not at the westerly circle owing to high seas. Early location data shows the position of the drifters during December (Fig. 8).

4.2 RVS Instrumentation *(Andy Jones & Ken Jones)*

4.2.1 General

All instrumentation generally performed well with only a few problems .The surface sampling equipment worked without fail for the entire cruise , as did the ADCP and the Echo sounder.
The CTD system had no serious problems, the tone fire worked well with only a few genuine misfires. The electrical connection required re-terminating on two occasions causing only slight delay to CTD casts.

4.2.2 Instrument Losses

There were a number of damages and losses to water bottles and reversing thermometers, in part due to the marginal weather conditions . These are summarised below:

6 off 10 l Niskin bottles
4 off SIS Reversing Thermometers
Details of the circu ıstances surrounding some of these losses is given in Appendix 1.

4.2.3 SeaBird Pur ›ed Oxygen Sensor

The Seabird pumpe xygen system was used with a noticeable improvement to the response of the oxygen senso. ›r a large part of the cruise, although performance deteriorated towards the end of the cruis Following this, the pump and plenum were detached and the oxygen data was collected u ıg the Neil Brown oxygen electrodein its standard, non-pumped configuration. It wa: ıspected that the observed fall off in performance may have been due to reduction in the f v from the SeaBird pump. A faulty termination in the power supply to the pump was detect and replaced but this did not significantly change performance. It was impossible to check ; flow rate of water through the pumped system against manufacturers specifications durin ıe cruise because of the absence of a manual for the equipment on the ship.

4.2.4 Instrument :ployments and Recoveries

The RVS bottom mo ıted ADCP mooring was deployed at S400 as requested by the PSO from previous Leg.

4.2.5 MilliQ Ultra ure Water System

There was continued (see Debrief Notes, Challenger 121B) concern expressed by the Master about excessive water consumption by this equipment. The MilliQ system produces high purity de-ionised water by a two stage process. Water from the ships freshwater supply is passed through a reverse osmosis cartridge and the purified water produced is stored in a reservoir. Water from this reservoir is then pumped, according to demand,through a second

stage consisting of ion exchange cartridges and UV treatment to remove dissolved organics. Calculations based on the manufacturers specifications suggest that the production efficiency of the first stage (RO) system is about 1:10, i.e. about 1 litre of first stage water is produced for every 10 litres input from the ships freshwater supply. Production of first stage water continues until the storage tank is filled, after which all incoming tap water is diverted to waste. The manufacturers specified output rate of first stage water is approximately 250 litres per day , hence a total maximum daily water consumption rate of 2.5 tonnes per day from the ships fresh water system is possible. However the actual maximum usage of high purity second-stage MilliQ water, for scientific purposes, during this cruise, never exceeded 50-60 litres per day. Consequently, it follows that water usage could be reduced to 1/5th of its current rate, if a water control valve was connected to a level device in the storage tank which caused the freshwater supply to the system to be stopped once the first stage reservoir is full, . An alternative approach might be to devise a system where the rejected water could be recycled. Attention should be payed to investigating possible solutions to this problem, since any restrictions to the use of the MilliQ system (e.g. because of problems in making ships freshwater) would have serious implications for performance of chemical analysis on board.

5. Computing *(Rob Lloyd)*

The standard RVS data acquisition and processing system was used for this cruise. The instruments logged were:-

SOLI	-Kipp & Zonen Solar Integrator.
TSG103	-Thermosalinograph.
FLUTE	-Fluorometer and transmissometer in deck tank.
LUMEN	-Luminescence.
RVS_CTDF	-Neil Brown MkIII CTD.
EA500D2	-Simrad EA500 echo sounder (38 KHz hull transducer)
GPS_4000	-Trimble 4000DS Differential GPS.
GPD_TRIM	-Trimble 4000AX GPS.
DECMK53GS	-Decca MK53G GPS.
BIN_GYRO	-Ship Gyro Compass.
CHF_NMEA	-Chernikeef EM Log.

Logging commenced at 95 335 08:01:30 and ended at 349 08:00:00.

The system crashed on two occasions causing some minor data loss. In the first incident a Level B (logger) 'black hole' occurred whilst hove-to in bad weather whilst in the Second the ship's clean power supply failed. At the end of the cruise the data was passed to the BODC representative
and a second copy made for temporary archive at SOC.

6. References

Huthnance, J.M., 1995. Cruise Report RRS Challenger Cruise 123A. Cruise Report No. 21 Proudman Oceanographic Laboratory, 36pp.

Lewis, M.R. and Smith, J.C., 1983. A small volume short incubation time method for measurementsof photosynthesis as a function of incident irradiance. Mar. Ecol. Prog. Ser. **13**, 99-102.

7. Tables

Table 1. Cruise Participants

Scientists		*Officers and Crew*	
K. J. Jones (PS)	DML	G.M. Long	Master
D. Meldrum	DML	P.W. Newton	C/O
S. M. Harvey	DML	D. H. Thomas	2/O
B. Grantham	DML	J. C. Holmes	3/O
L. Mitchell	SAMS	B. McDonald	C/E
S. Jones	UWB	J. R. Crosbie	2/E
R. McCandliss	UWB	C.J. Phillips	3/E
J. Foster	Edinburgh University	P.G. Parke	Elec.
A. LeGall	SUDO	G.A. Pook	CPO(D)
X. Saldago	PML	P.R. Bennett	PO(D)
R. Lowery	BODC	G. Crabb	SG.1A
A. Jones	RVS	P. Allison	SG.1A
R. Lloyd	RVS	R. Johnson	SG.1A
		J. C. Manning	SG.1A
		R. Bell	S.C.M.
		G. Welch	Chef
		W. J. Link	Steward
		R. Stephen	Steward
		G. Slater	MM.1A

Table 2. Summary of CTD casts Challenger 123B/95

Event Code	Start time Date & time	End time Date & time	Site Code	Lat (deg N)	Lon (deg E)	Water depth (m)
CTD1	02/12/1995 14:04	02/12/1995 14:22		55.29573	-6.68061	72.3
CTD2	03/12/1995 22:11	03/12/1995 22:35	S140	56.46396	-8.98109	145.6
CTD3	03/12/1995 23:09	03/12/1995 23:33	S150	56.46167	-9.02717	162.8
CTD4	03/12/1995 23:57	04/12/1995 00:18	S200	56.46183	-9.04475	202.1
CTD5	04/12/1995 00:50	04/12/1995 01:24	S300	56.465	-9.0732	386.6
CTD6	04/12/1995 01:49	04/12/1995 02:45	S500	56.46228	-9.10019	494.6
CTD7	04/12/1995 03:22	04/12/1995 04:25	S700	56.46278	-9.16973	730.3
CTD8	04/12/1995 04:58	04/12/1995 06:00	S700	56.46992	-9.17332	733.7
CTD9	04/12/1995 06:35	04/12/1995 07:35	S700	56.46459	-9.17147	732.9
CTD10	04/12/1995 08:42	04/12/1995 09:43	S700	56.46251	-9.17711	752.1
CTD11	04/12/1995 10:52	04/12/1995 11:57	S850	56.46298	-9.2254	843.8
CTD12	04/12/1995 13:54	04/12/1995 14:07	CIRCLE1	56.24636	-9.06734	158.9
CTD13	04/12/1995 17:15	04/12/1995 17:39	CIRCLE2	56.25168	-9.22174	625.5
CTD14	04/12/1995 21:04	04/12/1995 22:15	S1000	56.46121	-9.28953	979.1

Event Code	Start time Date & time	End time Date & time	Site Code	Lat (deg N)	Lon (deg E)	Water depth (m)
CTD15	04/12/1995 23:13	05/12/1995 00:40	S1150	56.46346	-9.38509	1117.1
CTD16	06/12/1995 15:04	06/12/1995 15:24	S200	56.46415	-9.03744	181.4
CTD17	06/12/1995 15:53	06/12/1995 16:19	S200	56.46136	-9.04049	187
CTD18	06/12/1995 16:43	06/12/1995 17:10	S200	56.46009	-9.04414	195.8
CTD19	06/12/1995 18:36	06/12/1995 18:58	S200	56.46185	-9.04293	195
CTD20	06/12/1995 21:04	06/12/1995 22:34	S1300	56.46873	-9.50133	1271.4
CTD21	07/12/1995 02:10	07/12/1995 03:37	S1500	56.4649	-9.63631	1468.2
CTD22	07/12/1995 05:34	07/12/1995 06:55	R1000	56.52767	-9.28803	984.6
CTD23	07/12/1995 07:23	07/12/1995 08:29	R1000	56.51773	-9.28667	976.9
CTD24	07/12/1995 14:26	07/12/1995 14:40	R1000	56.51713	-9.29479	999
CTD25	07/12/1995 15:17	07/12/1995 16:05	R700	56.51764	-9.17706	682.7
CTD26	07/12/1995 17:16	07/12/1995 17:58	R500	56.52777	-9.10217	428.1
CTD27	07/12/1995 18:31	07/12/1995 19:01	R300	56.51011	-9.05116	258.6
CTD28	07/12/1995 19:20	07/12/1995 19:44	R200	56.50629	-9.03962	204.8
CTD29	07/12/1995 20:24	07/12/1995 20:41	R140	56.50455	-8.93237	141.6
CTD30	07/12/1995 21:32	07/12/1995 21:50	N140	56.60951	-8.92144	132.8
CTD31	07/12/1995 22:20	07/12/1995 22:38	N200	56.6288	-8.97549	143.5

Event Code	Start time Date & time	End time Date & time	Site Code	Lat (deg N)	Lon (deg E)	Water depth (m)
CTD32	07/12/1995 23:03	07/12/1995 23:35	N300	56.63411	-9.02267	358.2
CTD33	08/12/1995 00:10	08/12/1995 00:50	N500	56.63739	-9.06717	507.2
CTD34	08/12/1995 01:17	08/12/1995 01:58	N700	56.64607	-9.10363	677.4
CTD35	08/12/1995 02:30	08/12/1995 03:38	N850	56.6614	-9.14499	864.9
CTD36	08/12/1995 04:30	08/12/1995 05:50	N1000	56.67514	-9.18377	983.8
CTD37	08/12/1995 06:22	08/12/1995 07:51	N1150	56.69281	-9.24728	1141.9
CTD38	08/12/1995 08:20	08/12/1995 09:48	N1300	56.70174	-9.32496	1293.6
CTD39	08/12/1995 10:29	08/12/1995 12:02	N1500	56.73355	-9.39954	1498.7
CTD40	08/12/1995 12:42	08/12/1995 14:40	N1500	56.73554	-9.40364	1509.3
CTD41	08/12/1995 15:05	08/12/1995 15:14	N1500	56.73305	-9.39909	1498.2
CTD42	08/12/1995 15:25	08/12/1995 17:12	N1500	56.73764	-9.39849	1507.2
CTD43	08/12/1995 19:18	08/12/1995 21:06	N1500	56.73948	-9.39054	1499.5
CTD44	09/12/1995 04:21	09/12/1995 06:51	N2300	56.98798	-10.9835	2375.2
CTD45	09/12/1995 19:20	09/12/1995 19:43	S140	56.47109	-8.95991	145.3
CTD46	09/12/1995 20:32	09/12/1995 20:51	S140	56.46497	-8.94004	142.5
CTD47	09/12/1995 21:17	09/12/1995 21:39	S140	56.46808	-8.96332	145.3
CTD48	09/12/1995 22:32	09/12/1995 22:51	P140	56.5476	-8.93567	137.5

