DEPARTMENT OF EARTH SCIENCES

Cruise Report

RRS DISCOVERY 184

BOFS 1989 LEG 3

I.N. McCave

UNIVERSITY OF CAMBRIDGE

DEPARTMENT OF EARTH SCIENCES

R.R.S. DISCOVERY

Cruise 184

14th July - 14th August 1989

BOFS 1989 Leg 3

Leg 3, Benthic Studies, of the Biogeochemical Ocean Flux Study between 47°N and 60°N along 20°W in the northeast Atlantic Ocean.

Joint Global Ocean Flux Study

North Atlantic Pilot Study

Principal Scientist

Professor I.N. McCave

1989

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DISCOVERY CRUISE 184 : TIME BREAKDOWN

Sailed Milford Haven	0354	15/7/89
Arrived Barry	0626	14/8/89

Total Cruise Time	30 days 02.5 hours	722.5 hours
Steaming time	4 days 08.5 hours	104.5 hours
Scientific time	24 days 13.1 hours	589.1 hours
Down time (1-3)	1 day 0.49 hours	28.9 hours

1. Bad weather 18.4 hours
2. Winch failure 10.2 hours
3. M/E failure 0.3 hours

1. INTRODUCTION

RRS Discovery cruise 184 was the third month of sea time in 1989 devoted to the Biogeochemical Ocean Flux Study. Earlier legs had concentrated on upper ocean work, but this leg was to investigate benthic processes and collect samples for evaluation of the history of productivity and fluxes in the region.

a. Scientific aims

i) determine fluxes of carbon and carbon-associated components across the sediment - water interface

ii) to relate contemporary benthic processes to the interpretation of the Holocene historical record.

iii) to relate the historical record obtained from differing water depths to the modern water column fluxes at those depths.

iv) to contribute measurements of currents, hydrographic and chemical properties along 20° W for the BOFS/JGOFS effort.

b. Specific cruise objectives

i) to survey potential coring sites by 3.5 kHz reflection profiler and bottom photography.

ii) to take suites of kasten and box cores, spanning as large a water-depth range as possible, from four principal areas on the 20° W transect.

iii) to X-ray and sample the cores in detail, providing samples for water content, carbonate and organic carbon content and chemistry, grain-size, radiochemistry, dating, mineralogy, micropalaeontology and stable isotope analysis.

iv) to sample cores on behalf of other workers and keep archive cores.

v) to squeeze or centrifuge samples from box cores for extraction and analysis of pore waters for nutrients, O_2, and redox sensitive species.

vi) to determine O_2 profiles in the surface few centimetres of box cores using O_2 electrodes with a micromanipulator system.

vii) take CTD/transmission-fluorescence casts with 12 x 10-litre Go-Flo bottles at each coring area plus casts between areas and on the runs out and back.

viii) to conduct basic-BOFS measurements on the water bottle samples including T/S, nutrients, O_2, DOC, POC & N, pigments, and total suspended matter.

ix) to maintain underway current measurements via ADCP and EM logs, fluorescence/transmission and T/S measurements on continuously pumped flow, and determine nutrients (NO_3, PO_4, SiO_2) on samples taken from that flow.

x) to recover, refurbish and redeploy sediment trap moorings, split, preserve and perform any necessary immediate analysis on trap samples.

xi) to sample the water column via in situ pumps and water bottles for analysis of natural uranium series radionuclides.

c. Narrative of the Cruise

Discovery sailed early on the 15th July from Milford Haven instead of the 14th from Falmouth because of possible delays due to a dock strike at Falmouth, and resulting congestion at Milford. We made a fair passage to the SSW through the Celtic Sea, pausing briefly to deploy the the 3.5kHz, and made our first CTD station in a water depth of 4535m on the continental rise at the foot of Goban Spur.

We then steamed on to recover the sediment trap array at 48°N 20°W. This had lost its top buoyancy and rose to the surface in a tangle. We took hold of it somewhere in the middle and safely recovered all that was left. At one time there were no fewer than six lines through the sheave during recovery. A drifting array of three sediment traps was then deployed.

The weather was fair for the mooring operations and the subsequent series of three coring stations. For the area immediately around the mooring we had a hydrosweep bathymetric map made by the Meteor which showed clearly a series of north-south trending highs, in contrast to the available conventional hand contoured maps based on soundings which incorporate a hypothesis of east-west trending highs on the lower flanks of the Mid-Atlantic ridge. This made it very difficult to find a shallow area for our first coring station because all possibilities lay beyond the area of reliable bathymetry. So we steamed west towards a mapped high point and proceeded to survey the area around it, eventually taking our first cores on the crest of a ridge at 3700 m. The survey was time-consuming and the next coring station was occupied in the area of Hydrosweep bathymetry. This demonstrated most clearly the advantages of having modern survey systems.

The final coring station in the 47°N to 48°N area lay close to the mooring site, which was also sampled by CTD and stand-alone pumps prior to re-deployment of the fixed mooring. The drifting array was recovered a little later some 25 miles to the north east. We were fortunate to locate it because we went to the location indicated by the last satellite fix on its Argos buoy, but on recovery found the buoy had disappeared due to a cable having chaffed through. In rising wind and sea a brief search at its last fix position convinced us that the search was futile. Unfortunately the buoy is not drogued, otherwise the information it continues to provide would be more useful concerning surface water movements.

A coring, and camera transect was then made of the East Thulean Rise from a depth of 4300m at the bottom to 2350m at the crest. This was uneventful save for a brief stiff blow up to a good force 7 in the early hours of the 25th July. This was followed by another coring and CTD transect of the south flank of Rockall Plateau, an area clearly affected by contour currents and containing the tails of Feni and Isengaard sediment drifts. Attempts to take cores in water shallower than 1000m were frustrated by rocky bottom and worsening weather though we did manage to cap the sequence with a multi core at 1265m a little further north.

Up to this point we had occupied 13 coring stations and taken 34 good cores since our first one on 19th July. The weather had remained relatively calm, the wind rarely rising above force 5. We now sailed north, across Hatton Bank and started coring around 59°N. Initially all went well and we took stations on Hatton Drift at 1750m and in the basin on the levee of Maury Channel at 2790m on 4th August.

We could not raise the northern sediment trap array at 59°N 22°W before the 6th August as it was programmed to shut on that day, and we could not hold our planned comparison exercises with the Germans (R.V. Meteor) and Dutch (R.V. Tyro) on the 5th because the Tyro had been delayed by strong westerly winds in its passage across from the Orkneys. So we went to the mooring site and took the basic BOFS measurements, CTD and SAP casts. We then went to 59°N 15°N 21°W to rendez-vous with Meteor and Tyro. The comparison exercise was held on the 6th in fair weather (wind 3 to 4) with slight swell. The comparisons were extremely useful, showing up an error in Meteor's CTD program and revealing several areas of discrepancy between our nutrient analyses and those of Tyro. These revolve around the nature and interpretation of standards and will be sorted out in months to come. A vigorous programme of social exchanges between ships accompanied the scientific work and we took our leave amid the mournful wail of parting ships horns at dusk, about 10.30 p.m. at that latitude.

Throughout much of this time the mechanical technicians had worked flat out to repair the main traction winch which suffered a serious hydraulic malfunction. This had prevented coring or a second SAP cast at the mooring site prior to our rendez-vous with Meteor and Tyro. We now returned to the mooring site and recovered the entire sediment trap array without difficulty. In the day required to turn around the mooring for re-deployment we steamed to the crest of Gardar Drift and took a core and CTD. It was intended to take another core on the flanks of the drift, but the spooling gear's sheave siezed up and coring was abandoned.

News of hurricane Dean had been a subject of interest as it turned towards our position (see map). However it was filling rapidly and gave no noticeable effect. Far more serious was a deep depression that formed behind it and the strong westerly air stream which developed for the next week. The mooring was deployed safely in winds of force 6 to 7 but an attempted core in force 6 came up empty. We completed the CTD programme and did the SAP work in two casts, rather than one in order to minimise the possibility of damaging the upper pumps by having them in the surface zone of strong wave heave for a long time.

It had been planned to take a Kasten and Multi-core at the Meteor's 59°N 15°N 21°W site because our oxygen micro-electrode and radionuclide work would have nicely complemented their benthic biology and biochemistry in studies related to bioturbation. Piston cores on the Maury channel levee and Hatton Drift had also been planned but none of these was possible because the persistent westerly force 6, occasionally 7, with swell to match made handling of corers and possibility of high-quality cores highly doubtful. So we were forced to sail on to the east.

Fortune smiled on us for 10 hours on the 10th. The eye of the depression passed over us (see map) and in the lull in the wind we cored the centre of Hatton-Rockall basin with three corers and also took CTD and camera dips. This was the last coring we were able to do because the back side of the depression gave a resumption of strong force 6 to 7 winds. We went to the southern end of North Feni Ridge where a CTD and coring station had been intended, but coring was not possible, and an isolated CTD not useful, so a brief survey was undertaken. We now have a good indication of the precise positions from which a useful suite of cores could be taken. At 13.00 on 11th August, still with a steady force 6 and with a somewhat alarmist forecast for Rockall of force 7 to 9, it was deemed that no further useful work could be done and the ship made for the North Channel, the Irish Sea and Barry.

Despite the disappointments of the last five days due to the wind, we did manage to take 43 good cores in 52 attempts, 34 CTD dips, 14 camera runs, 9 SAP casts, 14 UOR tows, continuous underway chemistry, recovery and deployment of two moorings, net hauls, rain collection and XBT shots. All in all a pretty successful collection. My thanks to all the scientific officers and crew, and technical staff who made this possible.

