P.O.L.

RRS CHALLENGER

CRUISE 33/88

4-16 AUGUST 1988

NORTH SEA SURVEY

CRUISE REPORT NO. 3

1989

NATURAL ENVIRONMENT RESEARCH COUNCIL

PROUDMAN OCEANOGRAPHIC LABORATORY

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ABSTRACT

This report describes RRS CHALLENGER cruise 33/88, from 4 to 16 August 1988, the first survey cruise of the North Sea Project.

The cruise was successful, with nearly all the objectives attained and very little time lost because of bad weather. All ten moorings were successfully deployed and the majority of the cruise track completed - a lower priority section along 53° 30'N and across the Dogger Bank was omitted because of lack of time. Along the track continuous surface measurements were recorded. CTD profiles were obtained at 109 out of a planned 120 sites. The success of the cruise can, in part, be ascribed to the assimilation of lessons learnt during the shakedown cruise (CHALLENGER 28/88).

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CRUISE REPORT NO. 3

RRS CHALLENGER

Cruise 33/88

4 - 16 August 1988

North Sea Survey

Principal Scientist

M.J. Howarth

1989

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CRUISE OBJECTIVES

1. To follow a set track around the southern North Sea (Figure 1.) making continuous measurements of:-

a) Sea surface temperature, conductivity, transmittance, fluorescence, dissolved oxygen and incident irradiance.

b) Air/sea fluxes.

c) Current profiles.

2. At 120 sites along the track (Figure 2):-

a) To record CTD profiles of temperature, conductivity, transmittance, fluorescence, dissolved oxygen and up- and down-welling irradiance.

b) To obtain water samples with a rosette sampler for calibration of the CTD sensors, for nutrient and trace metal measurements and (once per day) for the estimation of primary productivity.

c) To obtain zooplankton samples (60 sites).

3. To deploy moorings for:-

a) Current meters at sites B,E and F.

b) Acoustic doppler current profilers at sites A,C and D.

c) Thermistor chains at sites A,B,C and D.

NARRATIVE

RRS Challenger cast off from the South Quay, Great Yarmouth, on time at 14.00 4 August - slack water, high tide. After the pilot had left, at 14.50, the non-toxic sea water supply was switched on for the start of surface sampling of temperature, conductivity, transmittance, fluorescence and dissolved oxygen. The ADCP was switched on. The ship steamed north inside the Scroby and Cross Sandbanks to the Scroby Buoy before turning east (see Figure 3 for the cruise track). At 16.00 the transducer pole for the echo sounder was deployed over the starboard side. The first CTD profile (165 at AA) was started at 17.42 - at each profile measurements of temperature, conductivity, transmittance, fluorescence, dissolved oxygen and up- and down-welling irradiance were recorded to within a few (in good conditions two) metres of the sea bed. During the upcast water samples were collected with up to twelve 10 litre Go-Flo bottles on the rosette for calibration of the CTD sensors, for nutrient analysis (nitrate, nitrite, ammonia, phosphate and silicate) and for trace metal analysis. At the CTD cast nearest to dawn water samples were collected for on deck incubation and C14 analysis. At about half the stations vertical trawls were taken to collect zooplankton. The time between CTD stations was usually about 1 to 2 hours.

At 20.00, 4 August, when mooring site E had been reached two sets of acoustics were succesfully wire tested. The single point spar buoy (marker) rig was deployed by 21.17, followed by the pop-up current meter rig (two S4s and one Aanderaa) from 22.21 to 22.51. The survey track was followed towards F but a short detour was enforced after a warning had been received from a Dutch warship to keep 10 miles clear of the wreck of the ANNA BROERE (52 36N 3 10E) and the CTD at AD was omitted. (The detour has since been built into the survey track.) Since the moorings were not ready a CTD profile only was recorded at F at 06.35 5 August and later that morning another short detour was taken between stations AH(171) and AI(172) to deploy the moorings. The marker rig was deployed by 13.30 and the pop-up current meter rig (one S4 and one Aanderaa) from 13.55 to 14.10.

During the rest of 5 August and all of 6 August the survey track in the Southern Bight, off the Thames estuary, in the Dover Strait and off the Rhine was traversed. The CTD at site AQ, in the Dover Strait, was omitted because permission had not been obtained in time from the French. Progress was slowed on the morning of 7 August by fog and on the same morning a failure by the Level B resulted in CTD 185 not being logged by the shipborne computer. The mooring at F was passed at 08.30 and spotted on the radar only. By 10.30 the fog had cleared. An acoustic wire test was performed from 15.00 to 15.30 and site D reached at 17.20. The ADCP was float tested successfully and then deployed by 18.16. The single point thermistor chain rig was deployed between 18.39 and 18.48.

During the rest of 7 August and all of 8 and 9 August the survey track was followed towards Texel and then by large ziz-zags into the German Bight. On the section from the Ems to the Elbe and northwards along the Danish coast a 'red tide' of yellowish-reddish plankton was steamed through, at times in very dense patches. The plankton occupied a thin surface layer and were distributed variably horizontally, although often in the form of ribbons aligned parallel to the weak wind - perhaps marking Langmuir circulation cells. During the night of 9 August Challenger's bow wave was visible since the plankton were being stimulated to glow. Two set of acoustics were wire tested from 12.55 to 13.14 9 August. CTD 215 (CA), off Helgoland, was recorded at 04.00 10 August and then a northward course followed parallel to the Danish coast as far as Esbjerg and Horn's Reef. At 13.20, after CTD 220 (CF), the westward transect along 55 30N began.

A potentially dangerous incident occurred during CTD 224 in which luckily no-one was hurt and no equipment lost. After the CTD profile it was intended to collect a water sample using the Kevlar winch beside the CTD A frame. In the process of switching control from the winch cabin to the deck, the CTD winch started to operate on its own, lifting the CTD up towards the block. Quick action by the seaman stopped it before any damage was done. One cause of this incident was that the handle on the deck control of the CTD winch had not returned to its self-centred off position.

When mooring site B was reached, at 23.50, the ship hove to to wait for daylight. Whilst waiting CTD 225 was recorded at 03.30 and four sets of acoustics wire tested, only two successfully. The marker rig was deployed by 05.24 11 August, the pop-up current meter rig containing three S4s and one Aanderaa from 05.42 to 06.09 and the thermistor chain rig from 06.38 to 07.03.

The westward course towards mooring site A was continued for the rest of 11 August although progress was slowed down by lumpy seas. The mooring site was reached at 06.15 12 August, the ADCP deployed at 07.28 and the thermistor chain rig from 08.04 to 08.26. Two large volume water samples, from above and below the thermocline, were collected at this site for trace metal analysis. The first was obtained from a full rosette of water bottles on CTD cast 233 prior to the rig deployment. The second was obtained on CTD cast 234 about one hour after the deployment, the delay being caused by the time taken for the first set of bottles to empty.