Event Code	Start time Date & time	End time Date & time	Site Code	Lat (deg N)	Lon (deg E)	Water depth (m)
CTD49	10/12/1995 00:50	10/12/1995 01:20	P200	56.56647	-9.03702	222.7
CTD50	10/12/1995 06:05	10/12/1995 06:38	P300	56.57959	-9.05978	334.3
CTD51	10/12/1995 07:20	10/12/1995 08:00	P500	56.57914	-9.10836	486
CTD52	10/12/1995 08:43	10/12/1995 09:40	P700	56.58842	-9.17988	698.7
CTD53	10/12/1995 10:17	10/12/1995 11:30	P850	56.59101	-9.23773	857.3
CTD54	10/12/1995 12:11	10/12/1995 13:25	P1000	56.59999	-9.28973	995.4
CTD55	10/12/1995 13:55	10/12/1995 15:05	P1150	56.61136	-9.36759	1148.6
CTD56	10/12/1995 15:55	10/12/1995 17:26	P1300	56.63016	-9.45291	1293.5
CTD57	10/12/1995 18:40	10/12/1995 20:31	P1500	56.65095	-9.59233	1495.1
CTD58	10/12/1995 22:02	10/12/1995 23:36	R1500	56.53001	-9.66836	1500.3
CTD59	11/12/1995 04:17	11/12/1995 05:50	N1500	56.7416	-9.38554	1496.2
CTD60	11/12/1995 06:24	11/12/1995 07:58	N1500	56.73318	-9.39654	1495.3
CTD61	11/12/1995 16:28	11/12/1995 17:31	R1000	56.51482	-9.29605	1000.2
CTD62	11/12/1995 17:58	11/12/1995 18:56	R1000	56.51541	-9.29389	997.2
CTD63	11/12/1995 19:17	11/12/1995 20:18	R1000	56.51582	-9.29567	1001.9
CTD64	11/12/1995 21:01	11/12/1995 22:17	R1000	56.5145	-9.30394	1018.3
CTD65	12/12/1995 02:30	12/12/1995 04:10	WP1	57.12637	-9.5652	1783.1

Event Code	Start time Date & time	End time Date & time	Site Code	Lat (deg N)	Lon (deg E)	Water depth (m)
CTD66	12/12/1995 05:28	12/12/1995 06:55	WP	57.1027	-9.43	1494.8
CTD67	12/12/1995 07:50	12/12/1995 08:41	WQ1	57.08387	-9.32292	743.7
CTD68	12/12/1995 09:20	12/12/1995 10:12	WQ2	57.07082	-9.29216	598
CTD69	12/12/1995 12:14	12/12/1995 12:45	WQ	57.05375	-9.22626	340.2
CTD70	12/12/1995 13:26	12/12/1995 14:00	WQ3	57.0373	-9.16003	203.5
CTD71	12/12/1995 14:28	12/12/1995 14:55	WR1	57.02702	-9.1087	151.9
CTD72	12/12/1995 15:36	12/12/1995 15:53	WR	57.00124	-9.00689	133.3
CTD73	12/12/1995 17:04	12/12/1995 17:24	NSA1	56.95222	-8.83541	128.2
CTD74	12/12/1995 18:24	12/12/1995 18:39	NSA2	56.87008	-8.83932	121.3
CTD75	12/12/1995 19:49	12/12/1995 20:05	NSA3	56.7837	-8.83463	125.6
CTD76	12/12/1995 21:00	12/12/1995 21:17	NSA4	56.70118	-8.83573	122.5
CTD77	12/12/1995 22:13	12/12/1995 22:31	NSA5	56.61766	-8.8382	133
CTD78	12/12/1995 23:21	12/12/1995 23:40	NSA6	56.53139	-8.83806	139.4
CTD79	13/12/1995 00:32	13/12/1995 00:50	NSA7	56.44841	-8.84185	
CTD80	13/12/1995 02:06	13/12/1995 02:35	S200	56.46564	-9.05154	
CTD81	13/12/1995 05:29	13/12/1995 06:19	S700	56.47422	-9.17638	736.5
CTD82	13/12/1995 06:52	13/12/1995 07:35	S700	56.47503	-9.17503	731.3

Event Code	Start time Date & time	End time Date & time	Site Code	Lat (deg N)	Lon (deg E)	Water depth (m)
CTD83	13/12/1995 08:10	13/12/1995 08:54	S700	56.48569	-9.15752	646.7
CTD84	13/12/1995 16:59	13/12/1995 17:26	S300	56.47689	-9.06233	308.9
CTD85	13/12/1995 18:06	13/12/1995 18:30	S300	56.47547	-9.06023	295.7
CTD86	13/12/1995 21:57	13/12/1995 22:17	NSB1	56.95712	-9.04662	141.8
CTD87	13/12/1995 23:15	13/12/1995 23:34	NSB2	56.86934	-9.05322	179.2
CTD88	14/12/1995 00:28	14/12/1995 01:00	NSB3	56.78765	-9.04919	421.9
CTD89	14/12/1995 01:48	14/12/1995 02:30	NSB4	56.70635	-9.04889	680.1
CTD90	14/12/1995 03:27	14/12/1995 04:00	NSB5	56.62298	-9.04895	410.4
CTD91	14/12/1995 04:49	14/12/1995 05:10	NSB6	56.53694	-9.04833	243.9
CTD92	14/12/1995 06:05	14/12/1995 06:30	NSB7	56.45485	-9.04779	201.9
CTD93	14/12/1995 10:26	14/12/1995 10:43	S140	56.46097	-8.96597	146

Table 3. Summary of samples taken for DOC/TDN analyses

Station	CTD	Depth Range , m	No of samples
S140	2	8-138	6
S150	3	9-156	6
S200	4	8-191	6
S300	5	7-372	8
S500	6	6-477	8
S700	7	5-718	8
S1000	14	9-976	9
S1300	20	8-1212	10
S1500	21	7-1453	10
N140	30	8-129	4
N200	31	7-139	5
N500	33	6-503	6
N700	34	6-668	7
N1000	36	5-984	8
N1500	39	8-1495	10

Station	CTD	Depth Range , m	No of samples
WP1	65	7-1767	10
WQ1	67	8-725	8
WR1	71	7-143	6

Table 4. Summary of non-toxic supply,surface water samples

Event code	Sampling date & time	Site code	Lat (deg N)	Lon (deg E)	Water depth	Determinands
PG151	01/12/1995 10:04		55.61536	-4.94711	80.8	Salinity S25
PG152	01/12/1995 14:31		55.24352	-5.77494	135.6	Salinity S26
PG153	01/12/1995 19:10		55.30193	-6.64221	78.4	Chlorophyll
PG154	01/12/1995 20:16		55.23392	-6.78299	22.4	Salinity S27
PG321	02/12/1995 08:18		55.22516	-6.77088	20	Salinity
PG322	02/12/1995 19:28		55.21074	-6.82713	14	Salinity
PG323	03/12/1995 08:22		55.28039	-6.81095	49.2	Salinity
PG156	03/12/1995 15:45		55.95893	-7.93012	164.8	Chlorophyll
PG324	03/12/1995 20:43		56.35447	-8.79893	135.8	Salinity
PG157	03/12/1995 22:20	S140	56.46364	-8.98029	145.6	Chlorophyll
PG158	03/12/1995 23:49	S150	56.46021	-9.04299	192.6	Chlorophyll
PG159	04/12/1995 00:32		56.46004	-9.06081	287.6	Chlorophyll
PG160	04/12/1995 01:02	S300	56.46432	-9.07251	377.3	Chlorophyll
PG161	04/12/1995 02:15	S500	56.46246	-9.09993	491.8	Chlorophyll
PG162	04/12/1995 03:40	S700	56.46154	-9.16773	727.4	Chlorophyll

Event code	Sampling date & time	Site code	Lat (deg N)	Lon (deg E)	Water depth	Determinands
PG164	04/12/1995 06:40	S700	56.46411	-9.17037	731	spm XRF/org C
PG165	04/12/1995 12:00	S850	56.46437	-9.23349	869.6	Chlorophyll
PG166	04/12/1995 16:03		56.24255	-9.0346	152.4	Chlorophyll
PG167	04/12/1995 23:29	S1100	56.46264	-9.39071	1122.6	Chlorophyll
PG168	06/12/1995 08:50	S400	56.45257	-9.08894	452.4	Chlorophyll
PG169	06/12/1995 09:00	S400	56.45364	-9.08416	421	Chlorophyll
PG325	06/12/1995 10:01		56.58489	-9.07295	378.6	Salinity
PG170	06/12/1995 15:10	S200	56.46326	-9.03823	182.2	Lead/Polonium
PG171	06/12/1995 16:30	S200	56.45977	-9.04412	197	Chlorophyll
PG172	06/12/1995 21:09	S1300	56.46288	-9.51903	1295.4	Chlorophyll
PG173	07/12/1995 00:17	S1400	56.45853	-9.59281	1394	Chlorophyll
PG174	07/12/1995 02:30	S1500	56.46338	-9.64483	1497.8	Chlorophyll
PG175	07/12/1995 05:45	R1000	56.5204	-9.29364	999.4	Chlorophyll
PG176	07/12/1995 16:05	R700	56.51825	-9.17316	666.8	Chlorophyll
PG177	07/12/1995 17:17	R500	56.52174	-9.10884	452.4	Chlorophyll
PG178	07/12/1995 19:00	R300	56.512	-9.04571	234.6	Chlorophyll
PG179	07/12/1995 19:20	R200	56.50518	-9.04375	223	Chlorophyll
PG180	07/12/1995 20:28	R140	56.5034	-8.93383	141.6	Chlorophyll

Event code	Sampling date & time	Site code	Lat (deg N)	Lon (deg E)	Water depth	Determinands
PG181	07/12/1995 21:44	N140	56.61003	-8.92035	132.8	Chlorophyll
PG182	07/12/1995 22:27	N200	56.62819	-8.97611	145.2	Chlorophyll
PG183	07/12/1995 23:33	N300	56.63969	-9.01799	354.8	Chlorophyll
PG184	08/12/1995 00:50	N500	56.64262	-9.06024	526.8	Chlorophyll
PG185	08/12/1995 01:54	N700	56.64736	-9.09842		Chlorophyll
PG186	08/12/1995 03:25	N850	56.66311	-9.14489	872.2	Chlorophyll
PG187	08/12/1995 05:15	N1000	56.67598	-9.18249	983.4	Chlorophyll
PG188	08/12/1995 07:00	N1150	56.69258	-9.24705	1141.6	Chlorophyll
PG189	08/12/1995 09:51	N1300	56.70415	-9.31775	1291.8	Chlorophyll
PG190	08/12/1995 12:15	N1500	56.73291	-9.39876	1496	Chlorophyll
PG191	08/12/1995 13:00	N1500	56.73384	-9.40133	1501.6	Chlorophyll
PG192	08/12/1995 14:12	N1500	56.73857	-9.40676	1518.8	Pb/Po
PG193	08/12/1995 21:54		56.77181	-9.55541	1724.8	Chlorophyll
PG194	09/12/1995 06:55	N2300	56.97967	-10.974	2374.4	Chlorophyll
PG195	09/12/1995 18:12	S140	56.47415	-8.98912	147	Chlorophyll
PG196	09/12/1995 20:35	S140	56.46553	-8.94141	142	Pb/Po
PG197	10/12/1995 01:10	P200	56.56661	-9.03838	227.4	Chlorophyll
PG198	10/12/1995 06:30	P300	56.5806	-9.0581	332	Chlorophyll