I.N. McCave

2. TOPOGRAPHY, 3.5kHz PROFILES and PHOTOGRAPHY

The area is well known and, on a large scale, is well charted in the IOS series of bathymetric maps. We started off at 47° to 48°N on the foothills of the Mid Atlantic Ridge, went north up the East Thulean Rise, up the Southern slope of Rockall Plateau, into the South Iceland Basin via Hatton Drift, across the northern plateau comprising Hatton Bank, Hatton-Rockall Basin, and Rockall Bank, finally across northern Rockall Trough on the way to the North Channel. For the most part, where topography was smooth, the available charts were adequate. However, in the south at 47-48°N, 21-22°W the published charts show a series of E-W trending ridges with high points. We were looking for such a high point for our first coring site. It rapidly became apparent that the topography comprised a series of N-S trending ridges, an observation strongly supported by the swath-mapped bathymetry of the area immediately to the east, around 20°W, provided by the Germans. The value of swath-mapped bathymetry became painfully apparent as we sailed around with our single channel system looking for a hill top. We eventually occupied station 11878 at 3700 m but were not able to hold that depth. For the next stations in the southern area we went to sites at greater depths where swath-mapped bathymetry was available.

The 3.5kHz profiler was operated with few gaps throughout the cruise. Interference of the 3.5 fish with the CTD wire necessitated its being winched in and out with tedious frequency, resulting, on one occasion, in the signal cable being pinched and cut by the end of the boom. The fish needs to be on the port side. Most of the area showed a sediment-covered aspect with acoustic penetration of 20 to 40 m. Only on parts of Maury fan and the peaks of southern Rockall Plateau was the bottom so hard as to give a prolonged echo with no penetration. We encountered several areas of mud waves under contour current systems, but no tight hyperbolic echoes suggestive of a furrowed bottom. The 3.5 system was new, having been just delivered from IOS for the cruise and I am grateful to the efforts of those who ensured that we had the gear and of Bernie Woodley who took care of it and made sure we had good records.

At most stations we deployed the twin camera rig at an early stage. We lengthed the trigger rope to 3 m to give a large field of view, but the lenses appear to suffer rather severe spherical abberation so the edge of the field is poorly focused. The illumination is perfectly adequate at this range. Initially we loaded both cameras with black and white film but from station 11884 (Cam6) onwards we had black and white in one and colour in the other. It is not planned to do serious stereo-pair work. In the south the results are excellent with relatively clear water and much evidence of fluff and mucus patches on the sea bed in places. Some stations on the south Rockall Plateau transect and northern stations on drifts show extreme turbidity obscurring the bottom (even though the trigger rope was shortened to 2 m). These photographs will be a valuable adjunct to the interpretations of both physical and biological benthic processes.

Echosounder rolls and logs were sent to IOS Wormley, 3.5 records and photographs are held at Cambridge.

3. CORING OPERATIONS

3a. Core numbering system; D184

The ship has "Discovery stations". Present practice is to assign each activity a number after a slash: e.g.

D11880/1 is CTD

D11880/2 is net haul etc

D11800/3 is kasten core.

This is extremely unwieldy for sample labelling. It is not likely to yield a rising sequence of numbers for cores if the portion after the slash is used alone. We have therefore designated our coring stations by a simple rising sequence of numbers applying the core type identifier after a #. Thus if D11880 were our third core station we could have:

D11880/1#3K kasten

D11880/2#3M multi

D11880/3#3C (IOS)BC

D11880/4#3P piston

D11880/5#3B (RVB)BC

If the next station at which cores were taken were D11882, a multicore there would be D11882/2#4M (if it was the second activity). Two remaining problems are: i) when more than one core of a given type is taken at one station and ii) the problem of the multicorer's several tubes. For more than one core apply a number after the letter, so two pistons they would be, e.g. #4P1 and #4P2. For the multi we use -1, -2 etc after the letter (or number for more than one deployment) to designate which core tube has been processed. This is not specific to a given position on the multicorer. Thus a multicore number looks like #3M-2 or, for a second deployment, #3M2-2.

There may be gaps in the sequence of numbers for a given core type if one is not taken at a coring station (particularly true of PC's). For core sample numbering one can use simply the part commencing #. A full list of cores bearing this numbering system is in the cruise report Station Log. It would be sensible if the BOFS core station numbering system were continued on our cruise next year as they will form a coherent set. This is similar to the Scripps and IFREMER practice of numbering cores with the name of the expedition. Some other institutes use a ship and cruise number designation. I prefer the campaign numbering system so these will be "BOFS" cores.

I.N. McCave

3b. Kasten-Coring

Objectives - During cruise 184 some emphasis was put on retrieving long-barrel kasten-cores which provide a historical record of the changing oceanic conditions from the Late-Pleistocene to present day. The analysis of the glacial to modern history of the fluctuating burial rates of carbon and associated elements is expected to throw some light on the contribution of oceanic processes to the rapid increase in CO_2 and temperature at the end of the ice age and their role in shorter term climatic variations. Furthermore, a comparison between sediment and sediment trap record will be attempted.

Requirements - The following requirements had to be fulfilled regarding the quality and quantity of sample material:

- the cores must cover the Late-Pleistocene to Holocene record
- sufficient material for several different research groups must be provided
- the stratigraphy must be preserved in subsamples
- several nearly identical subsamples must be provided for different research teams
- reference sections must be taken and kept in long term storage
- large high resolution X-rays and photographs must be taken from the complete cores
- the sediment surface must be undisturbed
- porewater must be kept in situ to allow geochemical studies

In addition to these goals the subsampling method needed to be inexpensive and allow for easy handli8ng of core sections on board and on land.

Kasten barrel - Since current kasten coring methods did not meet these goals a new core-barrel was designed including new sampling and recording techniques. The dimensions of the core barrel (3000 x 150 x 150 mm) were taken from Kuehl et al. 1985[1]. One side of the square barrel was removable and served as the lid. A double bottom on the oppostie side allowed lifting of the whole core (sideways extrusion) and subsampling of slabs in any size. A sliding weight (Kuehl et al) provided extra stability to keep the barrel vertical during penetration. To prevent the surface of the core from slumping, a perforated plate was fitted into the barrel and pressed onto the core surface with arod before the barrel was taken on board. This tended to destroy the integrity of the top ~2cm. However this is better than previous versions where the material just slumps. Future improvements will use 4mm sieve mesh for the plate.

Sampling technique - To provide different research groups with undistrubed and nearly identical sub-cores, U-shaped square drain-pipes (1000 x 60 x 60mm) were pressed into the opened surface of the core. Individual samples of ca. 10cm^3 were taken in 4 cm spacing between the drain pipe pairs and stored in air-tight containers to allow water content analysis. The core was then lifted up by 6 cm and the drain pipes were separated from the core with a cheese wire, they were thn closed, sealed and stored in wooden trays. A layer of plastic trays (330 x 150 x 20 mm) was pressed into the core surface and removed using the lift-mechanism again. These trays were X-rayed on board and later on used to measure magnetic susceptibility. After this step, the X-ray slabs were stored in a freezer. Finally, two more drain pipes were taken from each metre.

Discovery Sta.No.	Core #	Depth (m)	Latitude (N)	Longitude (W)	Length (m)	Subc.	Slabs	Water content
11878 /3	1	3700	47°11.4'	23°31.7'	0.35	1	0	0
11879 /2	2	4100	47°46.2'	21°37.3'	1.56	4	5	43
11880 /2	3	4545	47°48.3'	19°42.4'	1.67	2	5	27
11881 /5	4	4207	49°50.8'	21°16.3'	1.99	4	5	28
11882 /4	5	3547	50°41.3'	21°51.9'	2.63	6	24	67
11883 /3	6	2865	51°07.0'	21°11.9'	2.20	4	24	55
11884 /4	7	2327	51°45.0'	22°32.2'	1.96	4	13	33
11886 /2	8	4045	52°30.1'	22°04.2'	2.46	6	24	62
11889 /2	9	3268	53°41.6'	21°19.5'	2.44	12	8	60
11890 /2	10	2777	54°39.9'	20°39.0'	2.64	12	8	65
11891 /4	11	2004	55°11.5'	20°21.1'	0.96	2	6	23
11896 /1	14	1756	58°37.2'	19°26.2'	2.28	12	7	58
11898 /1	15	2785	59°06.0'	10°08.0'	1.54	8	5	36
11902 /1	16	2370	59°28.2'	23°14.1'	2.60	12	8	65
11905 /1	17	1150	58°00.2'	16°30.3'	2.44	12	8	62
				Total	29.72	101	150	684

Results - The table indicates the number of good kasten-cores, their location and the amount of material yielded by each core. Altogether, 29.72 m of core were retrieved at 15 sites where kasten-coring was possible (average = 2 m per attempt, 2.64 m is the longest possible core). These cores provided 101 square drain pipes 1 m long, 150 X-ray slabs and 684 substamples for water content and CHNOS-analysis. All cores were described at sea noting the kind of deposit, its texture, structure, colour, and the nature of the boundaries.

Laboratory analysis - The square drain pipes will be distributed between the research teams of N. Shackleton, H. Elderfield and I.N. McCave in Cambridge and analysed for C_{org}, CO_3C, H_2O, non-CO_3%, $\delta^{18}O$, $\delta^{13}C$, Cd/Ca, REE/Ca, $Sr^{87/86}$, size CO_3, size non-CO_3, clay % MIKC(XRD), foram species composition, Nanno species composition.

E. Zangger

[1]Kuehl, S.A.; Nittrouer, C.A.; DeMaster, D.J. & Curtin, T.B. (1985): A long, square-barrel gravity corer for sedimentological and geochemical investigation of fine-grained sediments. Marine Geology 62: 365-370.