The Northumbrian coast at the end of the 55 30N transect was reached at 22.45 (CTD 240, CY). A southward course was now taken to the mouth of the Tyne (CTD 243, DB at 03.30 13 August), followed by a zig-zag to Tees Bay (CTD 248, DH at 12.00). The apex of the zig-zag (DE) was missed out to save time so that the moorings at C could be deployed in daylight that evening. Two sets of acoustics were wire tested successfuly from 07.24 to 07.46. Whilst in Tees Bay two toroids were sighted, presumably part of the MAFF experiment there. Site C was reach at 19.40, the ADCP deployed at 19.50 and the thermistor chain from 20.07 to 20.18. One large volume water sample was collected from the CTD cast here (253) for trace metal analysis. Since it was now apparent that the survey track could not be completed it was decided to traverse the triangle C to A to the Dogger Bank to C. After the CTD at A (256, 05.30 14 August) progress was again slowed by lumpy seas for most of the day. The start of CTD 262 was delayed by half an hour whilst the CTD wire was freed from the shackle pin of the meter block suspended beneath the CTD A frame. The wire had snagged on the pin presumably whilst taking up the slack - in the dark it could not be seen. C was reached at 02.00 15 August and the toroid light sighted.

A southward course was taken to the mouth of the Humber (CTD 268, DQ at 09.30) and on towards the Wash, interrupted by a circuit round DR, DS, EK which included the deepest CTD of the survey track, in the Sole Pit. The trace metal surface sampling system was tested from 16.00-19.00. The sample is drawn up a polyethylene tube mounted in the PES fish with its orifice protruding. This was the first test of the system, which worked and survived the ship steaming at full speed, although the drag on the tube was sufficient to pull its orifice back into the PES fish. A large volume water sample for trace metal analysis was obtained at CTD 272, EL, at 18.00, in the Humber plume. Station AA was reached at 06.00 16 August, the final CTDs taken (278,279) and surface and ADCP sampling ended at 07.40. The pilot was taken on board at 10.30 and RRS Challenger docked at 11.15.

The cruise had been successful with nearly all the objectives attained. All the moorings had been deployed and CTDs obtained at 109 out of a planned 120 sites. The majority of the CTDs missed were at lower priority sites. Very little time had been lost because of bad weather.

INDIVIDUAL PROJECT REPORTS

Surface sampling equipment (R.Powell)

The total irradiance and PAR sensors on gimballed tables worked well. The gimballed tables have had their damping reduced but will need balancing with levels and weights to get a horizontal platform. The deck transmissometers worked well. Cleaning of these transmissometers was carried out daily by scientific staff. In rough weather the flow through the header tank for the transmissometer was reduced from 25 litres/min to 10 litres/min to eliminate air bubble problems. The deck fluorometer worked well. The thermosalinograph worked well but has, as previously, a salinity offset. The Lloyds chart recorders displaying the horizontal profiles proved their scientific worth, although all have trouble with paper catching in the paper drive sprockets.

Transmittance measurements: Continuous measurements of surface transmittance were obtained along the survey track using two deck-mounted transmissometers (in water jackets) within the flow of the non-toxic supply. Flow rates through the water jackets of 20-25 litres/min were maintained for most of the cruise to achieve a horizontal resolution of 100-150 metres. During periods of more stormy weather the flow rate was reduced to about 10 litres/min to reduce aeration effects, with a consequent unavoidable reduction in horizontal resolution.

Vertical profiles of transmittance were obtained at all CTD stations using a transmissometer mounted horizontally near the bottom of the CTD. These profiles approached to within 1-2 metres of the sea bed.

Calibration samples: Water samples were taken at 3 depths (e.g. surface, mid-depth and bottom) using the rosette sampler at the following CTD stations:

165-220,222,224,226,228,230,232,236,240,241-262,264-278

For each sample between 1 and 6 litres were filtered through pre-weighed 0.45 micron membrane filters. The filters were then rinsed with distilled water, dried in a laminar flow cabinet and stored in individual petri-dishes.

Samples were also taken at intervals from the 'PPIMS' water jacket transmissometer.

Problems.

1. Some conflict in the use of the only laminar flow cabinet by trace metal, air-sea fluxes and supended sediment experiments. Action required: RVS is supplying a cabinet for the use of the suspended sediment experiment.

2. The tap above the flow meters to take samples from the non-toxic supply is broken. Action required: RVS to replace tap please.

3. The curtain in the Fish Lab did not provide sufficient protection especially during windy conditions when it 'flapped around a lot'. Action required: RVS to consider installing a wooden partition with door, bolted to the rails.

Biology (A.Pomroy)

Primary Production: Eleven on deck 14C-CO3 uptake experiments were completed at stations 168,177,185,195,204,215,225,232,244,256,265. Samples were incubated in triplicate (with dark controls) at six simulated depths for 24 hours. No problems were encountered.

Chlorophyll: Surface, mid-depth and bottom water samples were filtered at each station to calibrate the on-deck and CTD fluoremeters. In addition samples were collected from each water bottle used in the primary production experiments.

Phytoplankton samples: Replicate 50 ml samples were collected from the surface Go-Flo bottle at every station in the southern and coastal parts of the cruise track, and at intervals on the more northerly legs. One sample was fixed with buffered formaldehyde solution and the other with Lugol's iodine solution.

Dissolved oxygen: An ENDECO type 1125 pulsed dissolved oxygen instrument was run continuously along the cruise track using sea water from the non-toxic supply. Replicate measurements were recorded at 15 minute intervals. No data were recorded between 1900 GMT on 11 August and 0944 on 12 August due to a computing error. No other problems were encountered with this system. Winkler titrations, in triplicate, were performed at intervals on samples from 36 CTD water bottles to calibrate the dissolved oxygen probe on the CTD. A further 39 calibration samples were taken from the non-toxic supply for the ENDECO 1125 pulsed dissolved oxygen instrument.

Nutrients (R.Howland)

Nutrient analyses were carried out at all stations and depths. However, problems were encountered using nitroprusside for the ammonia analysis, and no ammonia data will be available for this cruise. It appears that the phenol / nitroprusside reagent only remains stable for a short period. The symptoms are an increasingly sharp baseline drift, descending into large random noise!

It is suggested that the method of Mantoura and Woodward, using ferrocyanide, might perform better.