Event code	Sampling date & time	Site code	Lat (deg N)	Lon (deg E)	Water depth	Determinands
PG199	10/12/1995 09:49	P700	56.59115	-9.19477	737.8	Chlorophyll
PG200	10/12/1995 11:30		56.58938	-9.24294	869	Chlorophyll?
PG201	10/12/1995 12:57	P1000	56.59935	-9.28808	991	Chlorophyll
PG202	10/12/1995 14:27	P1150	56.61157	-9.36837	1150.5	Chlorophyll
PG203	10/12/1995 17:15	P1300	56.63125	-9.44247	1284.8	Chlorophyll
PG204	10/12/1995 20:25	P1500	56.65048	-9.58433	1484.4	Chlorophyll?
PG205	10/12/1995 23:18	R1500	56.52626	-9.6605	1489	Chlorophyll?
PG206	11/12/1995 06:20	N1500	56.72919	-9.40817	1505	Chlorophyll
PG207	11/12/1995 17:32	R1000	56.51246	-9.29491	996	Chlorophyll
PG208	11/12/1995 18:30	R1000	56.51513	-9.29407	998	Chlorophyll
PG209	11/12/1995 18:50	R1000	56.51408	-9.29155	990.4	Po/Pb
PG210	11/12/1995 20:30	R1000	56.51846	-9.30103	1015	SPM analysis
PG211	12/12/1995 03:19	WP1	57.12684	-9.56513	1784.2	Chlorophyll
PG212	12/12/1995 07:00	WP	57.106	-9.43897	1550.8	Chlorophyll
PG213	12/12/1995 10:17	WQ2	57.07687	-9.30752	673.6	Chlorophyll
PG214	12/12/1995 12:20	WQ	57.05167	-9.22159		
PG215	12/12/1995 13:40	WQ3	57.03693	-9.15931	201.8	Chlorophyll
PG216	12/12/1995 14:30	WR1	57.02507	-9.10342	151	Chlorophyll

Event code	Sampling date & time	Site code	Lat (deg N)	Lon (deg E)	Water depth	Determinands
PG217	12/12/1995 15:50	WR	57.00181	-9.01065	134	Chlorophyll
PG218	12/12/1995 17:05	NSA1	56.95118	-8.83528	127.2	Chlorophyll
PG219	12/12/1995 18:35	NSA2	56.87122	-8.84066	120	Chlorophyll
PG220	12/12/1995 20:07	NSA3	56.78442	-8.83809	127	Chlorophyll
PG221	12/12/1995 21:13	NSA4	56.70185	-8.83646	122	Chlorophyll
PG222	12/12/1995 22:23	NSA5	56.61777	-8.83863	133.4	Chlorophyll
PG223	12/12/1995 23:42	NSA6	56.5311	-8.84299	139	Chlorophyll
PG225	13/12/1995 02:20	S200	56.46559	-9.05208		Chlorophyll
PG226	13/12/1995 07:15	S700	56.47536	-9.17522	729.4	Chlorophyll
PG224	13/12/1995 12:35	NSA7	56.45828	-9.1558	669.4	Chlorophyll
PG227	13/12/1995 17:36	S300	56.47833	-9.05847	288.2	Chlorophyll
PG228	13/12/1995 21:52	NSB1	56.95214	-9.04938	143.8	Chlorophyll
PG229	13/12/1995 23:17	NSB2	56.86693	-9.05349	183.4	Chlorophyll
PG230	14/12/1995 00:38	NSB3	56.78615	-9.049	420.4	Chlorophyll
PG231	14/12/1995 02:15	NSB4	56.7079	-9.04837	689.2	Chlorophyll
PG232	14/12/1995 03:43	NSB5	56.62334	-9.04897	414	Chlorophyll
PG233	14/12/1995 04:55	NSB6	56.53587	-9.04809	241.8	Chlorophyll
PG234	14/12/1995 06:30	NSB7	56.45895	-9.04687	205.6	Chlorophyll

Event code	Sampling date & time	Site code	Lat (deg N)	Lon (deg E)	Water depth	Determinands
PG235	14/12/1995 10:34	S140	56.46085	-8.96573	146	Chlorophyll

Table 5. Summary of Sedimentation Velocity Tube Experiments

Event Code	Start Date & time	Site code	Lat (deg N)	Lon (deg E)	Water depth	Remarks
SVT1	11/12/95 14:25	N1500	56.74508	-9.42429	1546	1st tube between 5 and 30m. 2nd at 30m.

Table 6. Summary of multicorer deploments

Event code	Start date&time	Site Code	Lat (deg N)	Lon (deg E)	Water depth (m)	Remarks
MC1	07/12/1995 09:10	R1000	56.51364	-9.28999	985	7/7 good cores
MC2	07/12/1995 10:20	R1000	56.51259	-9.26946	935.2	7/7 good cores
MC3	07/12/1995 11:21	R1000	56.51321	-9.29618	998	7/7 good cores
MC4	11/12/1995 08:55	N1500	56.74728	-9.43297	1559.4	7/7 good cores
MC5	11/12/1995 10:10	N1500	56.74639	-9.42649	1551.8	7/7 good cores
MC6	11/12/1995 11:17	N1500	56.74488	-9.42665	1547.8	7/7 good cores
MC7	13/12/1995 09:35	S700	56.47389	-9.16208		7/7 good cores
MC8	13/12/1995 10:19	S700	56.47703	-9.16513	692.6	6/7 good cores
MC9	13/12/1995 11:05	S700	56.47437	-9.16497	694	3/7 good cores
MC10	13/12/1995 11:52	S700	56.47563	-9.16387	689	4/7 good cores

Table 7. Results of sediment core oxygen uptake experiments.

Station	Date	Oxygen uptake rate ($mmol.m^{-2}.d^{-1}$)
R1000	7/12/95	9.5
N1500	11/12/95	6.6
S700	13/12/95	4.7

Table 8. Summary of Bed-Hop Camera Deployments

Event ID	Deployment Date & time	Site Code	Lat (deg N)	Lon (deg E)	Water depth (m)	Notes
CAM1	07/12/1995 13:09	R1000	56.51752	-9.27122	1002	25 frames exposed
CAM2	11/12/1995 12:06	N1500	56.74591	-9.41789	1542	25 frames exposed
CAM3	13/12/1995 15:24	S700	56.46126	-9.16216		25 frames exposed

Table 9. Summary of Drogue Releases

Buoy ID	Release date & time	Site Code	Lat (deg N)	Lon (deg E)	Water depth (m)
24281	04/12/1995 14:13	CIRCLE1	56.2477	-9.0685	159
24285	04/12/1995 14:32	CIRCLE1	56.2611	-9.049	154
24286	04/12/1995 14:51	CIRCLE1	56.2608	-9.0834	161
24290	04/12/1995 15:09	CIRCLE1	56.2456	-9.0984	171
24291	04/12/1995 15:28	CIRCLE1	56.2294	-9.0823	165
24292	04/12/1995 15:49	CIRCLE1	56.2294	-9.0482	155
24298	04/12/1995 16:07	CIRCLE1	56.2454	-9.0344	151
24282	04/12/1995 17:50	CIRCLE2	56.2455	-9.2208	598
24287	04/12/1995 18:04	CIRCLE2	56.2618	-9.2028	544
24304	04/12/1995 18:20	CIRCLE2	56.2604	-9.2366	686
24289	04/12/1995 18:34	CIRCLE2	56.245	-9.2544	752
24305	04/12/1995 18:50	CIRCLE2	56.2295	-9.2362	707
24296	04/12/1995 19:06	CIRCLE2	56.2294	-9.2061	515
24302	04/12/1995 19:28	CIRCLE2	56.2406	-9.1945	440.7
24293	05/12/1995 14:57	CIRCLE3	56.2416	-9.4311	1174
24297	05/12/1995 15:17	CIRCLE3	56.2601	-9.4157	1172

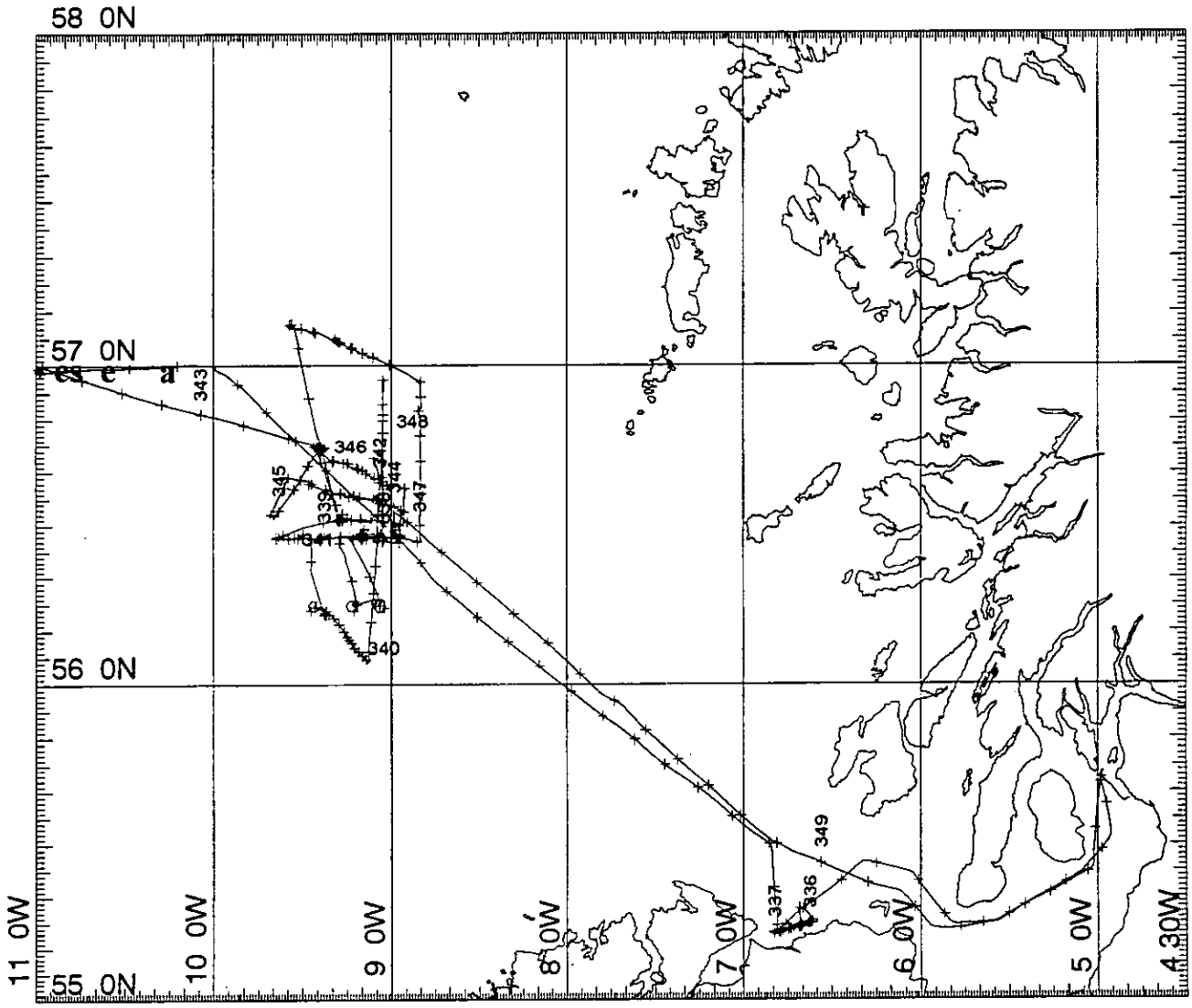
Buoy ID	Release date & time	Site Code	Lat (deg N)	Lon (deg E)	Water depth (m)
24299	05/12/1995 15:33	CIRCLE3	56.2602	-9.4511	1259
24300	05/12/1995 15:48	CIRCLE3	56.245	-9.4672	1253
24301	05/12/1995 16:02	CIRCLE3	56.2297	-9.4504	1194
24303	05/12/1995 16:14	CIRCLE3	56.2306	-9.4208	1142
24284	05/12/1995 16:28	CIRCLE3	56.2453	-9.3986	1122