3c. Box Coring

Box cores to provide high quality sections of the upper sediments (~0.5m) were required for three distinct purposes i) pore water extraction for geochemical analysis, ii) studies of active solid phase bioturbation (to ~10cm) and radiocarbon dating (to 0.5m), and iii) sedimentology of the surficial sediments (disturbed in the longer Kasten cores).

The IOS box corer was used throughout. This corer is a double spade design with a box 30 x 30 cm square section. When closed the spades form a seal at the bottom and top of the corer. In the configuration used on this cruise the spades were under the control of an auto-retractor actuated by an acoustic release. This arrangement prevents pre-triggering, allowing faster pay-out speeds, and a tilt-indicator incorporated in the release ensures that the orientation of the corer can be checked to be approximately vertical before a core is taken. When the corer is landed in the sea floor the release is activated, and spade closure must be effected before the corer is withdrawn.

Box cores were run at 14 of the 18 coring sites selected on the cruise. The first (11878/2#1C) had a disturbed surface as the result of a spade strap jamming in its runner, and the corer fell over on the hard bottom at site 13 (11894/3#13C) and recovered a grab sample containing many stones. The remaining 12 cores had good to excellent surfaces. On deck, the corer was opened, the overlying water was syphoned off, and four 10cm diameter sub-cores were driven in. These sub-cores were then sampled on board for pore water and bioturbation studies, or were sealed and stored at 4°C for sedimentology or as archive sections.

J. Thomson
H.E. Wallace

Box Core Subcores Preserved for Sedimentology

D Station	BOFS#	Subcore	length (m)
11878	# 1	none	-
11879	# 2	✓	0.44
11880	# 3	✓	0.55
11881	# 4	✓	0.51
11882	# 5	✓	0.39
11883	# 6	✓	0.53
11884	# 7	✓	0.44
11886	# 8	✓	0.51
11889	# 9	✓	0/52
11891	# 11	✓	0.44
11894	# 13	stones	-
11896	# 14	✓	0.48
11898	# 15	✓	0.55
11905	# 17	✓	0.45

These are preserved at Cambridge.

3d. Multicore Sampler

The Multicore Sampler (Duncan & Assoc.) was extensively used on cruise D.184 to obtain undisturbed ocean floor cores. Normally the sampler was deployed with just six tubes which was believed to allow deeper penetration than could be achieved if all 12 tubes were used. Sediment sample depths in each tube averaged 20cm throughout the operations. The sampler almost always obtained completely undisturbed sediment-water interfaces with clear overlying water, which allowed observation of many fine scale features such as small brittle stars, faecal pellets and polychaete worm tubes slightly raised from the surface. In several samples several millimeter thick sections of marine fluff and gel were noted resting on sediment surface. Good preservation of the sediment surface is achieved with the sampler due to the slow insertion of tubes and height of water inside the tube above the sediment. This water should remain in the tube until subsampling of tube commences.

The purpose of obtaining undisturbed cores is to identify active geochemical processes operating within the upper few centimeters of the ocean floor from the data provided by the solid phase chemistry and oxygen saturation levels. The methods employed for oxygen saturation determination are discussed elsewhere. The principal aims of the surface solid phase geochemistry is to examine the kinetics of organic carbon remineralisation and calcium carbonate dissolution, to determine bioturbation depth and rates from excess ^{210}Pb data, and to determine particle fuxes from reactive trace metal and uranium series radioisotope disequilibrium data.

For this study it was necessary to take fine scale sediment slices from the sediment cores vis:

0-1cm	1mm slices
1-2cm	2mm slices
2-10cm	5mm slices
10-20cm	10mm slices
>20cm	20mm slices

This was achieved using a screw jack mechanism connected to a piston that would rise 1mm every 1 revolution. A plastic ring of the same internal diameter as the tube was placed above the tube so that the extruded sediment did not collapse and so that the thin (0.25mm) mellonite plastic sheet used fo slicing did not warp when passing through the sediment. Three tubes were subsampled from each of the 13 multicore sampler sites yielding approximately 1600 subsamples (Cores #1-6M, 8-9M, 11M, 13-15M and 17M).

T. Brand

4. PORE WATER WORK

4a. Extraction for Nutrients and Trace Metals

Objectives - The objectives were to obtain pore water samples from box cores and to analyse them subsequently for nutrients and trace metals e.g. Mn and Fe; this information then to be used to characterise the redox state of the top half metre or so of the sediment column and to examine the chemical processes involved in early burial diagenesis and the breakdown of

Ben	Cstatn	Hashno	Max error	Min error	Mean error	Prs min er	Prs max er
4876	11876	2	0.00453	0.00000	0.00220	3618.6	3200.2
4945	11877	6	0.00482	0.00000	0.00183	3480.6	4651.2
5151	11880	7	0.00464	0.00000	0.00194	3548.9	3193.5
5247	11881	2	0.00397	0.00000	0.00169	3391.3	3168.5
5460	11885	2	0.00916	0.00000	0.00321	3484.9	4368.8
5599	11887	1	0.00764	0.00038	0.00419	3321.6	3017.3

After temperature recalibration

Ben	Cstatn	Hashno	Max error	Min error	Mean error	Prs min er	Prs max er
4876	11876	2	0.00659	0.00000	0.00168	3004.6	3410.5
4945	11877	6	0.00571	0.00000	0.00198	3133.0	3443.3
5151	11880	7	0.00568	0.00000	0.00190	3135.1	3553.0
5247	11881	2	0.00635	0.00005	0.00223	3260.1	3389.0
5460	11885	2	0.00534	0.00000	0.00221	3484.9	3774.3
5599	11887	1	0.00385	0.00000	0.00149	3321.6	3103.2

organic matter.

Methods - The methods employed were basically those used by the IOS and Swansea Geochemistry groups over the years, i.e. sectioning the cores in nitrogen filled glove bags at in situ temperatures and extracting the pore water by refrigerated centrifugation. Cores were obtained by sub-sampling IOS box core samples with 10 cm i.d. polycarbonate core liner. All subsequent manipulations of these sub-cores and pore waters were undertaken in the IOS Cold Container, with the centrifuge located in the gravimeter room. The time taken to process a core limited the number of pore water samples that could be taken from any one core to 24. These were usually 1 cm thick sections taken contiguously over the firest 12cm and then spaced according to stratigraphy to the bottom of the core. Intermediate (non-pore water) sections were stored in plastic bags. Following centrifugation of the sample (at 3000 rpm, 4°C, 30 min) the supernatant pore water was removed and filtered through an in-line Nuclepore 0.4 µm filter into two sample bottles. One of these was pickled with 15µl $HgCl_2$/5ml of sample (for nutrients) and one to 1% v/v with 6M Aristar HCl (for metals) and stored cool. The residual solids from the centrifugation were stored in plastic bags and, along with the 'intermediate' sections, stored frozen. Each core had been completely processed within 12 hours of it arriving on deck.

<u>Summary of Activities</u>

Stn.No.	Depth (m)	Core Site No.	Length (cm)	Pore Water Sections	Sediment Sections
D11878	3855	1	24	6	4
D11879	4053	2	42	16	13
D11880	4540	3	52	24	18
D11881	4067	4	46	24	13
D11882	3547	5	38	22	9
D11883	2685	6	50	24	14
D11884	2365	7	40	24	13
D11886	4005	8	49	24	15
D11889	3275	9	50	24	14
D11891	2017	11	40	24	13
D11896	1760	14	49	24	13
D11898	2790	15	52	24	17
D11905	1150	17	42	24	13

Hence a total of 5.74m of sub-core was processed into 308 pore water and 169 non-pore water sections.

Discussion - Once the initial problems with balancing pairs of centrifuge tubes had been overcome (core 6 onward), the whole process was very successful. However, owing to the nature of the sediment it was rare to obtain more than 10ml of pore water sample. Ideally analysis should have taken place on board as a means of checking on the validity of the procedures employed. This was not possible from both a space/time and personnel perspective. Owing to pressure effects in carbonate-rich sediments, such as encountered on this transect, in situ measurements are necessary to characterise fully the carbonate system (e.g. alkalinity, pH). Consequently shore based analysis will be restricted to NO_3, PO_4, Si, Mn and Fe in the first instance. Solid phase bulk characterisation will also be undertaken.

Many thanks to the IOS team for obtaining such an excellent suite of box cores and to all who braved the cold container with me - the company and hands were much appreciated. Sincere thanks also to Sarah Colley of IOS whose technical expertise, experience and equipment made the pore water extraction operation possible in the first place.

S.J. Wakefield

4b. Oxygen Microelectrodes

Oxygen in marine sediment has two roles in the cycle of carbon in the oceans.

1. Degradation of organic matter in the sediment is carried out mainly through oxygen reduction by microbial activity. This process supplies the water column with dissolved carbon and various other nutrients to facilitate primary production in the photic zone. At the same time, this process decreases the absorption of carbon from atmospheric source.

2. Dissolution of $CaCO_3$ particles in the sediment is governed by the saturation level of $CaCO_3$ in the surrounding water. The degradation of organic matter by reduction of oxygen increases the total CO_2 in the pore water but due to alkalinity and pH level in sea-water there is a decrease in the concentration of CO_3^{--}, thus dissolution of $CaCO_3$ is facilitated. Through this process, the three components of the carbonate system in the sea-water change their relative contribution to the total CO_2. The decrease of dissolved carbon as H_2CO_3 allows the absorption of atmospheric CO_2 in sea-water to increase.