On the whole the auto-analyser system functioned quite well, but there were several problems. Firstly, regular checks during the cruise showed the efficiency of the Cu/Cd reductor column varied between 84% and 98.7%, randomly, for no apparent reason. The cadmium wire method of Stainton is more efficient and easier to set up. Secondly, a lot of editing will be required to take out optical interference at the end of the sample peaks of the nitrite and silicate channels at low concentrations.

The computer makes the system a little inflexible, but works well for the CTD stations. If surface sampling between stations is required, then they should be analysed without the computer, and the concentrations either worked out by hand or edited into a computer file later. To this end, and for general editing it would be a great advantage to be able to input chart recorder peak heights, since there is no quick way of relating ADC units to peak height.

In addition, dissolved aluminium analyses were carried out at most depths on 82 stations. Concentrations ranged from 1 to 2 nM Al in the central northern region, to 15 to 18 nM Al in the plumes of the Weser, Ems and Rhine in the south.

Zooplankton (H.Witte)

Zooplankton samples were obtained at 60 stations, Table 1; 10 were in the open sea, about 25 in coastal waters, and the same amount in special areas like the Dogger Bank, the German Bight and north of the Frisian Isles.

On all the stations hauls were made with a big vertical net (diameter 70 cm, mesh width 300 microns) to collect and quantify zooplankton bigger than 300 microns (cheatognats, mysids, hydromedusa, adult copepods etc.) Where possible trawls were made by hand with a small vertical net (diameter 18 cm, mesh width 50 microns) to get an impression of the zooplankton too small to be caught by the big net. All together both trawls took less than 10 minutes on each station.

The samples were preserved in a 4% formaldehyde solution, and will be taken to NIOZ (the Netherlands Institute for Sea Research) where they will be analysed.

All the objectives were achieved.

Trace metals (G.Millward, A.Tappin, A.Turner)

Dissolved trace metals: The main objective of this first survey cruise, to generate sufficient samples to give good spatial and vertical coverage within the bounds of the survey track, has been achieved. The rosette/CTD system has worked well, as have the six GO-Flo bottles modified for trace metal sampling (although one is being taken to Southampton for minor repairs to the cording). With this system in excess of 150 samples have been collected for subsequent shore-based analysis for a range of dissolved trace metals (Cd, Cu, Mn, Ni, Pb, Zn). To complement these studies over 40 samples of suspended particulates have been taken for subsequent particulate metal determination (total and acid-leachable). A limited number of (surface) samples have also been collected using Kevlar line. In addition, a small number of surface samples have been taken using an underway pumping system, deployed for the first time during this cruise. Here, the sample is drawn from an acid-cleaned polyethylene tube (the take off point is located in the clean chemistry container) through which seawater is pumped via a compressor-driven Teflon-lined bellows pump mounted near the PES fish (forecastle deck, port side). The compressor is located in the anteroom of the clean container. Sampling is carried out at ca 4 m depth (i.e. just below the hull) by deploying the PES fish, through which the polyethylene tube is fixed so that the tube intake is proud (ca. 10 cm) of the fish nose. Some problems remain concerning the drag on the tube, and solutions are in hand to reduce this.

Collected samples will be analysed at Southampton to assess the cleanliness of this sampling approach.

Samples for antimony and cadmium isotope determination have also been collected for groups at Southampton and Cambridge Universities.

Particulate trace metals: The objective of this work was to collect suspended solids from strategic locations in the North Sea in order to define the sources and sinks for particulate trace metals. Procedural difficulties were overcome in the first two days of the cruise and the three chemists maintained an effective 24 hour sampling routine. The sampling was carried out using ultraclean 10 litre Go-Flo bottles which were often used in pairs to obtain 20 litres of water for filtering. Large quantities of water ($5 < \text{volume in litres} < 30$) were filtered through acid-washed 0.4 micron Nuclepore membranes (142 mm diameter) which were held in a filter press provided by RVS. Four filter presses were made available but only one was fully operational. The other three leaked because the 'O'-ring seals could not be properly seated in their grooves. These presses will have to be made operational prior to the next trace metal survey because the delay in filtering may lead to sample modification during standing. During the cruise 50 particulate samples were obtained.

General: Go-Flo bottle rack. The paintwork on the rack and cover is now badly flaking and cracked and there is a significant potential for sample contamination. In the near future the rack and cover needs to be repainted with a hard finish white epoxy paint. In addition sealing the gap between the rack and the container roof would prevent rain / seaspray transporting garbage from the roof into the rack. In the longer term thought needs to be given to the construction of another rack in more appropriate material.

The new stage built at the foot of the rack became a repository for wires, tools, equipment etc., especially prior to and after mooring operations. This rendered it dangerous for chemists loading and unloading bottles, particularly in rough weather. The stage and passage to it from the CTD needs to be kept clear at all times to avoid accidents.

Clean chemistry container. People traffic into and from the container needs to be reduced to minimise the potential for contamination, and this can be done by providing a second clean air cabinet in the main laboratory for use by gravimetrics and atmospherics, and by installing a water still in the wet laboratory for micro-nutrient analysis.

The air-conditioning unit in the container has been used during the cruise, although frequent (every other day) defrosting of the condenser was required. The general purpose alarm (ship to container and vice versa) was satisfactorily installed during the first week; however the smoke detectors in the container did not work.

Air/sea fluxes (G.Bradshaw, C.Ottley)

Organic / trace metals:

Aim: To collect and determine atmospheric loadings of organic / inorganics and relate to point sources and study seawater solubilities.

Results: An excellent survey has led to the group collecting the following samples:-

Organics	13 x Hi-vol
Inorganics	14 x Hi-vol
Cascade Impactor	3

Experiment problems: A drop of pressure has occured in the organic / cascade impactor pumps (port and starboard). These will have to be checked before the September survey cruise. Hose-splitting has occurred; the Liverpool group need to seek an alternative material. The wind detector indicator gives a good warning about funnel contamination but in strong winds sampling can continue out of the zone previously considered.

The replacement of filters during darkness should be done whilst at a CTD station, when the bow light can be lit by the bridge.

Marine derived aerosols: Wet and dry deposition in the marine environment is complicated by a significant proportion of material being resuspended. The aim of this work is to try to establish what the proportion is. This will allow terrestrial derived loading to be calculated via the simple subtraction of the results obtained in this work from those obtained in the work of Liverpool University. This can also be applied to the work on rainfall by the University of East Anglia.

The equipment worked well, however some electronic problems need resolving. This should prove relatively simple. Hopefully on later cruises the equipment will be able to sample on the starboard as well as the port quadrant.

Rainwater sampling: Since rainwater is a major mechanism for atmospheric deposition, its measurement is important in assessing the pollutant / natural budget for the North Sea.