Table 10. Details of ADCP deployment Challenger 123B/1995

	Deployment							
Site Code	**Date**	**Time**	**Lat (deg N)**	**Lon (deg E)**	**Water depth**	**Serial No**	**Argos No**	**Release No.**
S400	06/12/95	0905	56.4540	-9.0808	398	394	53 (24329	42

8. Figures

Fig. 1 Cruise Track



MERCATOR PROJECTION

GRID NO. 1

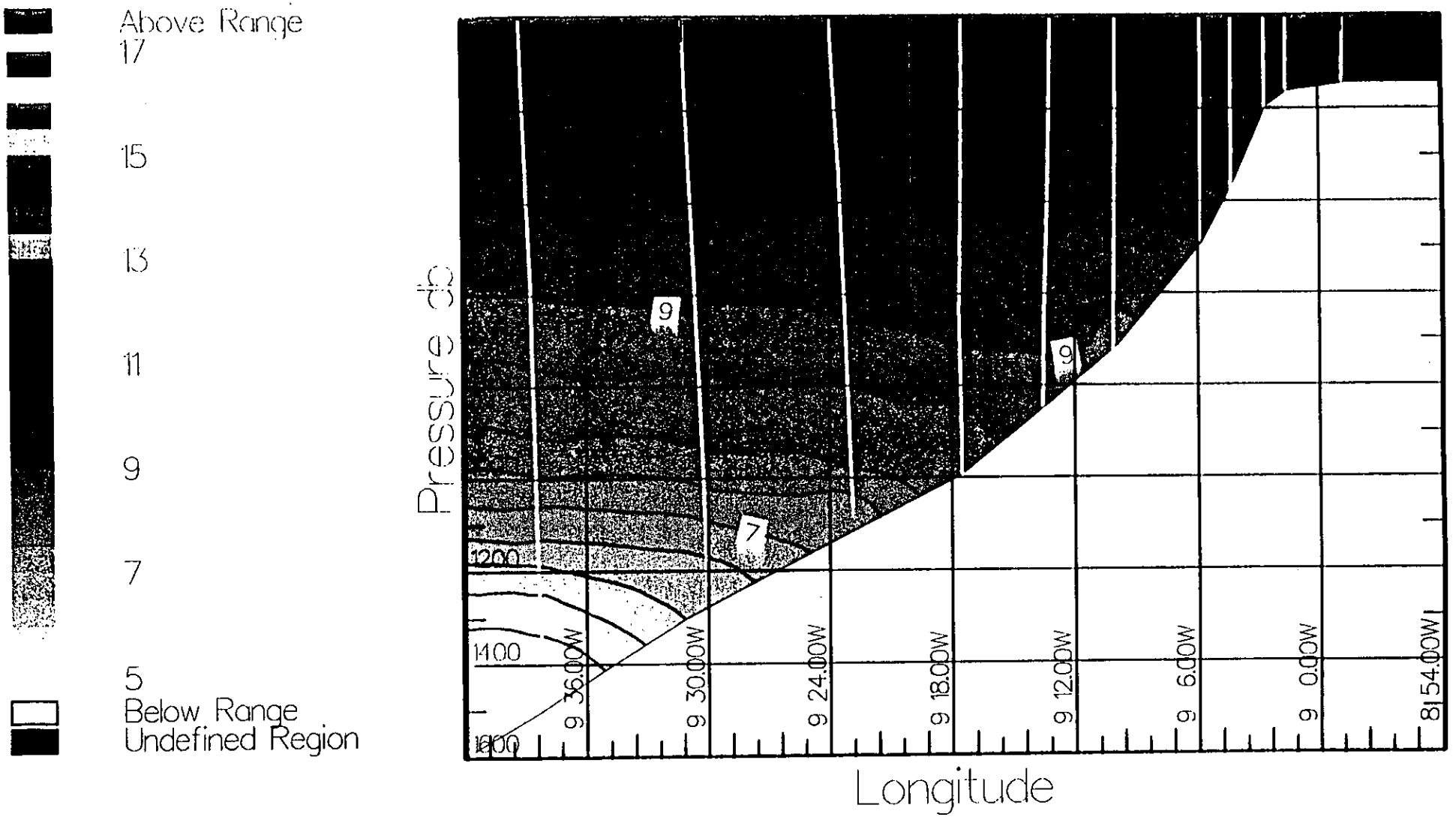
SCALE 1 TO 2500000 (NATURAL SCALE AT LAT. 55)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

Challenger 123B

Fig. 2. **Temperature (°C), salinity (*ppt*), transmittance (*V*) and dissolved oxygen (*V*) transects along the S Line, Challenger 123B. (Uncalibrated data).**

Fig 2a.



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VARIABLE:- Temperature

Fig 2b.

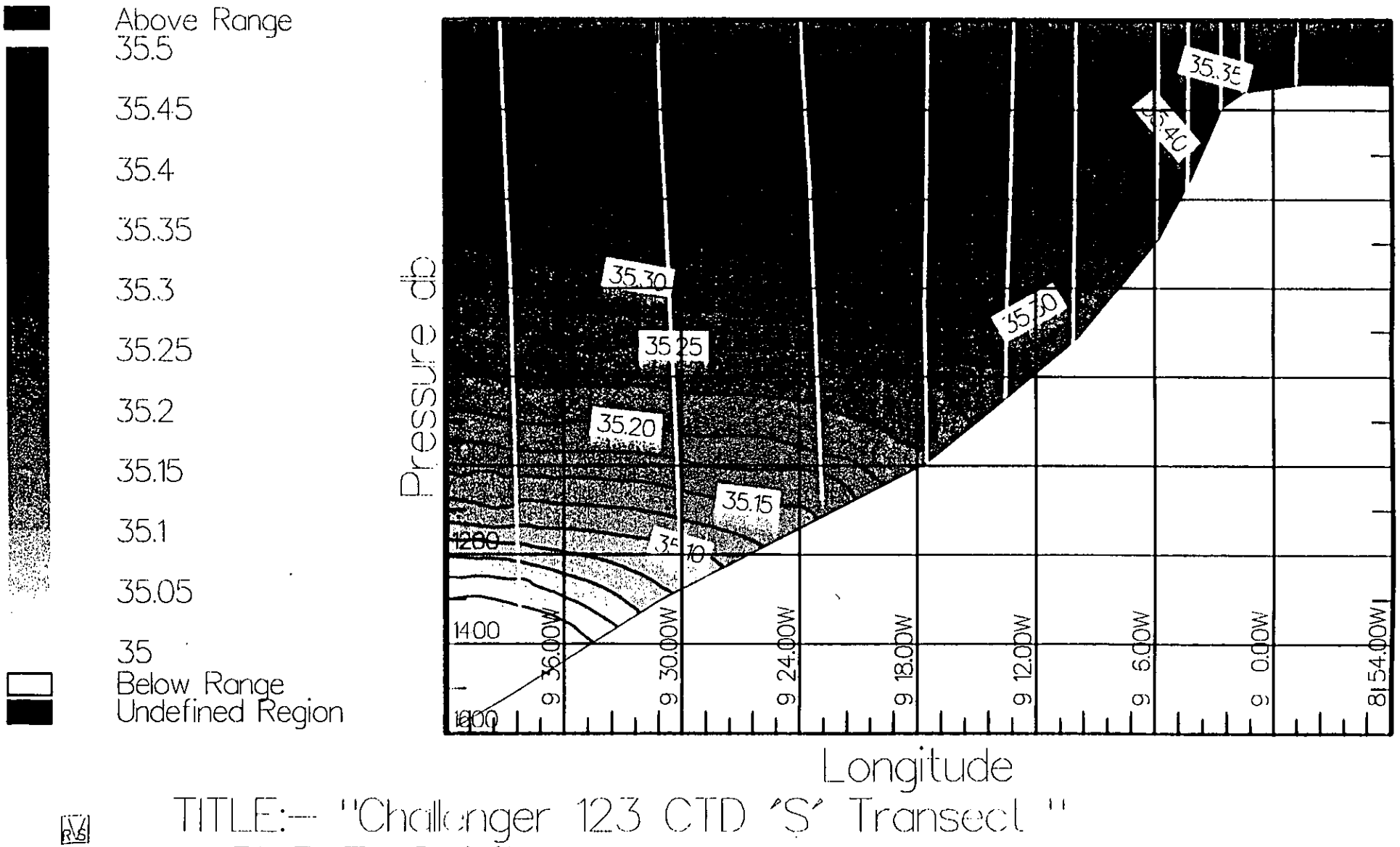

Above Range
35.5
35.45
35.4
35.35
35.3
35.25
35.2
35.15
35.1
35.05
35
Below Range
Undefined Region
Pressure db
35.30
35.25
35.20
35.15
35.10
35.35
35.40
1400
1600
9 36.00W
9 30.00W
9 24.00W
9 18.00W
9 12.00W
9 6.00W
9 0.00W
8 54.00W
Longitude
TITLE:— "Challenger 123 CTD 'S' Transect"
VARIABLE:—Salinity