Method - The oxygen measurements in the sediments were carried out using a combined oxygen (Clark type) micro-electrode (made by Micro-Sense) with a tip diameter of 100-200 μm. This gives rise to an oxygen consumption equivalent to less than 500 pA. This small oxygen consumption by the electrode is compensated by diffusion and therefore the oxygen concentration, as measured by the electrode, is not influenced by the measurement process. The output electrical signal from the electrode was amplified by a Micro-Sense Supplier Converter which also supplies the required voltage for the polarization of the oxygen electrode. The amplified signal is read by a conventional millivolt-meter. The movement of the electrode was done by the aid of micromanipulator which can be moved in 5 μm steps. A Multicore Sampler was used to collect completely undisturbed cores. The sediment depth in each core is about 20cm, above which is about 40cm of captured bottom sea-water. Once on board the cores were incubated at 3°C for 2 - 6 hours prior to the measurement. It was shown from the first core that this time of incubation does not cause any measurable difference in the oxygen measured. This period of incubation was required to obtain a constant temperature profile in the sediment and the water above since the electrodes are sensitive to changes in temperature (about 5% per 1°C). Measurements in each core were carried out from above the sediment where the sea-water was still well stirred by eddy diffusion. The zero-depth was an arbitrary point above the sediment where a first change in the electrode's signal was noticed. For calibration, the oxygen micro-electrodes were immersed in air-saturated sea-water and nitrogen-saturated sea-water, at 3°C and the two different electrical signals were recorded. Since the electrode's electrical signal is linearly proportional to the oxygen concentration, the calculation of level of oxygen-saturation relative to saturated sea water is straightforward.

The following table gives the cores and sub-cores with replicates on which oxygen profiles were made. The electrical current is in pico-ampere and the reading is accurate to 1 pA. The accuracy of the micromanipulator is 5 μm.

E. Traub

Oxygen Microelectrode Determination

Core	Subcores and replicates (A, B etc)		
#1M	-4(A)	-4(B)	-5(A)
#2M	-4(A)	-4(B)	
#3M	-4(A)	-4(B)	
#4M	-4(A)	-4(B)	-4(C)
#5M	-4(A)	-4(B)	-4(C)
#6M	-4(A)	-4(B)	
#8M	-4(A)	-4(B)	
#9M	-4(A)	-4(B)	-4(C)
#11M	-4(A)	-4(B)	
#13M	-4(A)	-4(B)	
#14M	-4(A)	-4(B)	-4(C)
#15M	-4(A)	-4(B)	
#17M	-4(A)	-4(B)	

4c. Pore Water Oxygen Analysis

Pore water oxygen analysis was performed by the method of Sorensen and Wilson (1984). Core sub-samples were equilibrated with a Helium atmosphere in sealed containers for about one hour. Gas chromatographic analysis of the headspace gas yielded the Oxygen to Nitrogen ratio. The oxygen content was then determined relative to a saturated sea-water standard.

Results from this method and the microelectrode method agreed well. Four sites were studied by both techniques. At this point it was decided to discontinue the chromatographic analyses.

N.C. Higgs

5. WATER COLUMN RADIONUCLIDES

5a. Stand Alone Pumps

The major requirement on the stand alone pumps (SAP) was to process large volumes of sea-water at specific depths in the water column for BOFS radionuclide studies. The water was first passed through a 293 mm diameter, 1 μm pore size Nucleopore filter, then in series through two 1 μm pore size polypropylene filters which had been impregnated with manganese oxyhydroxide. The manganese-impregnated cartridges had been prepared in pairs, so that it could be assumed that each had the same absorption efficiency. In this way the filter and absorber cartridges of each sample allow measurement of the particulate/dissolved speciation of natural radionuclides. These radiochemical analyses will be undertaken at IOS Wormley. The principal interest is in the thorium isotopes ^{230}Th and ^{228}Th, although ^{226}Ra, ^{210}Pb and ^{210}Po will also be measured.

Five SAPs purchased for the BOFS programme remained for this cruise, and these were augmented by the prototype version of the SAP, kindly reassembled and loaned by T.J.P. Gwilliam (IOS). Since the interest was in the full water column and organic contamination was not a major concern, the SAPs were mounted directly on to the coring warp of the aft traction winch by means of standard net-bar clamps attached to the central bar of the SAPs. A wire test with two pumps to shallow depth demonstrated that it was not necessary to prime the pumps by pre-filling with water as had been done on the earlier BOFS cruises.

Two casts with all six SAPs programmed to pump for two hours were carried out at each of three sites:

i) in the area of the 47°N sediment trap array (11880/1 and 11880/9) to 4545m.

ii) in the area of the 59°N sediment trap array (11899/1 and 11901/1) to 2880m.

iii) at an intermediate station at 52°N in a water depth of 4326m (11885/1 and 11885/8).

The only serious problem encountered was at Station 11880/9 where the entire deployment was made in Force 6 conditions. Although all the SAPs operated satisfactorily, one pump had slipped down the warp on to the underlying pump, and four of the six power cables were damaged. It was clear from the pump volumes that most of the damage had been incurred on recovery. The cables had been looped into coils below the SAPs: subsequently the cables were tied upwards on to the SAP frames and there was no recurrence of the problem in similar sea conditions later.

Considered as a new instrument, the performance of the SAPs through this cruise was good. Details which should be considered in any future redesign are, i) better protected or more robust power cables, ii) larger clamps for attachment to the coring warp, and iii) cartridge holder mounted vertically rather than horizontally to give less drag on hauling in rough conditions.

J. Thomson

5b. <u>Water Bottle Sampling for Radionuclides</u>

Water column profiles over the summer thermocline were taken to determine the levels of ^{210}Pb and ^{210}Po in the dissolved and particulate phases. The level of scavenging of these elements gives an indication of the particulate flux through the water column.

Experimental - Each sample was filtered through Asypor (0.45 μm) filters to remove particles. The filters were stored for processing ashore. Concentrated HCl (40ml), stable lead (5×10^{-5} gl^{-1}) and ^{208}Po (4dpm) were added to the sample and left to equilibrate for two days. Cobalt ($5 \times 10^{-2} gl^{-1}$) and APDC (ammonium pyrolydine-dithiocarbonate:1g) were then added to co-precipitate out the lead and polonium isotopes. The precipitate was removed using Whatman GF/D which were also stored for processing ashore.

Samples of 20 l were taken from each depth as follows:

Station 11877	Depths(m)	2.20,50,70,100,200,300
11885,11892,11899		2,25,50,125,300,500,1000

G. Ritchie

6. SEDIMENT TRAPPING and RELATED FLUX STUDIES

6a. <u>Mooring Operations</u>

The aim was to recover two sediment trap moorings, deployed on previous Discovery cruises, and subsequently redeploy them for approximately 1 year. In addition a drifting array comprising three sediment traps was to be deployed for a short period at each site.

Site 1.	47° 58.19'N	19° 32.91'W
	Initial Deployment	17/04/89
	Recovered	18/07/89
	Redeployed	23/07/89

The mooring was located using the release signals, no signal was received from the transponder. On release it became apparent, from the ascent time, that the main buoyancy was missing. After approximately one hour, the secondary buoyancy was sighted on the surface and a pick-up line was attached using the ship's boat. The mooring was recovered using the starboard forward A frame and double barrel capstan.

The mooring line had parted approximately 430M below the main buoyancy, with the resulting loss of one Parflux trap, 1 Aanderaa current meter, the transponder and the 1.3M steel sphere. Data from the remaining current meter indicates the mooring was intact for one week after deployment.

The mooring was redeployed buoy first using the Schat davit and afterdeck capstan at 47° 58.74'N 19° 31.97'W, water depth 4550 m(uncorr.). All mooring lines were new and prestretched.

A drifting sediment trap array was deployed aft at 47° 59.8'N 19° 33.00'W on 18/07/89. It was subsequently recovered on 24/07/89 at 48° 20.1'N 18° 58.0'W. Between these dates it was tracked using ARGOS positional information relayed from P.M.L.

Relocation was aided by light and radio beacons on the spar and dhan buoys. On recovery the ARGOS buoy was missing. A search was instigated using R.D.F. and last known position, however this was hampered by deteriorating weather conditions and was eventually abandoned.

Site 2.	59° 00.58'N	21° 59.520'W
	Initial Deployment	05/06/89
	Recovered	07/08/89
	Redeployed	08/08/89

Release and recovery were straight forward. All recovered lines were examined and assessed suitable for redeployment.

The mooring was redeployed at 59 00.56°N 21 57.9°W, water depth 2887 m(uncorr.). The main buoyancy from the recovered mooring [16x17" glass spheres] were replaced by a 1.3M steel sphere.

Because of the loss of the ARGOS buoy at the southern site, no drifting traps were deployed at the northern site.

K. Goy

6b. <u>Description of Samples Collected in Traps</u>

After sampling of the supernatants to test the efficiency of preservatives added to the traps, all samples were refrigerated prior to return to a shore laboratory for subsampling and distribution to various BOFS research groups. Preliminary visual inspection of the collected material was undertaken and the results summarised below.

<u>Site 1</u> Moored Array - 13 sampling periods of one week duration.

1000m depth trap : Sampling was incomplete due to lost buoyancy.

3000 and 4400m depth traps : The collected samples show a clear temporal variation in flux from low values in April to a maximum in mid June with a subsequent modest decline. This variation is likely to reflect the sedimentation of the spring bloom.

Site 1 Floating Array - 4 sampling periods of one day duration.

50m depth trap : Failed to sample, operator error suspected.

100m depth trap : Collected material dominated by zooplankton "swimmers" as anticipated at this time of the year.