Procedure: The major aim is to collect rainwater for metal analysis and major ions eg SO4 and NO3. This entails the use of four rain collectors, one of each type on the port and starboard bridge wings. Two factors play a role in collecting an uncontaminated rain sample. The first is sea spray, which must be kept to a minimum. The second is funnel smoke. This can be reduced by sampling only in a bow wind or by opening the port or starboard collectors depending on the wind direction.

Problems: Access to the bridge wings can be hazardous in strong winds, thus this should be done at CTD stations where the ship's motion is greatly reduced.

Only two major rainfall samples were collected. The other events being of minor intensity resulting in samples too small to enable analysis.

General: A second laminar flow hood on Challenger is essential. This had been requested but was not ready.

The ship's officers and crew have been very heplful, particularly the officers on the bridge who provided weather information on a regular basis.

Moorings (D.Flatt, R.Powell, J.Howarth)

Ten moorings were succesfully deployed during the cruise. The deployments went well, due mainly to the excellent crew and good weather. The view of the working area on the after-deck of the crew operating the auxiliary winches is severely restricted by the clean chemistry container.

Acoustic doppler current profilers in sea bed frames were deployed at A, C and D (POL); thermistor chains on single point moorings beneath a toroidal buoy at A, B, C and D (POL); S4s on pop-up moorings with separate marker buoys at B, E and F (RVS). All acoustic releases, including spares, were wire tested before deployment. There were signs of water in the spar buoy SF1 (marker rig at B), perhaps from recent deployments but it was little, so was laid. The S4 current meters were checked to see if they had started by detecting their radiated magnetic field with a transformer as a pick up connected to an oscilloscope. Information about the deployments is given in Table 2.

Shipborne acoustic doppler current profiler (ADCP) (R.Powell)

The ADCP was satisfactory but the A (high density) disc drive of the controlling PC requires attention. The data were logged on drive B. The gyro heading input failed, resulting in data quality impairment between 18.30 8 August and 19.00 12 August. No fault was found and on reassambly the ADCP was working again.

Computer (A.Robinson)

Level A: All level A systems worked well, requiring no attention throughout the cruise. Problems that were noticed on the shakedown cruise had been fixed (both hardware and software). The following sensors were logged - EM log, gyro, MX1107 satellite navigation, Decca, solarimeter, PAR light meters, thermosalinograph, fluorimeter and two deck transmissometers, Simrad depth recorder and RVS CTD. Surface data were sampled at 30 second intervals and navigation calculated similarly.

Level B: The biggest source of problems on the cruise was the Level B where there were repeated crashes, whose cause is not known. One possibility is the lack of air-conditioning on Challenger, since the temperature in the Level B box reached 46 degrees Celsius. The Level B was pulled out of the rack and run with its lid off to help cooling, but crashes were still common. The crashes were mostly limited to the console, with logging carrying on for a short time at least. Since the Level B alarm is run from the console line the system had to be rebooted to allow monitoring.

Steps have been taken to reduce the heat in the Level B box by providing a separate box and power supply for the Winchester Disc. The new configuration will be tested on Challenger 34; if the problem is not cured then the entire level will need replacing.

If heat is not the problem then possible causes are the console terminals (M2080s which are getting old) and the software which drives the console display. The second of these two is harder to check since it has not been possible to recreate the fault by bringing the Challenger Level B back to the lab.

PC-SUN translation: An IBM PS2 was installed for transferring data collected on other PCs to the SUN - dissolved oxygen (AMSTRAD) and shipborne ADCP; nutrient data from the auto-analyser was not made available. The transfer of the data went very smoothly, the oxygen transfer taking about 5 minutes per day and the ADCP taking a little longer due to the amount of data transferred.

The only problem with the transfer was that the time stamping on the oxygen files was wrong because the AMSTRAD software clock runs at one third the speed of an IBM. Therefore the oxygen data while being at fifteen minute intervals were time stamped at five minute intervals. No attempt was made to fix the problem.

Difficulties were experienced with the PS2 3 1/2 inch disc drive but these did not prevent data transfer as all data to be transferred came on 5 1/4 inch discs. Whether the problem lies with the discs or the drive has not yet been determined.

Level C: The Plessey system was used only at the start of the cruise to download the Level A CTD. Throughout this report references to the Level C refer to the SUN workstation upgraded Level C.

The configuration of the Level C was as follows:-

SUN 3/60M + 2x141 megabyte Winchesters + 1/4 inch cartridge.

SUN 3/60FC + SCSI tape controller + 1/2 inch tape.

MICOM ethernet terminal server to link peripherals and Level B to Level C.

The configuration of the workstations managed to cope with the workload. The Challenger is not designed for the deployment of hardware such as this with the bench space only allowing knee room in front of one workstation.

The file server carried out parsing of data along with relative motion calculations and CTD processing. This load brought the machine very close to its limits. In theory the full system of three workstations has much greater capacity than the old system but in practice with only one operator the work is done for the most part on one machine. The lack of space especially in bad weather makes moving from machine to machine awkward and the way in which work must be allocated to different machines is not easy. Conscious thought is required all the time to make the best use of the system. Having said that, except for the contouring requirements, with a little thought and because of the nature of the North Sea Project a survey leg could be carried out with a single workstation if necessary.

The B-C link via the ethernet (using v24 and a port on the terminal server) worked well but when clearing backlogs of data was a little slow. Using the terminal server provides a more robust link than when using an RS423 port on the workstation.

The Nicolet and Advance plotters were connected to the MICOM and worked well. Given the quantity of plots to be done their production is highly dependant upon the Nicolet plotter being usable. If for some reason the plotter cannot be used i.e. breakdown or malfunction due to bad weather the same results could not be achieved using the Advance flatbed since it is too slow and needs supervision for paper changing.

The line printers on board (paper tigers) are of poor quality so instead of giving the PSO hardcopies of the station log at the end of the cruise the file was transferred to an IBM disc.

While making GF3 tapes it was noticed that the system was sensitive to bad tapes, 3 out of 7 tried were unusable. It is possible that the tape driver does not retry as much as the Plessey system. The most worrying factor is that after a failure to write to tape the writing process continues regardless of the failure.

CTD processing: The convention decided upon was that raw files would be called ctdrxxxx and processed files ctdpxxxx where xxxx is the station number (i.e. for station 165 ctdr0165 and ctdp0165). This system allows up to 9999 CTD dips to be recorded, which should be enough for the North Sea Project.

Overnight the data were left to accumulate in the raw file and the following morning processed, cleaned and split into separate station files. This backlog did not take too long to process.

Once renamed the processed data were cleaned by taking out all records where the pressure was zero - the chances of real data having zero pressure are too small to worry about. This was necessary because of the number of spikes in the data. The clean data were then plotted.