Fig. 2c

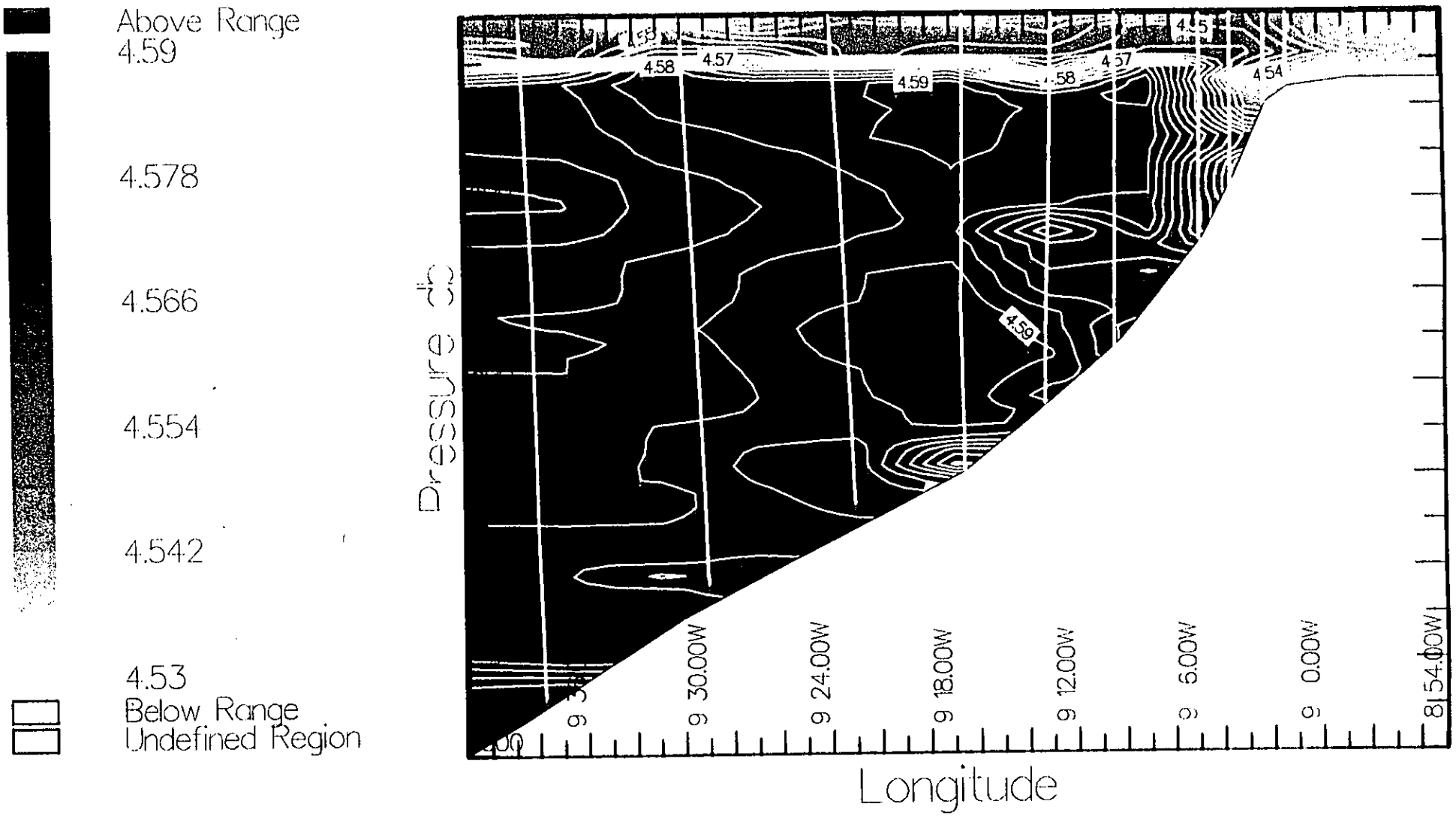

Above Range
4.59
4.578
4.566
4.554
4.542
4.53
Below Range
Undefined Region
4.58
4.57
4.59
4.58
4.57
4.54
4.59
Pressure db
9 30.00W
9 24.00W
9 18.00W
9 12.00W
9 6.00W
9 0.00W
8 54.00W
Longitude
TITLE:- "Challenger 123 CTD 'S' Transect"
VARIABLE:- Transmission

Fig. 2d.

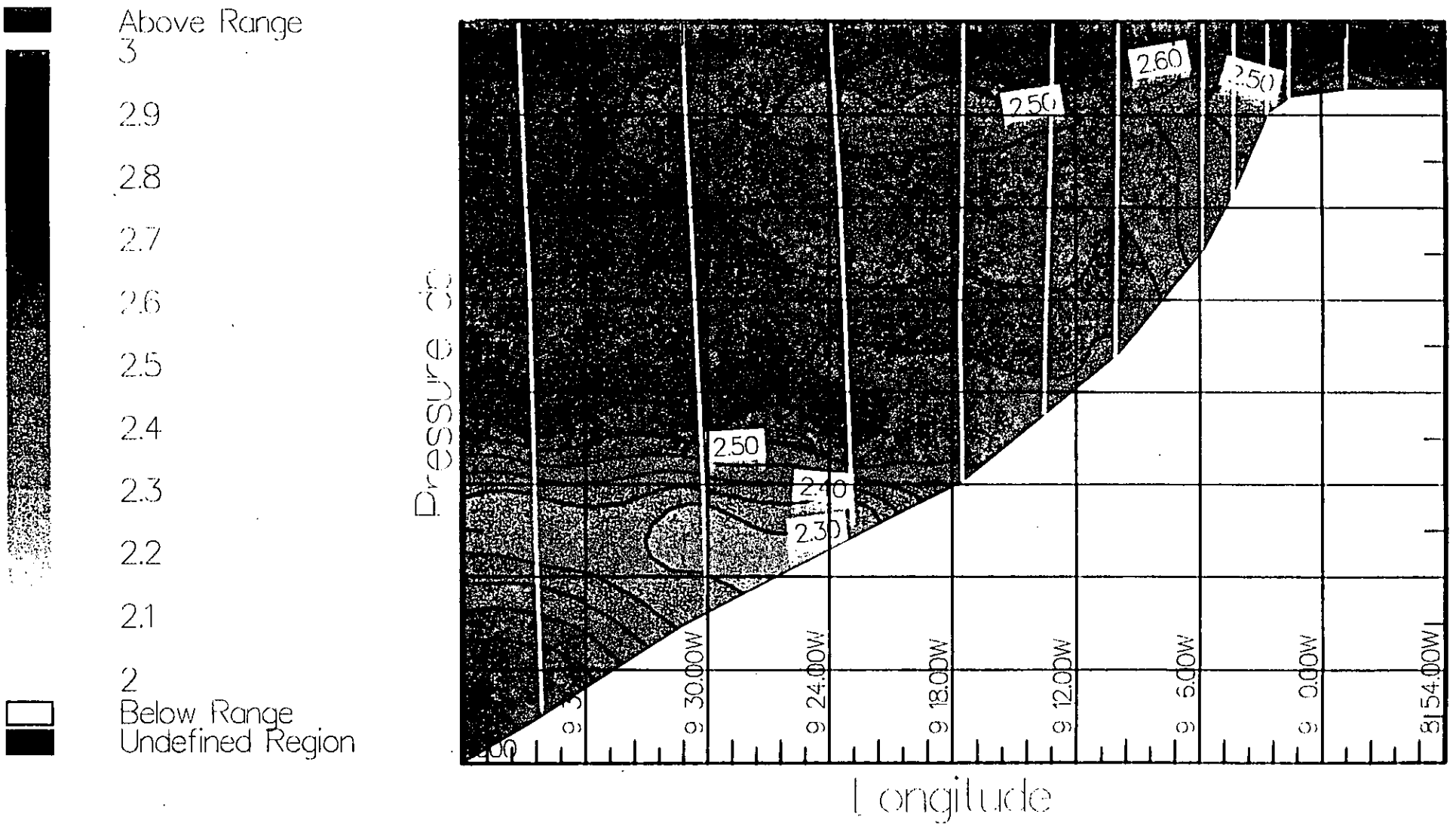
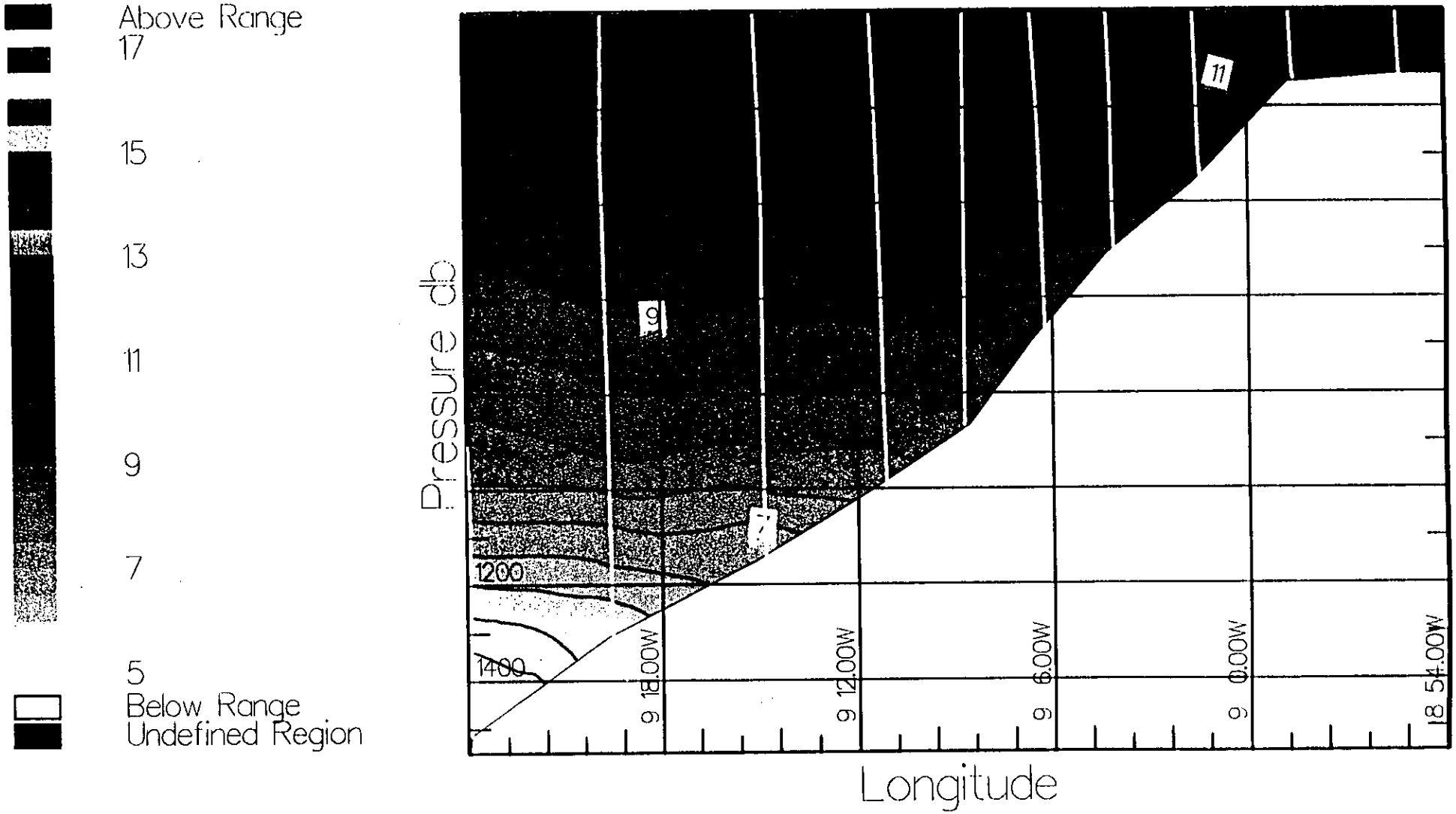

Above Range
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2
Below Range
Undefined Region
2.60
2.50
2.50
2.50
2.40
2.30
Pressure db
9 30.00W
9 24.00W
9 18.00W
9 12.00W
9 6.00W
9 0.00W
Longitude
TITLE:- "Challenger 123 CTD 'S' Transect"
VARIABLE:- Oxygen

Fig. 3. **(a) Temperature (°C), (b) salinity (*ppt*), (b) transmittance (*V*) and (c) dissolved oxygen (*V*) transects along the N Line, Challenger 123B. (Uncalibrated data).**