300m depth trap : Collected material appears to include faecal pellets and phytodetrital debris.

Site 2 Moored Array - 11 sampling periods of 4 to 7 day duration.

300m depth trap : Dominated by swimmers.

1000m depth trap : While swimmers are present, sedimenting material is clearly present.

2000 and 2700m depth traps : The samples again show clear temperal variability, probably related to the settling of the spring bloom. The peak of sedimentation at this site is later and the period of high flux much shorter than at site 1.

The 1000 and 2000m traps failed to complete the rotation of the sampling carousel but the traps were successfully recovered without loss of the composite sample collected in the last sampling bottle to move into position. This problem was traced to battery failure.

In summary the sediment traps functioned reasonably satisfactorily though the problems of poor quality finishing of the equipment noted on previous cruises were evident. The abrupt battery failure is also a cause of concern. However, almost all the samples that we planned to be collected were collected and promise exciting results. The confirmation of "swimmers" as a serious problem at shallow depths in these waters will require adjustment of mooring designs in future years.

T. Jickells

6c. Stand Alone Pumps (SAPs)

Additional sets of samples were collected with SAPs at 47°N and 59°N on 0.45 nuclepore filters for major and trace element analysis. These samples were collected from approximately the same depth as the sediment traps (i.e. 50, 100, 300, 1000, 3000, 4300m at 47°N and 50, 100, 300, 1000, 2000 and 2800m at 59°N) and will be used to compare the compositions of large fast sinking particles, as sampled by sediment traps, and smaller slow sinking particles which dominate the material sampled by SAPs. The volumes filtered are noted below.

47°N 1½hr pumping time		59°N 2hr pumping time	
Depth(m)	Vol. filtered(l)	Depth(m)	Vol. filtered(l)
50	92.5	50	230
100	327.9	100	270
300	513.5	300	443.9
1000	768.8	1000	706.5
3000	845.0	2000	920.2
4300	648.7	2800	821.7

The effect of the intense chlorophyll maximum at 47°N is clearly evident. Otherwise the volumes filtered suggest steadily decreasing particle concentration with depth, and a small increase near the bottom of the water column.

At 47°N SAPs were used without Mn oxide cartridges, and the pumps were therefore filled with water and corked during deployment to prevent back pressure damaging the filters as reported in earlier use. At 59°N the oxide cartridges were used so this procedure was unnecessary.

All samples were successfully collected, even under the poor weather conditions (20-30 knot winds) at 59°N at the time of deployment. A notable feature of the filters when examined was the presence of millimeter sized aggregates on many filters particularly at 47°N. These were also noted on the previous cruise (Discovery 183) and they are thought to represent aggregated dead phytoplankton settling after the spring bloom. In this context visual inspection suggested that the aggregates became rarer but increased in size with depth suggesting processes of consumption and aggregation in the deep water column. After inspection, filters were stored frozen for subsequent analysis.

T. Jickells

6d. Rain Collection

As an extension of an NERC sponsored project on atmospheric inputs to the North Sea, rain collections were undertaken on this cruise. Limited data on rainwater composition over the world's oceans are available, despite the fact that this is now recognised as a major source of many elements to the oceans. Separate collectors for major and trace elements were deployed forward on the monkey island above the bridge as the best compromise between accessibility and freedom from contamination sources such as rigging and the exhaust funnels. Collection was undertaken only with the ship within 45° of head to wind to further minimise contamination dangers, and collectors were angled for efficient collection. In total 10 rain storms were sampled and two of these were sufficiently large to yield multiple samples, yielding 16 samples in total.

In the region 52 - 58°N mist and light drizzle were encountered repeatedly. Such precipitation is very inefficiently sampled by conventional rain gauges so a mist collector was built and, although the design was not optimal, this yielded a further three samples.

All samples were frozen for return to UEA for subsequent analysis.

T. Jickells

7. BASIC BOFFING

7a. CTD Sensors

All sensors except the Transmissometer functioned well throughout the cruise and were in good agreement with those on Meteor during the intercalibration exercise. However the agreement in potential temperature (which was to 0.003°C in the mixed layer on our simultaneous cast) was achieved only after Meteor had altered her computer processing of in situ temperatures. Our initial comparison revealed a discrepancy of 0.125°C!

The optical transmission data, while apparently internally consistent on a single cast suffer from severe fluctuation in the baseline voltage. This was noticed early on through differences in mid-water attenuation coefficients but a measurement of the voltage in air gave a value of 4.822V, very close to the factory value of 4.820V. This suggested some immeasurable internal jitter and put us off the scent. Subsequently, after looking at the blocked light path zero (which was 0.000 ± 0.002V), and making several more deployments, the f.s.d. in air was measured again. This time a value of 4.951V was obtained, sufficient to explain the mid-water baseline shifts. Subsequently (CTD 314 to 322) the f.s.d. voltage was measured before each lowering. It was found to be extremely unstable and there can be no guarantee that a further shift did not occur during lowering.

CTD	Air	Blocked
314	4.951V	0.000V
315	4.895	"
317	4.948	"
318	4.941	"
319	4.878	"
321	4.943	"
322	4.941	"

The unit is SeaTech Transmissometer No. 116D, 0.25m path length. The routine in the shipboard computer was calculating the attenuation coefficient for a 1m path length. This was corrected.

The fluorescence sensor appears to have a pressure-related fault. On deep casts the sensor records a rapid increase in fluorescence that is unrelated to any hydrographic or optical feature of the water column. This fault occurred at depths (dB) of 4550 (#292), 4540 (#295) and 4430 (#290) but did not occur at 4390 (#300) or any shallower depths.

7b. Rosette/Go-Flo Bottles

The Go-Flo bottles were left uncovered at Milford Haven Dock which meant that they were received in a very dirty condition. Hopefully this will be avoided in future since a canvas cover has now been made to fit over the top of the rosette system.

After completely stripping down and cleaning the ball-valves of all the bottles at the start of the cruise, there were only occasional leaks. These were easily remedied by application of small amounts of silicone grease to the appropriate parts of the ball valves. Experiences on this and past cruises shows that for Go-Flo bottles to operate consistently the ball-valves need servicing about once every two weeks.

7c. BOFS Level 1 Measurements

(i) From Go-Flos: The following determinations are to be made on water collected using the rosette/go-flo system.

BOFS #	Measurement	
2	CTD, transmissometry)	Measurements on-board -
3	Oxygen; Winkler titrations)	no major problems were
4	Nutrients)	encountered.
7	P.O.C./Chlorophyll	
8	Pigments	
10	Bacterial Biomass	
11	Biomass mesoplankton - Net haul from 100m depth to surface.	
12	Biomass microplankton	
13	Phytoplankton composition	

All samples were collected using BOFS Level One protocols.

Nutrient samples were collected from every CTD cast (34 in total), one from each depth. The locations of the other samples are listed in the following table.

(ii) Underway Measurements: These measurements were taken from the "non-toxic" seawater supply. This is surface seawater taken in through a stainless steel inlet in the hull of the ship and pumped through cleaned plastic tubing into the main laboratory. Samples were taken hourly for nutrients and four hourly for P.O.C. and phytoplankton while the ship was in transit between stations.

T. Lunel, G. Smith, I.N. McCave

Station (CTD)	Bottle	Pressure	Oxygen Winkler	Microplank 1L	50ml	Phytopl Lug	Form	POC PON	Chloro -phyll	Bact. Biomass	HPLC Pigment
11876/2 (290)	2	4604.1	X								
	3	4581.1	X								
	4	3755.1	X								
	5	2992.8	X								
	6	2234.6	X								
	7	1501.7	X								
	8	1249.0	X								
	9	999.9	X								
	10	897.3	X								
	11	751.2	X								
	12	600.3	X								
11876/3 (291)	1	395.0	X								
	2	299.0	X								
	3	250.0	X								
	4	200.7	X								
	5	150.3	X								
	6	123.2	X								
	7	100.7	X								
	8	76.9	X								
	9	53.0	X								
	10	43.4	X								
	11	23.3	X								
	12	13.1	X								
11877/6 (292)	2	4638.0	X					X		X	X
	3	4612.0	X					X		X	X
	4	4009.0	X					X		X	X
	5	3502.0	X					X		X	X
	6	2756.0	X					X		X	X
	7	2001.0	X	X	X			X		X	X
	8	1499.9	X	X	X			X		X	X
	9	1247.0	X					X		X	X
	10	997.0	X	X	X			X		X	X
	11	897.0	X					X		X	X
	12	748.0	X					X		X	X
11877/7 (293)	1	596.0	X	X	X	X	X	X		X	
	2	398.0	X			X	X	X		X	
	3	300.0	X	X	X	X	X	X	X	X	X
	4	250.0	X			X	X	X	X	X	X
	5	200.0	X			X	X	X	X	X	X
	6	150.0	X			X	X	X	X	X	X
	7	102.0	X			X	X	X	X	X	X
	8	76.0	X			X	X	X	X	X	X
	9	52.0	X			X	X	X	X	X	X
	10	43.0	X			X	X	X	X	X	X
	11	22.0	X			X	X	X	X	X	X
	12	10.0	X			X	X	X	X	X	X
11880/7 (295)	1	4651.5	X					X			
	2	4625.4	X					X			
	3	4602.5	X					X			
	4	4551.7	X								
	5	4451.5	X					X			
	6	3993.3	X					X			
	7	3472.2	X					X			
	8	2979.8	X								
	9	2493.9	X					X			