It should be noted that the CTD data are only calibrated to engineering units from the counts produced by the deck unit. These numbers should be the same as used on the BBC micro system. No calibration should be carried out on the data to make them match experimental results. The oxygen calculations produce results about one third of the actual value because the Neil Brown oxygen calculations allow a multiplier and offset to be applied to oxypc. The standard values are 0.338 (multiplier) and 0.0 (offset). Since proctd has no way of applying an offset (the multiplier can be applied via the calibration of oxyc) and to avoid confusion, the multiplier has not been applied. In general calibration to match experimentation should be done ashore, the data collected on the survey legs should be consistent and not reprocessed to suit PSOs.

Plotting: Plots were produced as specified of the cruise track (the land outline was not available but has now been installed), station positions, CTD profiles and stacked time series plots of surface measurements. The time taken to produce multiple copies on the Nicolet of the CTD profiles is not prohibitive and paper usage can be minimized by plotting 3 copies to a column. A transect plot was attempted but the process was too labour intensive. While handing over to Andrew Lord the process of extracting the data from the CTD files and joining it to the navigation was automated. For transects along lines of latitude or longitude the process is relatively simple, however other lines require a great deal of work to determine the x coordinate.

Contour plots of surface salinity and temperature were produced. Because the data for these plots are not available until the logging has stopped (or very close to it) the production of contour plots must come at the end of the cruise. At that time all processing, data transfer, backup, archiving and plotting has to be finished ready to be taken away when the ship docks. On Challenger 33 the last CTD station was at 0800 and logging stopped immediately afterwards whilst the ship docked at Great Yarmouth at 1200.

As an experiment a contour plot of salinity data was made about halfway through the cruise. The interpolation of the data took 50 minutes, creating the plot and making a hard copy took about 15 minutes and extraction of data from the RVS files into a form that UNIMAP can understand took around 10 minutes. Since interpolation seems to be carried out in memory and was done on the discless workstation there is little room for improvement, except cutting down the data set. At the end of the cruise the interpolation for the temperature and salinity contours took 30-40 minutes each; the data were subsampled every minute to give 15,000 points, the maximum allowed is 20,000.

Table 1
CTD Station List

Stn No.	Site	Start Position Lat.	Long.	Depth m	Start Time Yr	Day	Hr.Min	Work Code	Comments
165	AA	52 43.5N	1 55.8E	27	88	217	17.42	A	
166	AB	52 43.1N	2 25.5E	49	88	217	23.26	B	
167	AC	52 39.8N	2 49.8E	44	88	218	01.43	A	
168	AE	52 37.3N	3 46.1E	29	88	218	06.33	A	C14
169	AF	52 37.6N	4 1.1E	27	88	218	08.03	B	
170	AG	52 37.6N	4 20.7E	22	88	218	10.01	B	
171	AH	52 34.5N	4 9.1E	26	88	218	11.22	A	
172	AI	52 27.7N	3 41.8E	30	88	218	15.47	B	
173	AJ	52 15.2N	3 15.9E	33	88	218	18.33	B	
174	AK	52 15.3N	2 50.2E	39	88	218	21.08	B	
175	AL	52 9.9N	2 19.8E	50	88	219	00.20	B	
176	AM	52 5.0N	1 49.9E	29	88	219	03.06	A	
177	AN	51 47.0N	1 46.9E	27	88	219	05.20	A	C14,NT
178	AO	51 30.0N	1 45.3E	39	88	219	07.36	B	
179	AP	51 10.7N	1 33.7E	53	88	219	10.44	B	
180	AR	51 28.1N	2 40.1E	33	88	219	17.33	B	
181	AS	51 45.7N	3 0.5E	36	88	219	20.16	B	
182	AT	51 50.1N	3 22.5E	28	88	219	22.00	A	
183	AU	52 8.0N	3 30.0E	30	88	220	00.29	A	
184	AV	52 12.8N	3 51.9E	22	88	220	02.44	B	NT
185	AW	52 20.5N	3 59.3E	25	88	220	05.20	B	C14
								CTD not logged on computer	
186	AE	52 37.3N	3 46.6E	30	88	220	08.30	A	
187	AY	52 47.3N	3 37.1E	31	88	220	10.13	A	
188	AZ	53 0.3N	3 26.3E	29	88	220	12.03	A	
189	BA	53 12.0N	3 16.1E	28	88	220	13.48	B	
190	BB	53 29.8N	3 0.5E	32	88	220	17.47	B	
191	BC	53 24.6N	3 26.9E	29	88	220	20.56	B	
192	BD	53 18.1N	4 0.5E	28	88	221	00.12	B	
193	BE	53 13.6N	4 20.1E	30	88	221	01.58	B	NT
194	BF	53 10.1N	4 37.5E	24	88	221	03.51	A	
195	BG	53 39.0N	4 49.5E	30	88	221	08.10	B	C14
196	BH	53 55.1N	4 49.6E	40	88	221	10.34	B	
197	BI	54 15.0N	4 50.1E	46	88	221	13.13	B	
198	BJ	54 35.1N	4 50.5E	47	88	221	16.04	B	
199	BK	54 19.1N	5 15.3E	43	88	221	18.35	A	
200	BL	54 3.2N	5 39.9E	37	88	221	21.18	A	
201	BM	53 56.7N	5 49.8E	33	88	221	22.48	A	
202	BN	53 50.0N	5 59.9E	29	88	222	00.26	A	
203	BO	53 39.0N	6 10.2E	25	88	222	02.38	A	
204	BP	53 43.0N	6 30.6E	22	88	222	04.17	B	C14
205	BQ	53 55.1N	6 25.8E	27	88	222	06.30	B	
206	BR	54 6.1N	6 25.2E	34	88	222	08.05	B	
207	BS	54 20.2N	6 24.8E	38	88	222	10.25	B	
208	BT	54 35.0N	6 25.0E	38	88	222	12.19	B	
209	BU	54 24.9N	6 42.4E	36	88	222	15.10	B	
210	BV	54 15.0N	7 0.1E	36	88	222	16.59	B	
211	BW	54 5.9N	7 0.5E	35	88	222	18.54	B	NT
212	BX	54 0.4N	7 14.2E	31	88	222	20.09	B	NT
213	BY	53 49.3N	7 20.5E	24	88	222	22.06	B	NT
214	BZ	54 13.5N	7 34.9E	38	88	223	01.59	A	
215	CA	54 16.1N	7 44.7E	26	88	223	03.42	A	C14
216	CB	54 25.2N	7 39.9E	25	88	223	05.17	A	