Fig. 3a



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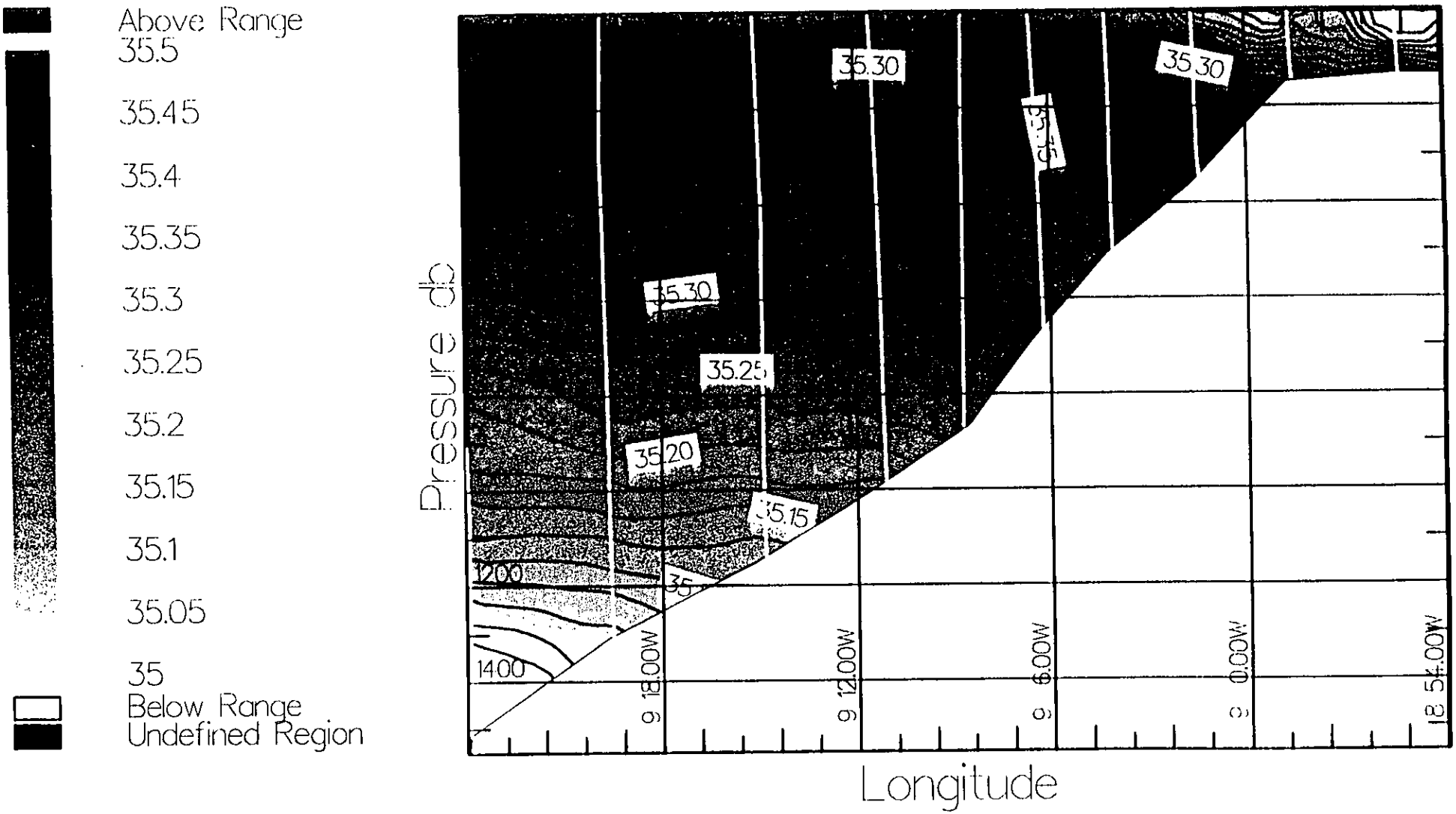
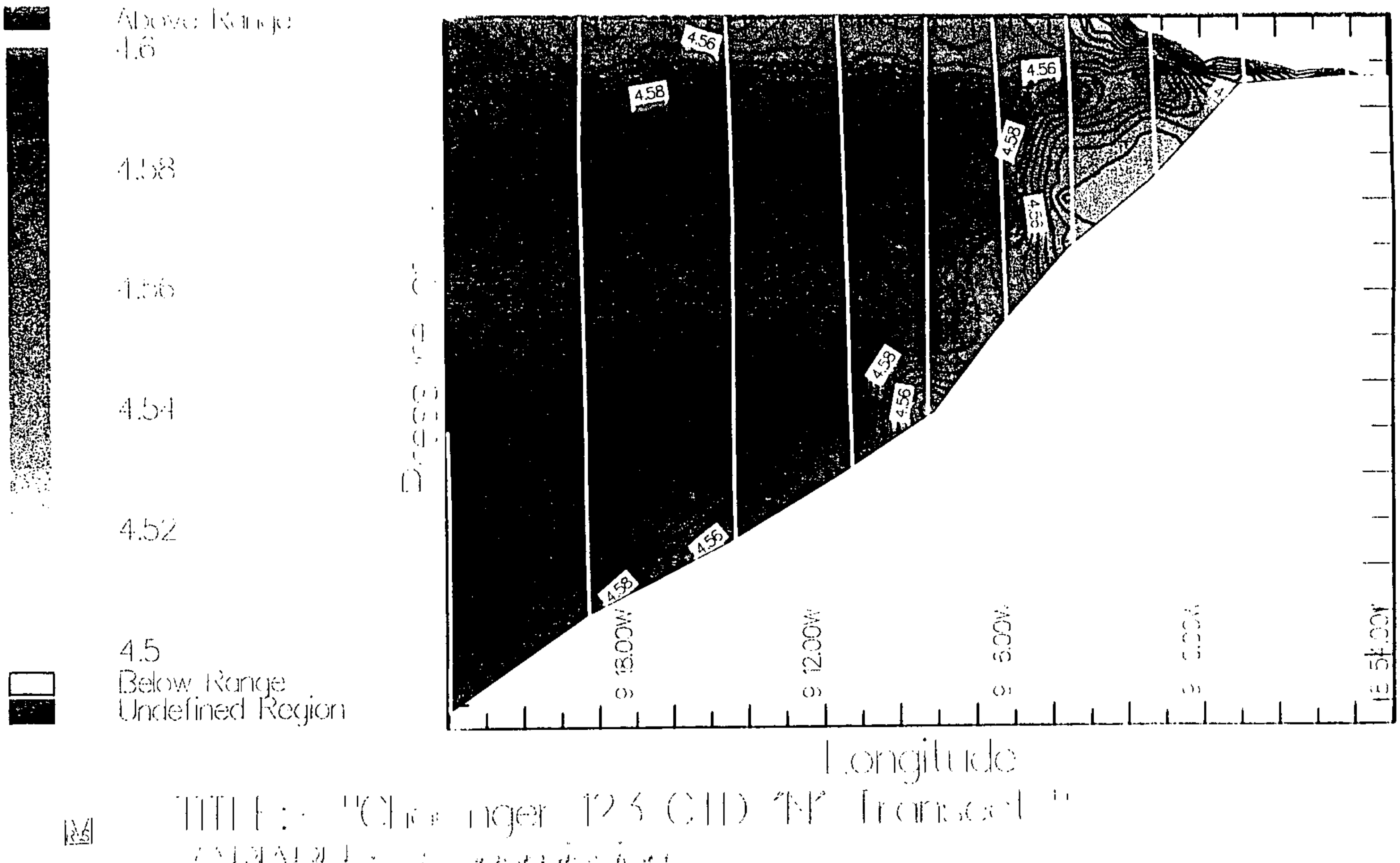
VARIABLE:—Temperature

Fig 3b.



TITLE:— "Challenger 123 CTD 'N' Transect"

Fig. 3c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4.56
4.54
4.52
4.5
Below Range
Undefined Region
4.56
4.58
18.00W
12.00W
6.00W
Longitude

Fig. 3 d.

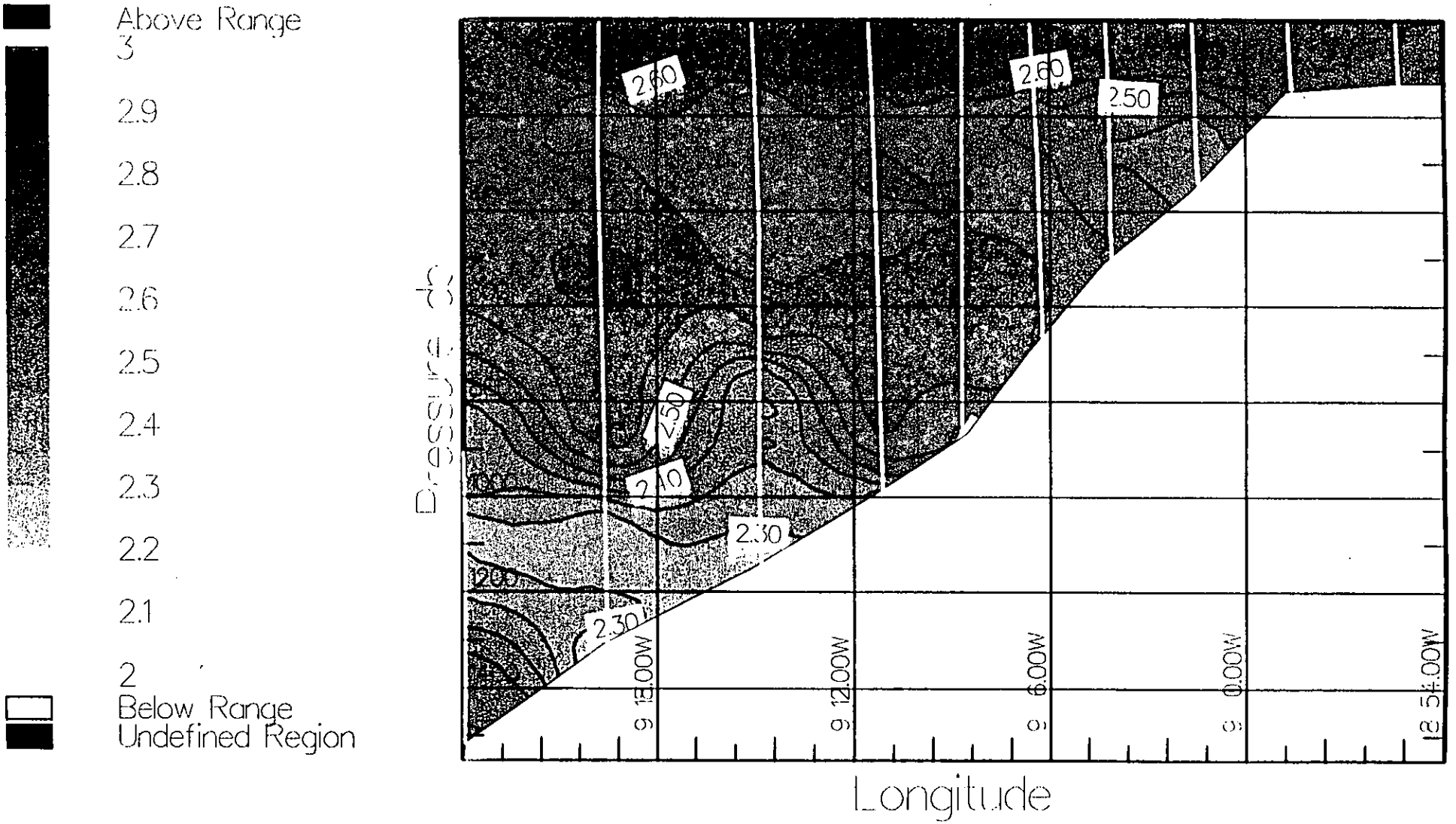

Above Range
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2
Below Range
Undefined Region
2.60
2.60
2.50
2.50
2.10
2.30
2.30
9 15.00W
9 12.00W
9 6.00W
9 0.00W
12 54.00W
Longitude
TITLE:— "Challenger 123 CTD 'N' Transect "
VARIABLE:— Oxygen

Fig. 4 DOC Calibrations.