Station (CTD)	Bottle	Pressure	Oxygen Winkler	Microplank 1L	Microplank 50ml	Phytopl Lug Form	POC PON	Chloro -phyll	Bact. Biomass	HPLC Pigment
11880/7	10	1999.6	X				X			
	11	1754.0	X							
	12	1504.4	X				X			
11880/12 (296)	1	1485.0	X							
	2	1387.0	X							
	3	1289.0	X				X			
	4	1192/0	X				X			
	5	1093.0	X							
	6	1044.0	X				X			
	7	994.0	X							
	8	944.0	X				X			
	9	893.0	X				X			
	10	8946.0	X				X			
	11	797.0	X							
	12	696.0	X				X			
11800/13 (297)	1	593.0	X				X	X		
	2	495.0	X				X	X		
	3	397.0	X				X	X		
	4	299.0	X				X	X		
	5	202.0	X				X	X		
	6	153.0	X				X	X		
	7	104.0	X				X	X		
	8	79.0	X				X	X		
	9	54.0	X				X	X		
	10	36.0	X				X	X		
	11	26.0	X				X	X		
	12	16.0	X				X	X		
11881/2 (298)	1	4130.0								
	2	4107.0								
	3	4013.0								
	4	3488.0		None Taken						
	5	2741.0								
	6	1998.0								
	7	1502.0								
	8	1251.0								
	9	996.0								
	10	899.0								
	11	801.0								
	12	707.0								
11881/32 (299)	1	596.0								
	2	500.0								
	3	400.0								
	4	299.0		None Taken						
	5	204.0								
	6	153.0								
	7	103.0								
	8	79.0								
	9	54.0								
	10	43.0								
	11	23.0								
	12	14.0								
11885/2 (300)	1	4388.0	X				X			
	2	4371.0	X				X			
	3	4346.0	X				X			
	4	3985.0	X				X			
	5	3493.0	X				X			

Station (CTD)	Bottle	Pressure	Oxygen Winkler	Microplank 1L	Microplank 50ml	Phytopl Lug	Phytopl Form	POC PON	Chloro -phyll	Bact. Biomass	HPLC Pigment
11885/2	6	2999.0	X					X			
(300)	7	2501.0	X	X	X			X			
	8	1997.0	X					X			
	9	1499.0	X	X	X			X			
	10	1376.0	X					X			
	11	1252.0	X					X			
	12	1125.0	X	X	X			X			
11885/4	2	994.0				X	X	X			X
(301)											
11885/7	1	894.0	X			X	X	X			X
(301B)	2	794.7	X			X	X	X			X
	3	698.0	X			X	X	X			X
	4	600.0	X			X	X	X			X
11885/4	4	502.0									
	5	398.0	X	X	X	X	X	X	X		X
	6	303.0									
	6	199.0	X	X	X	X	X	X	X		X
	7	151.0	X	X	X	X	X	X	X		X
11885/4	8	128.0									
	8	102.0	X	X	X	X	X	X	X		X
	9	77.0	X	X	X	X	X	X	X		X
11885/4	9	54.0									
	10	42.0	X	X	X	X	X	X	X		X
	12	29.2									
	11	22.5	X	X	X	X	X	X	X		X
	12	12.0	X	X	X	X	X	X	X		X
11887/1	1	3792.0									
(302)	2	3788.0									
	3	3774.0									
	4	3747.0		None Taken							
	5	3697.0									
	6	3525.0									
	7	3423.0									
	8	3321.0									
	9	3019.0									
	10	2616.0									
	11	2010.0									
	12	1508.0									
11888/1	1	3474.0									
(303)	2	3469.0									
	3	3454.0									
	4	3431.0		None Taken							
	5	3337.0									
	6	3291.0									
	7	3151.0									
	8	3050.0									
	9	2989.0									
	10	2900.0									
	11	2851.0									
	12	2501.0									
11890/1	1	2809.0									
(304)	2	2804.0									
	3	2774.0									
	4	2649.0		None Taken							
	5	2441.0									
	6	1488.0									

Station (CTD)	Bottle	Pressure	Oxygen Winkler	Microplank 1L	Microplank 50ml	Phytopl Lug	Phytopl Form	POC PON	Chloro -phyll	Bact. Biomass	HPLC Pigment
11890/1 (304)	7	981.0									
	8	598.0									
	9	502.0									
	10	201.0									
	11	101.0									
	12	51.0									
11892/1 (305)	1	2108.0	X	X	X			X			
	2	2102.0	X					X			
	3	2081.0	X					X			
	4	1989.0	X					X			
	5	1742.0	X					X			
	6	1488.0	X	X	X			X			
	7	1283.0	X					X			
	8	1182.0	X					X			
	9	1085.0	X	X	X			X			
	10	886.0	X					X			
	11	792.0	X					X			
	12	698.0	X					X			
11892/3 (306)	1	991.7									
	3	500.0									
	5	300.0									
	7	127.0		None Taken							
	9	51.0									
	11	32.0									
11892/5 (307)	1	597.0	X	X	X	X	X	X			X
	2	548.0	X			X	X	X			X
	3	449.0	X			X	X	X			X
	4	351.0	X	X	X	X	X	X			X
	5	201.0	X			X	X	X	X		X
	6	152.0	X	X	X	X	X	X	X		X
	7	102.0	X	X	X	X	X	X	X		X
	8	77.0	X	X	X	X	X	X	X		X
	9	63.0	X	X	X	X	X	X	X		X
	10	43.0	X	X	X	X	X	X	X		X
	11	23.0	X	X	X	X	X	X	X		X
	12	13.0	X	X	X	X	X	X	X		X
11895/1 (309)	1	3009.0	X					X			
	2	2989.0	X					X			
	3	2918.0	X					X			
	4	2705.0	X					X			
	5	2505.0	X					X			
	6	2006.0	X					X			
	7	1754.0	X					X			
	8	1505.0	X					X			
	9	1256.0	X					X			
	10	1006.0	X					X			
	11	905.0	X					X			
	12	805.0	X					X			
11895/2 (310)	1	699.0	X					X			
	2	600.0	X					X			
	3	501.0	X					X			
	4	401.0	X					X			
	5	301.0	X					X	X		
	6	201.0	X					X	X		
	7	153.0	X					X	X		
	8	104.0	X					X	X		

Station (CTD)	Bottle	Pressure	Oxygen Winkler	Microplank 1L	Microplank 50ml	Phytopl Lug Form	POC PON	Chloro -phyll	Bact. Biomass	HPLC Pigment
11895/2 (310)	9	63.0	X				X	X		
	10	44.0	X				X	X		
	11	23.0	X				X	X		
	12	13.0	X				X	X		
11896/6 (311)	1	1767.0								
	2	1763.0								
	3	1673.0								
	4	1504.0		None Taken						
	5	1004.0								
	6	804.0								
	7	605.0								
	8	404.0								
	9	204.0								
	10	104.0								
	11	54.0								
	12	13.0								
11897/1 (312)	1	2882.0	X				X			
	2	2989.0	X				X			
	3	2877.0	X				X			
	4	2863.0	<----------------------Did not close-------------->							
	5	2790.0	X				X			
	6	2004.0	X				X			
	7	1503.0	X				X			
	8	1004.0	X				X			
	9	1256.0	X				X			
	10	903.0	X				X			
	11	804.0	X				X			
	12	704.0	X				X			
11897/2 (313)	1	599.0	X				X			
	2	500.0	X				X			
	3	401.0	X				X			
	4	301.0	X				X	X		
	5	202.0	X				X	X		
	6	153.0	X				X	X		
	7	103.0	X				X	X		
	8	78.0	X				X	X		
	9	53.0	X				X	X		
	10	43.0	X				X	X		
	11	23.0	X				X	X		
	12	13.0	X				X	X		
11899/2 (314)	1	2893.0	X				X		X	
	2	2888.0	<------------------------Leaky Bottle---------------->							
	3	2877.0	X				X		X	
	4	2799.0	X				X		X	
	5	2485.0	X	X	X		X		X	
	6	1995.0	X				X		X	
	7	1501.0	X	X	X		X		X	
	8	1304.0	X				X		X	
	9	1103.0	X	X	X		X		X	
	10	901.0	X				X		X	
	11	802.0	X				X		X	
	12	703.0	X				X		X	
11899/4 (315)	1	994.0								
	3	497.0								
	5	302.0		None Taken						
	7	128.0								
	9	54.0								
	11	29.0								

Station (CTD)	Bottle	Pressure	Oxygen Winkler	Microplank 1L	Microplank 50ml	Phytopl Lug	Phytopl Form	POC PON	Chloro -phyll	Bact. Biomass	HPLC Pigment
11899/6	1	597.0	X	X	X	X	X	X		X	X
(316)	2	547.0	X			X	X	X		X	X
	3	448.0	X			X	X	X		X	X
	4	350.0	X	X	X	X	X	X	X	X	X
	5	202.0	X			X	X	X	X	X	X
	6	152.0	X	X	X	X	X	X	X	X	X
	7	102.0	X	X	X	X	X	X	X	X	X
	8	78.0	X	X	X	X	X	X	X	X	X
	9	63.0	X	X	X	X	X	X	X	X	X
	10	43.0	X	X	X	X	X	X	X	X	X
	11	23.0	X	X	X	X	X	X	X	X	X
	12	13.0	X	X	X	X	X	X	X	X	X
11902/2	1	2381.0						X			
(318)	2	2378.0						X			
	3	2363.0						X			
	4	2288.0						X			
	5	2010.0						X			
	6	1759.0						X			
	7	1507.0						X			
	8	1304.0						X			
	9	1105.0						X			
	10	904.0						X			
	11	804.0						X			
	12	704.0						X			
11902/3	1	596.0						X			
(319)	2	501.0						X			
	3	401.0						X			
	4	301.0						X	X		
	5	202.0						X	X		
	6	153.0						X	X		
	7	103.0						X	X		
	8	78.0						X	X		
	9	53.0						X	X		
	10	43.0						X	X		
	11	23.0						X	X		
	12	23.0						X	X		
11903/1	1	2623.0									
(320)	2	2617.0									
	3	2520.0									
	4	2000.0									
	5	1501.0									
	6	999.0		None Taken							
	7	702.0									
	8	403.0									
	9	203.0									
	10	103.0									
	11	53.0									
	12	13.0									
11904/1	1	2920.0	<-------------------------Leaky Bottle------------->								
(321)	2	2904.0	X								
	3	2821.0	X								
	4	1515.0	X								
	5	2011.0	X	X	X						
	6	1759.0	X								
	7	1508.0	X	X	X						
	8	1256.0	X								