217	CC	54 40.0N	7 40.4E	22	88	223	07.18	A	
218	CD	54 55.1N	7 40.1E	22	88	223	09.13	B	
219	CE	55 10.1N	7 39.9E	22	88	223	11.11	A	
220	CF	55 27.1N	7 39.8E	24	88	223	13.09	B	
221	CG	55 30.0N	7 19.8E	29	88	223	14.47	A	NSS
222	CH	55 30.0N	6 59.9E	28	88	223	16.20	A	
223	CI	55 29.8N	6 30.2E	42	88	223	18.26	B	NSS
224	CJ	55 29.7N	6 0.3E	49	88	223	20.49	A	NT
225	CK	55 30.0N	5 30.1E	52	88	224	03.44	A	C14,NT,NS,NSS
226	CL	55 29.4N	4 59.7E	44	88	224	09.50	B	
227	CM	55 30.0N	4 31.0E	32	88	224	11.56	B	NT,NS,NSS
228	CN	55 30.0N	3 45.0E	34	88	224	15.23	B	
229	CO	55 30.0N	3 10.1E	36	88	224	18.32	B	NSS
230	CP	55 30.0N	2 35.1E	47	88	224	21.40	B	
231	CQ	55 29.9N	2 1.9E	57	88	225	00.19	B	NS,NSS
232	CR	55 29.6N	1 24.7E	79	88	225	03.40	B	C14
233	CS	55 30.1N	0 54.3E	68	88	225	06.31	A	NSS
234	CS	55 30.4N	0 54.0E	81	88	225	09.47	B	NSS, repeat of 233
235	CT	55 30.0N	0 23.8E	74	88	225	12.21	B	NSS
236	CU	55 29.6N	0 3.8W	76	88	225	15.04	B	
237	CV	55 29.9N	0 32.0W	61	88	225	17.17	A	NT,NSS
238	CW	55 30.1N	0 52.3W	94	88	225	19.02	B	NSS
239	CX	55 30.1N	1 12.1W	87	88	225	20.57	A	NSS
240	CY	55 29.9N	1 33.1W	31	88	225	22.40	B	
241	CZ	55 20.0N	1 29.9W	41	88	226	00.20	A	
242	DA	55 9.8N	1 26.8W	39	88	226	01.48	A	NT
243	DB	54 59.5N	1 18.3W	43	88	226	03.24	A	
244	DC	54 60.0N	0 57.0W	85	88	226	05.09	A	C14
245	DD	54 60.0N	0 36.2W	70	88	226	07.03	A	
246	DF	54 52.0N	0 33.2W	63	88	226	08.50	A	
247	DG	54 44.1N	0 51.2W	54	88	226	10.38	A	
248	DH	54 39.0N	1 3.1W	23	88	226	12.02	A	
249	DI	54 39.0N	0 52.9W	44	88	226	13.07	B	NT
250	DJ	54 34.8N	0 36.9W	53	88	226	14.47	A	
251	DK	54 30.6N	0 20.8W	61	88	226	16.13	B	
252	DL	54 25.8N	0 0.2E	49	88	226	17.56	A	
253	DM	54 19.8N	0 24.1E	64	88	226	20.32	A	
254	EF	54 41.2N	0 32.9E	74	88	226	23.09	A	
255	EE	55 6.0N	0 43.9E	77	88	227	02.15	A	
256	CS	55 30.0N	0 53.9E	86	88	227	05.23	A	C14
257	ED	55 15.1N	1 10.3E	67	88	227	08.09	B	
258	EC	55 5.2N	1 20.6E	56	88	227	10.42	B	
259	EB	54 55.6N	1 29.9E	30	88	227	12.54	B	
260	EA	54 38.7N	1 30.0E	35	88	227	16.32	B	
261	DZ	54 19.9N	1 30.4E	50	88	227	18.53	B	
262	EH	54 19.7N	1 8.5E	48	88	227	21.38	B	
263	EG	54 20.1N	0 46.0E	60	88	227	23.35	B	NSS
264	DM	54 14.3N	0 27.0E	60	88	228	01.44	A	
265	DN	54 5.0N	0 27.6E	58	88	228	03.32	A	C14
266	DO	53 50.8N	0 22.2E	51	88	228	05.27	A	
267	DP	53 29.9N	0 22.5E	24	88	228	07.45	A	
268	DQ	53 29.9N	0 22.5E	17	88	228	09.25	B	NT
269	DR	53 32.0N	0 42.0E	98	88	228	11.08	B	
270	DS	53 37.3N	0 54.6E	25	88	228	12.37	B	
271	EK	53 43.1N	0 42.8E	30	88	228	14.24	A	
272	EL	53 19.2N	0 30.0E	16	88	228	17.55	A	
273	EM	53 9.6N	0 31.0E	22	88	228	19.21	A	
274	EN	53 4.9N	0 30.0E	36	88	228	20.05	A	