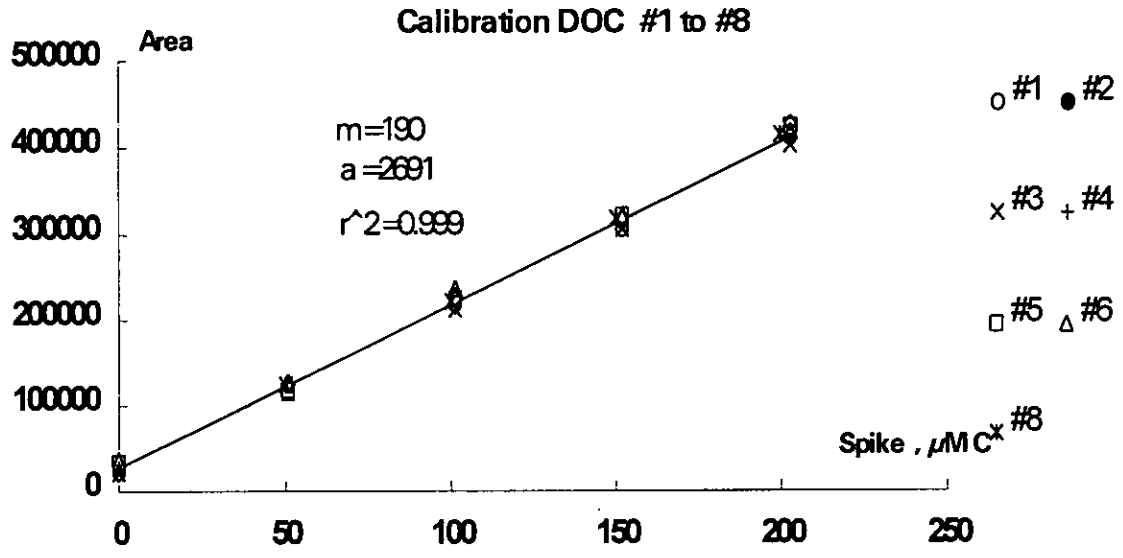


Fig. 5 DON Calibrations

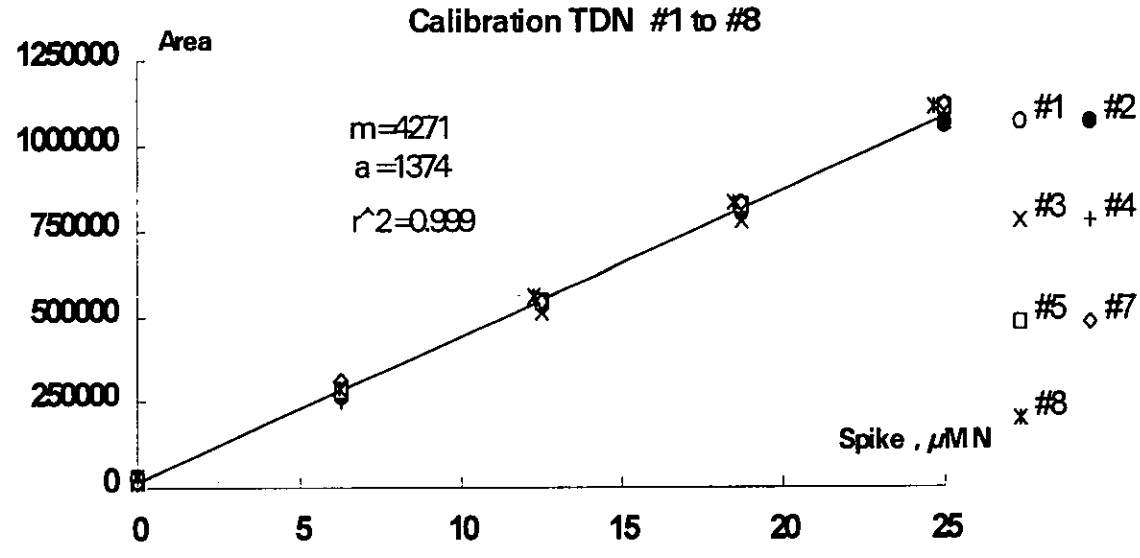


Fig. 6 Vertical profile of DOC at S1500

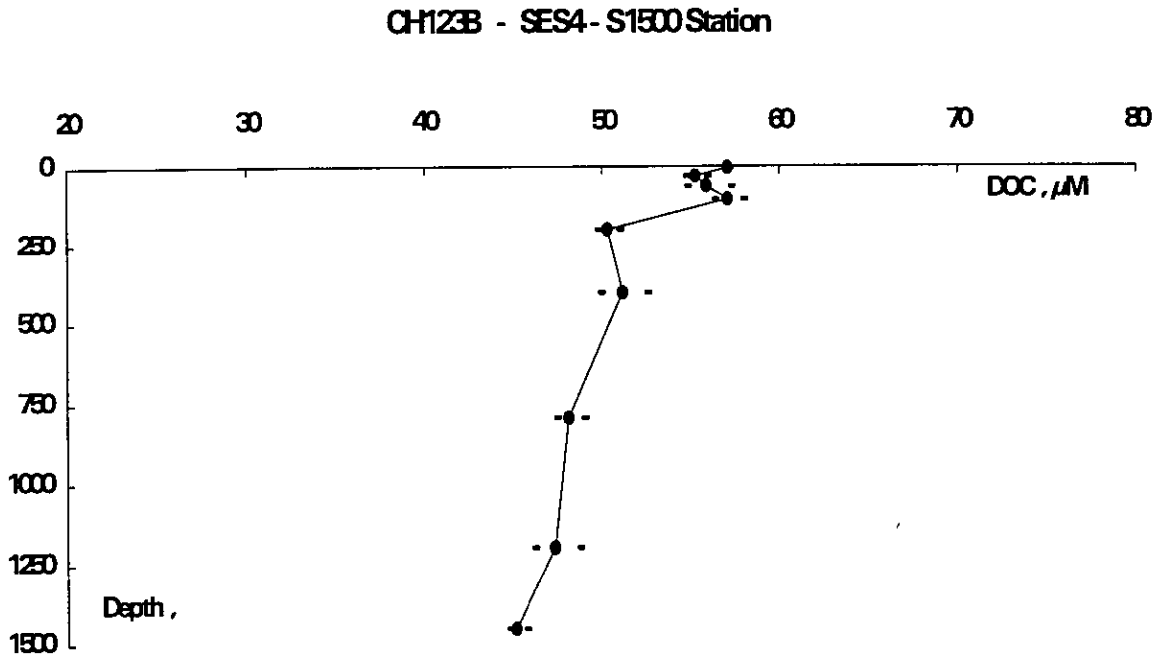


Fig. 7 Vertical Profile of DON at S1500

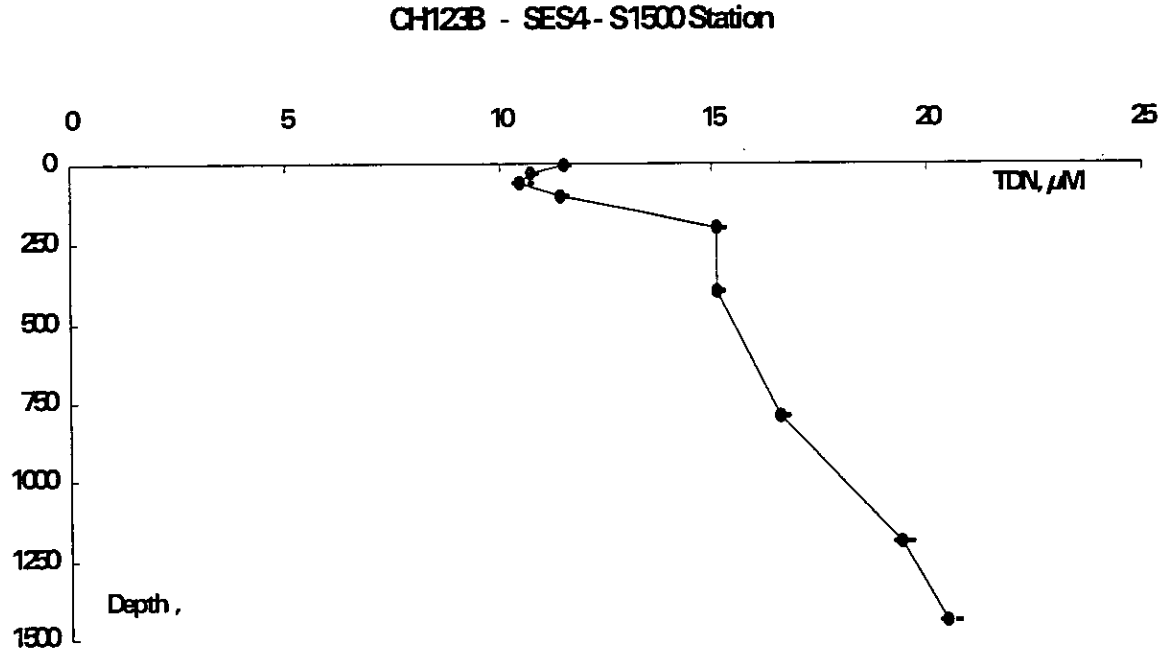
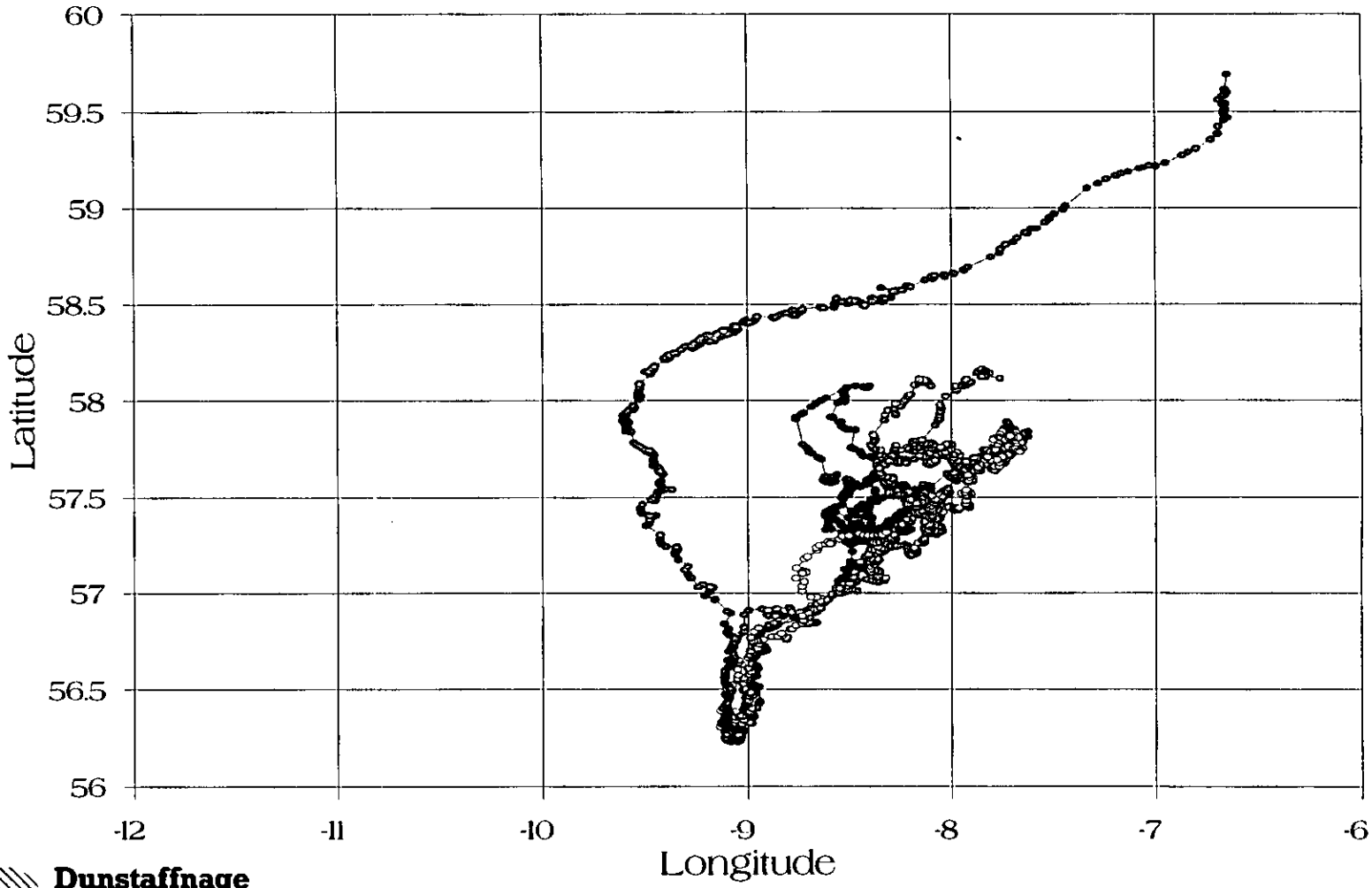