Station (CTD)	Bottle	Pressure	Oxygen Winkler	Microplank 1L	Microplank 50ml	Phytopl Lug Form	POC PON	Chloro -phyll	Bact. Biomass	HPLC Pigment
11904/1	9	1005.0	X	X	X					
(321)	10	906.0	X							
	11	805.0	X							
	12	705.0	X							
11904/2	1	599.0	X	X	X					
(322)	2	498.0	X							
	3	399.0	X							
	4	302.0	X	X	X					
	5	202.0	X							
	6	152.0	X	X	X					
	7	102.0	X	X	X					
	8	79.0	X	X	X					
	9	52.0	X	X	X					
	10	23.0	X	X	X					
	11	13.0	X	X	X					
	12	5.0	X							
11905/4	1	1155.0								
(323)	2	1140.0								
	3	1001.0								
	4	802.0								
	5	602.0								
	6	402.0		None Taken						
	7	202.0								
	8	153.0								
	9	103.0								
	10	52.0								
	11	24.0								
	12	13.0								

Lug - Lugols solution; Form - Formalin

7d. Undulating Oceanographic Recorder (U.O.R.)

The U.O.R. provides almost continuous underway monitoring of temperature, conducitivity, chlorophyll (fluorescence) and light transmittance at depths between 0 and 60m. It is also capable of measuring received light from both vertically upwards and downwards.

14 deployments were carried out between stations on the B.O.F.S. line 48° 24.9'N 19° 08.3'W - 59° 00.47'N 22° 00.83'N. Initial examination of the data was carried out between deployments, further analysis will be undertaken at P.M.L.

K. Goy

U.O.R. TOWS

TOW	Deploy Date	Time	N		W		Recovery Date	Time	N		W	
1	24.7	1056	48°	24.9	19°	08.3	25.7	0142	49°	48.5	21°	19.2
2	26.7	0330	49	51.3	21	19.2	26.7	0942	50	40.9	21	51.6
3	27.7	0602	50	40.0	21	52.3	27.7	0950	51	05.9	21	11.8
4	27.7	2152	51	05.2	21	11.9	28.7	0451	51	43.62	22	28.77
5	28.7	2110	51	44.8	21	31.3	29.7	0032	52	15.7	22	17.00
6	30.7	1637	52	34.3	22	06.9	30.7	2049	53	08.6	21	40.00
7	30.7	2342	53	10.5	21	38.8	31.7	0137	53	29.1	21	27.7
8	31.7	1843	53	42.8	21	18.7	1.8	0103	54	39.8	20	39.80
9	1.8	0603	54	40.11	20	39.45	1.8	0902	55	08.3	20	22.9
10	1.8	1816	55	12.1	20	21.3	1.8	2136	55	41.6	20	42.4
11	2.8	1250	55	34.4	20	11.8	2.8	1658	56	09.29	20	42.27
12	2.8	2115	56	12.5	20	44.1	3.8	0704	57	52.34	21	21.03
13	3.8	1518	58	17.4	20	16.0	3.8	1808	58	35.5	19	28.0
14	4.8	2349	59	04.5	20	09.5	5.8	0540	59	00.47	22	00.83

7e. Apstein Nets

A 20 μm Apstein closing net was used to collect material in vertical tows at three stations 47°N, 55°N and 59°N. Depth sampling intervals were 300-100m, 100-50m and 50-0m. No problems were encountered with this operation. The material collected by this size net which should include faecal material and large rapidly sinking aggregates, will be examined chemically and microscopically for comparison with material collected by the sediment traps. Visual inspection of the net hauls suggests little material below 50m, while the 50-0m tow regularly contained large quantities of material of obvious green colour. Samples were preserved in formalin and refrigerated for return to shore laboratories.

T. Jickells

7f. XBT's

A single XBT was launched every day of the cruise except for periods around mooring deployments and recoveries when the operator was otherwise engaged or when the ship was on the continental shelf. In total 22 launches were completed and all bar one transmitted to the Royal Navy as required. The equipment worked satisfactorily with the following exceptions:

1) One XBT failed
2) Two XBT's gave apparently anomalous temperatures
3) The HP control unit often refused to accept station positions.

Results along the 20°W transect show rapid cooling of surface waters from 47-53°N. Deeper water cooled more slowly than surface water (top 20m) along the transect with the result that the seasonal thermodine, which was evident at all stations at 25-50m, became somewhat less dramatic but was persistent.

T. Jickells

8. RVS COMPUTING

The computing system consists of a series of microprocessor based sampling boxes (level As), which feed their data to a logging computer (level B). The data is recorded on magnetic tape and also passed to a networked set of graphic workstations (level C). There, the data are stored in separate files on disc, calibrated, any derived variables calculated and then plotted. At the end of the cruise, the data are archived in the International Standard Format, GF3.

During cruise 184, the following instruments were sampled routinely. EM Log, Gyro, Transit Satellite, GPS, Met. instruments, Turner Fluorometer, Surface Irradience, Thermosalinograph, Nutrients, CTD, UOR and ADCP (acoustic-doppler current profiler).

Throughout the cruise, all the computers fulfilled their tasks without hitch. Some navigation was lost however, due to a problem with the EM log. As we were on station for most of this time and had BGS data for some of the rest, this was not a severe loss.

At the end of the cruise all the data were archived and sent to Dr M. Fasham at IOSDL.

D.A. Jones

9. EQUIPMENT LOSSES and BREAKDOWNS

9a. <u>Losses</u>

From the mooring which was recovered incomplete there was missing 1 Anderaa RCM, 1 Parflux sediment trap, 1 acoustic transponder and 1 steel buoyancy sphere. From the drifting trap array one Argos buoy was lost (but is still being tracked by satellite). One strobe shield and trigger weight was lost overboard during camera recovery in rough weather.

9b. <u>Mishaps</u>

i) Cooling pipe in main winch burst.

ii) Block on CTD wire siezed. Block was removed and another substituted on a new mounting.

iii) Winch for 6mm wire not operational.

iv) Coring wire jumped off tension arm and damaged. The end was cut off and re-terminated.

v) The 3.5 kHz cable was cut by the inboard end of the boom. Cut and re-spliced.

vi) The 3.5 kHz fish wire became caught up with the CTD wire. Subsequently the 3.5 was taken inboard whenever CTD or camera were deployed with wind over force 5.

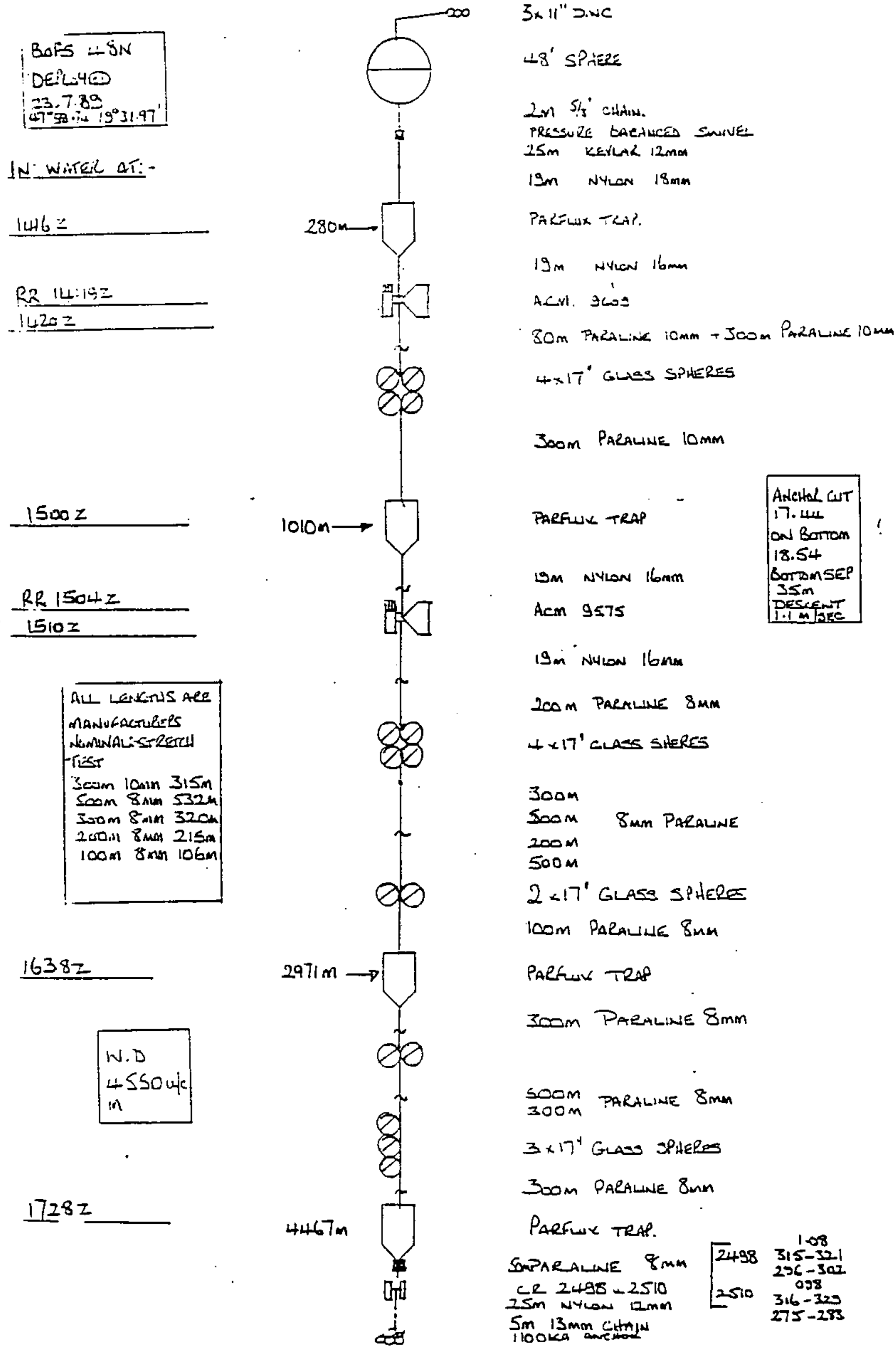
vii) Multicorer was banged against the stern, bending the central column. This was straightened, but not perfectly.