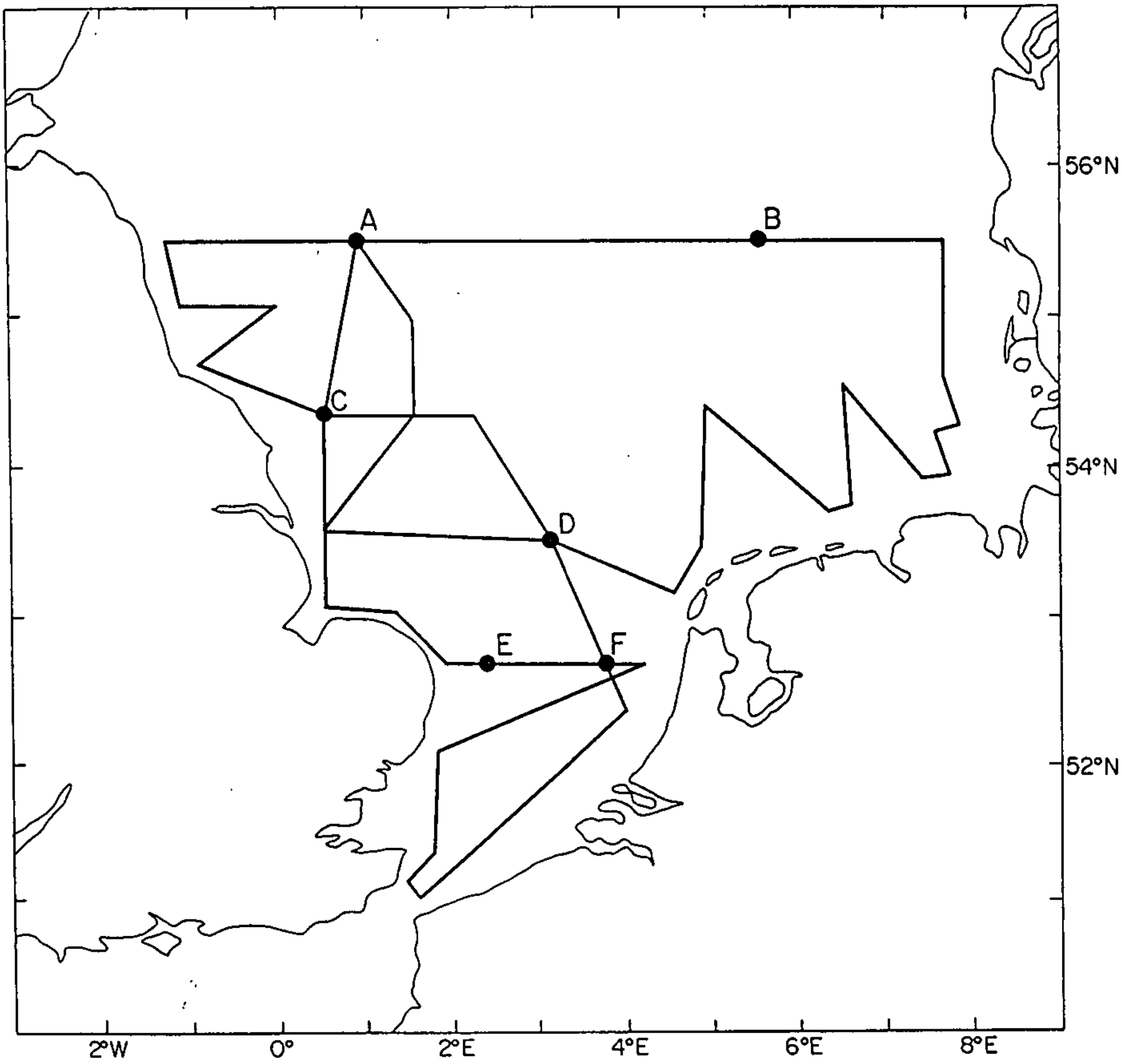
275	EO	53 13.2N	0 47.2E	24	88	228	22.23	A	
276	EP	53 1.0N	1 3.9E	17	88	229	00.30	A	NT
277	EQ	53 0.9N	1 26.7E	26	88	229	02.24	A	
278	AA	52 43.4N	1 56.1E	27	88	229	06.01	A	
279	AA	52 43.0N	1 55.9E	29	88	229	07.18	A	NSS, repeat of 278

Stations are numbered sequentially throughout the North Sea Project.
The nominal positions of the sites are displayed in Figure 2.
Samples were obtained near-surface, mid-depth and near-bottom for nutrients, chlorophyll and suspended sediment, and near bottom for salinity and temperature (reversing thermometers).

Work codes:
- A CTD and water bottles.
- B CTD, water bottles and plankton trawl.
- C14 Samples for deck incubation and 14C analysis.
- NT No reversing themometer reading.
- NS No salinity sample.
- NSS No suspended sediment sample.

Table 2
Deployments

Rig	Latitude N	Longitude E	Decca Chain	Decca Red	Decca Green	Decca Purple	Water Depth(m)	Time Deployed	Instrument	Height
A	55 30.0	0 54.0	2A	-	F30.64	A63.56	85	0728 12/8/88	POLDOP # 2 Aanderaa RCM4 # 7570	Sea bed frame "
	55 30.4	0 53.9	2A	-	F31.20	A61.15	85	0826 12/8/88	Logger # 8 Aanderaa chain # 1612	10-60 m below surface
B	55 30.0	5 30.7	9B	E0.27	F44.15	-	52	0609 11/8/88	S4 # 12 S4 # 13 S4 # 14 Aanderaa RCM8 # 9347	37 m above sea floor 27 " 15 " 7 "
	55 30.4	5 31.3	9B	E0.73	F43.85	-	52	0703 11/8/88	Logger # 9 Aanderaa chain # 1610	5-45 m below surface
C	54 19.9	0 24.2	2A	A8.58	B44.88	H66.36	59	1950 13/8/88	POLDOP # 1 Aanderaa RCM4 # 4387	Sea bed frame "
	54 19.9	0 24.0	2A	A8.56	B44.82	H66.38	60	2018 13/8/88	Logger # 7 Aanderaa chain # 1609	5-45 m below surface
D	53 30.0	3 00.0	2E	J8.92	D41.24	E69.56	31	1816 7/8/88	POLDOP # 3 Aanderaa RCM4 # 6443	Sea bed frame "
	53 29.7	2 59.9	2E	J8.78	D41.32	E69.62	31	1848 7/8/88	Logger # 10 Aanderaa chain # 1608	5-30 m below surface
E	52 42.9	2 25.3	2E	H12.07	F30.78	H58.46	49	2251 4/8/88	S4 # 15 S4 # 16 Aanderaa RCM8 # 9353	35 m above sea floor 20 " 7
F	52 36.7	3 45.2	2E	I7.39	D37.08	A61.84	30	1410 5/8/88	S4 # 17 Aanderaa RCM8 # 9348	12 m above sea floor 7 "



Site	Latitude N	Longitude E	Rigs
A	55° 30'	0° 54'	ADCP, TC
B	55° 30'	5° 30'	CM, TC
C	54° 20'	0° 24'	ADCP, TC
D	53° 30'	3° 00'	ADCP, TC
E	52° 41'	2° 25'	CM
F	52° 37'	3° 46'	CM

CM - S4 currents meters; TC - Thermistor chain; ADCP - Acoustic doppler current profiler in bottom frame.

Figure 1. Planned survey track.