Fig. 8. Drifter positions during December 1996

Argos drift tracks

Circle 1 - 12/95

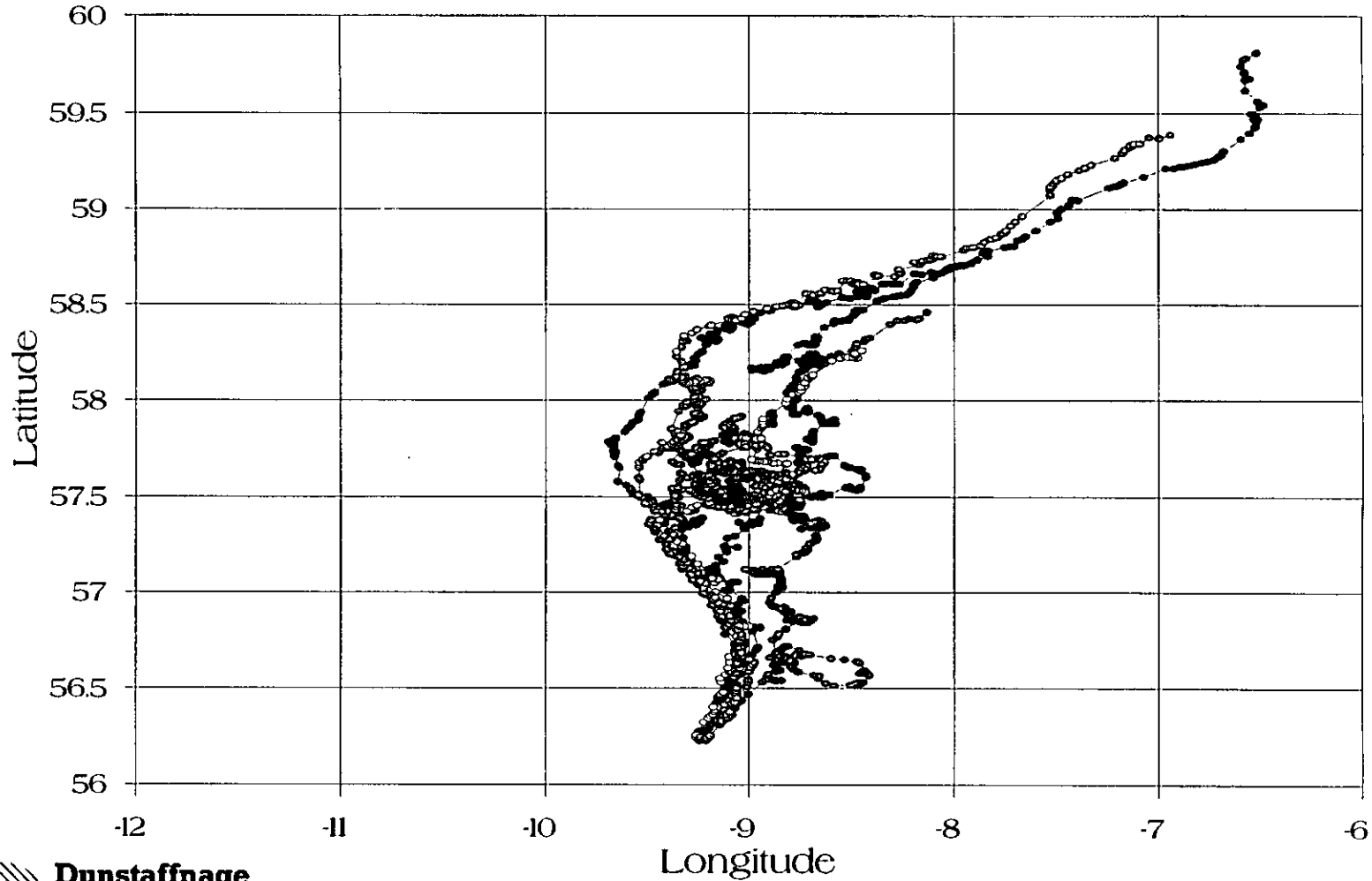


Dunstaffnage Marine Laboratory

LOIS-SES Drifter Programme

Argos drift tracks

Circle 2 - 12/95

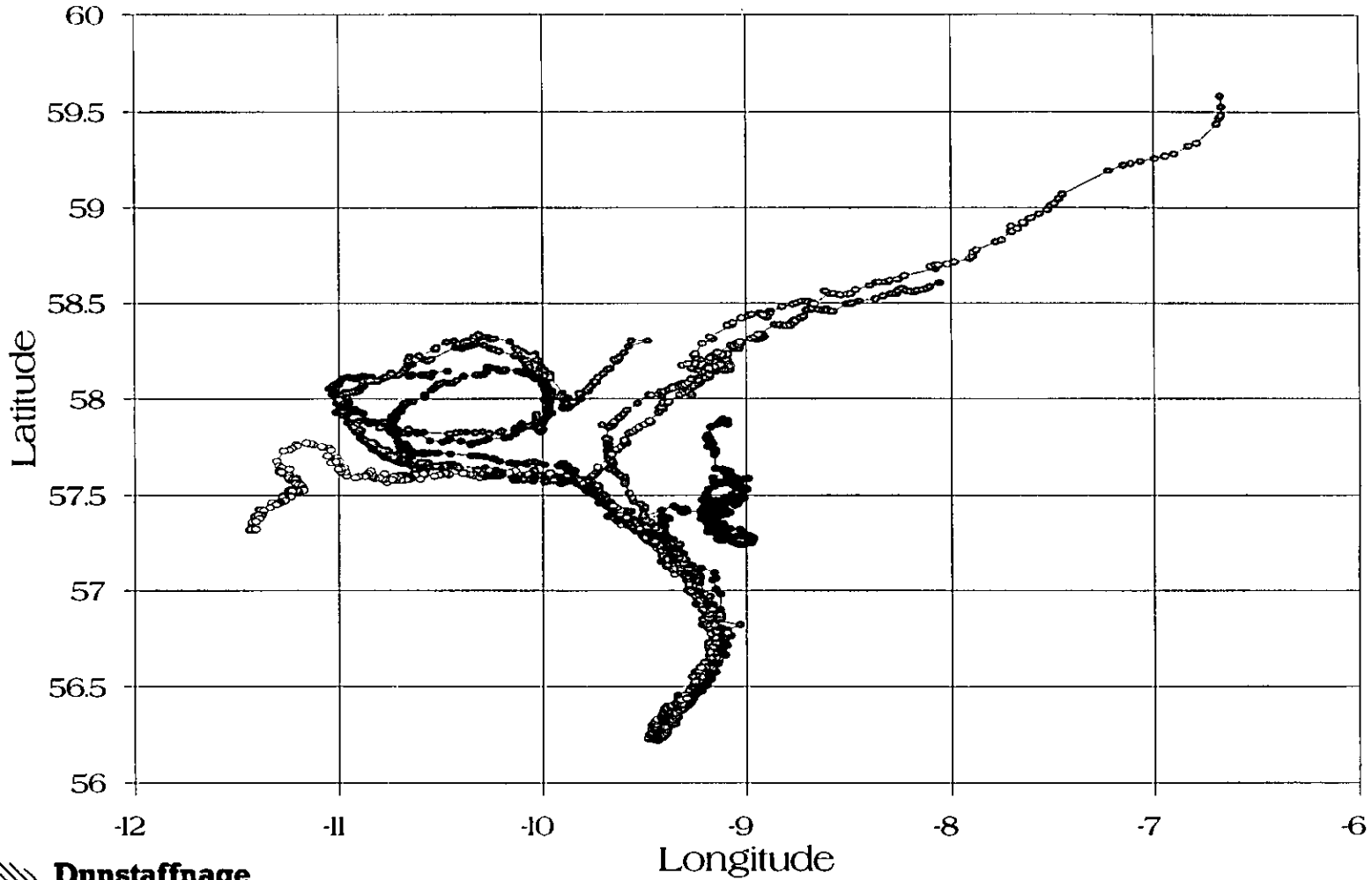


Dunstaffnage Marine Laboratory

LOIS-SES Drifter Programme

Argos drift tracks

Circle 3 - 12/95



Dunstaffnage Marine Laboratory

LOIS-SES Drifter Programme

Appendix 1 Report on circumstances resulting in loss and damage to rosette sampler bottles and thermometers

RRS *CHALLENGER*

Damage report: **Cruise 123B, Station S700, 0730Z 13 December 1995**

Gear lost or damaged: **5, Niskin 10 litre water bottles**
1, SIS reversing thermometer and frame

1. CTD and rosette were deployed in a moderate swell, wind about force 5, without incident or cause for concern.

2. At 60 m below the surface on the up-cast, the bridge was called and asked for permission to recover the CTD. This procedure had been adopted for some days so that the ship might be brought head-to-swell to reduce the chance of rolling during the recovery of the CTD.

3. Bridge replied that realignment of the ship was considered to be pointless owing to the confused nature of the swell, and that recovery should proceed.

4. The winch driver was then instructed by the scientific watch leader to haul in the CTD.
5. The instrument broke the surface too far from the ship's side for the wire to be caught by hand. The ship immediately rolled to starboard, taking the CTD wire further out of reach, then rolled to port, causing the CTD to strike the ship's side, in air, roughly at the static water-line.

6. Bottle no. 1, carrying the thermometer, broke free from the rosette frame and safety rope and was lost. Four other bottles were damaged but recovered.

7. The incident was witnessed by Roy Lowry of BODC, in addition to those on watch.

David Meldrum
Dunstaffnage Marine Laboratory
(Scientific Watch Leader)

13 December 1995