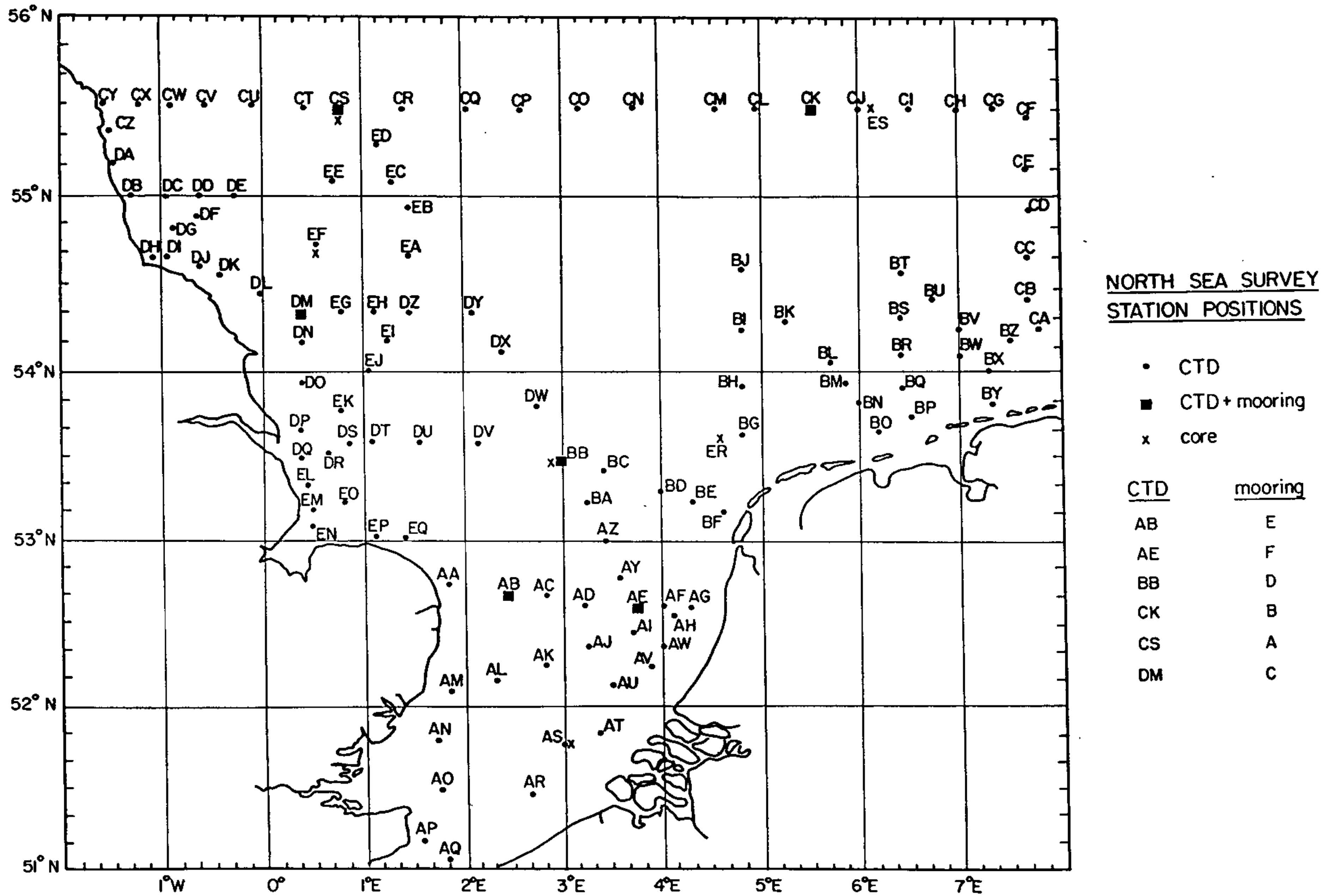


Figure 2. Nominal CTD positions.

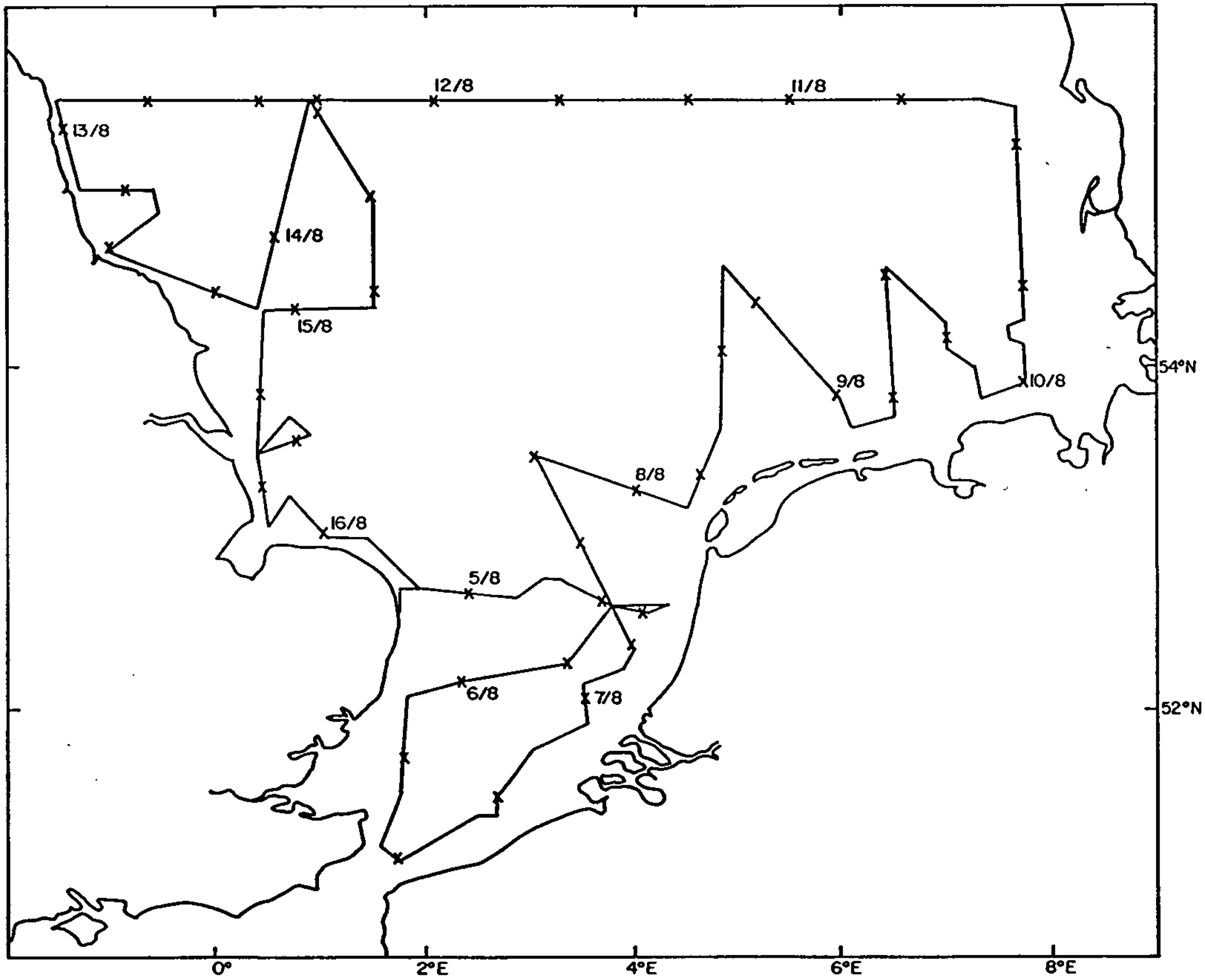


Figure 3. Cruise track. RRS Challenger's position is marked every 6 hours.