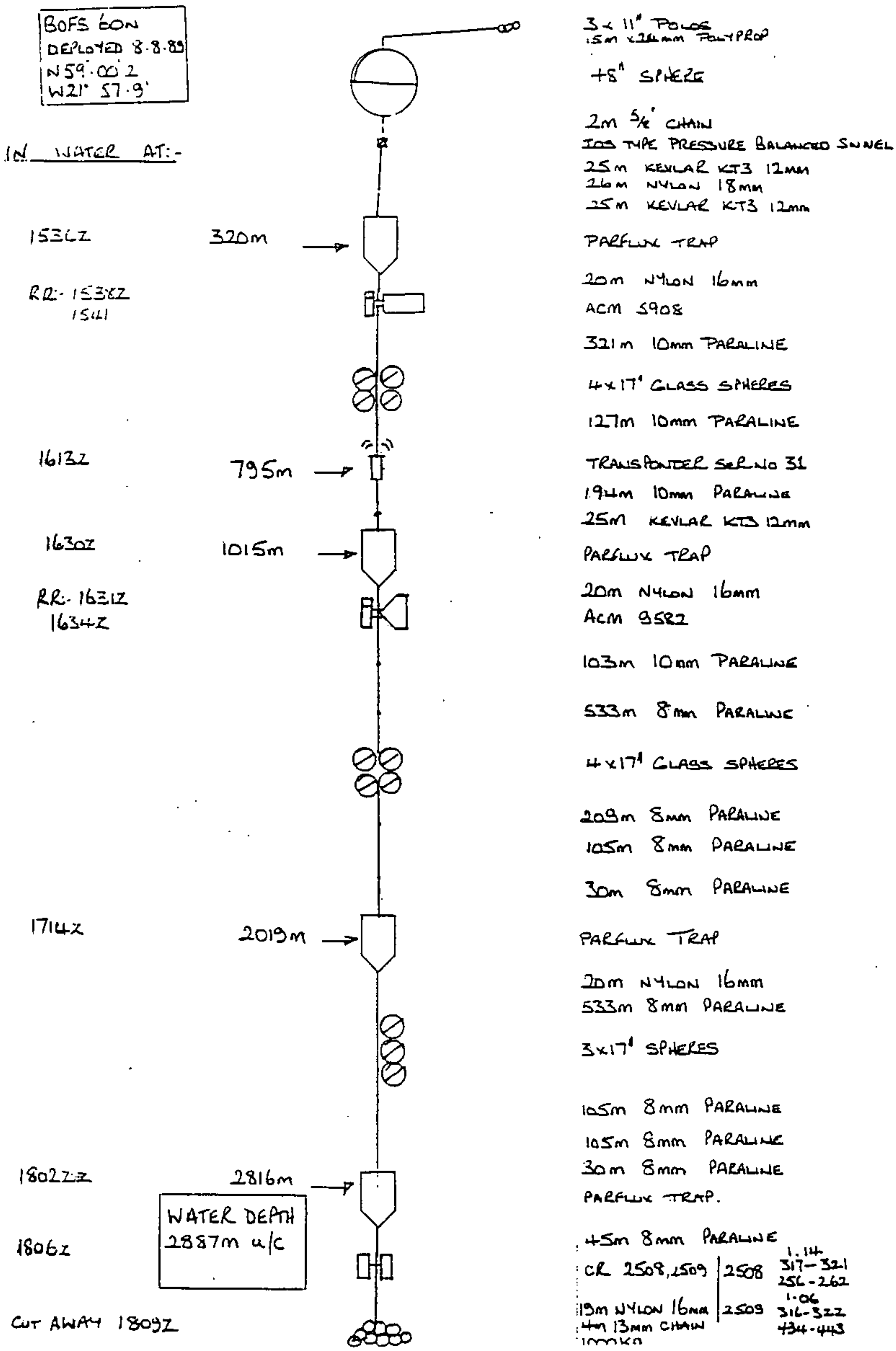
viii) Main winch failure - no back tension. Cause ultimately located after replacement of hydraulic pump.

ix) Main winch spooling wheel siezed. Lost attempt to take core in narrow weather window. Plates on wheel eased and wheel run back in.

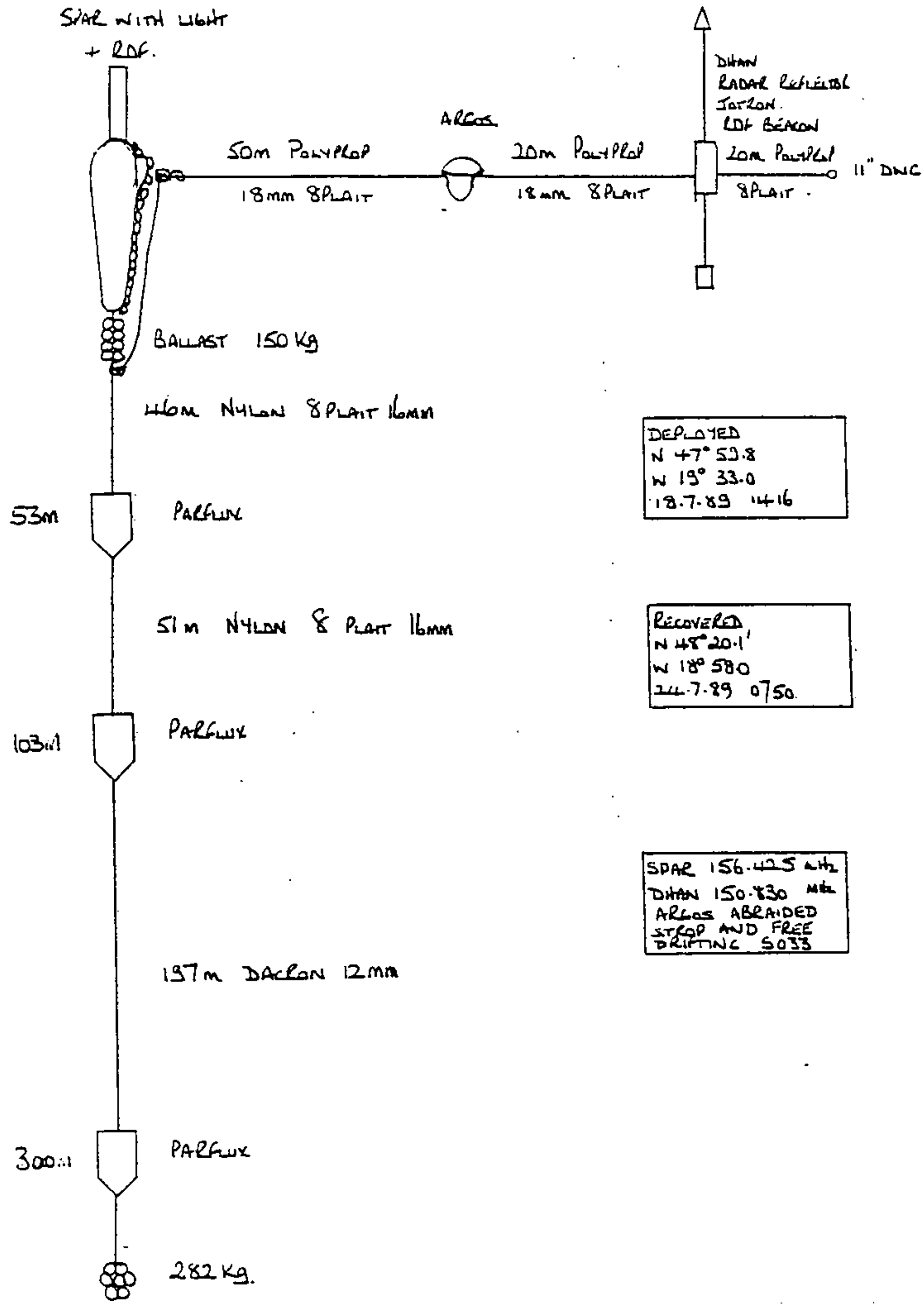
The fact that these various mishaps (which are not unexpected on a venerable ship) resulted in the loss of only 10 hours operating time says much for the skill, dedication and long hours put in by the mechanical and electronic technical staff. They have my thanks and those of the BOFS community.

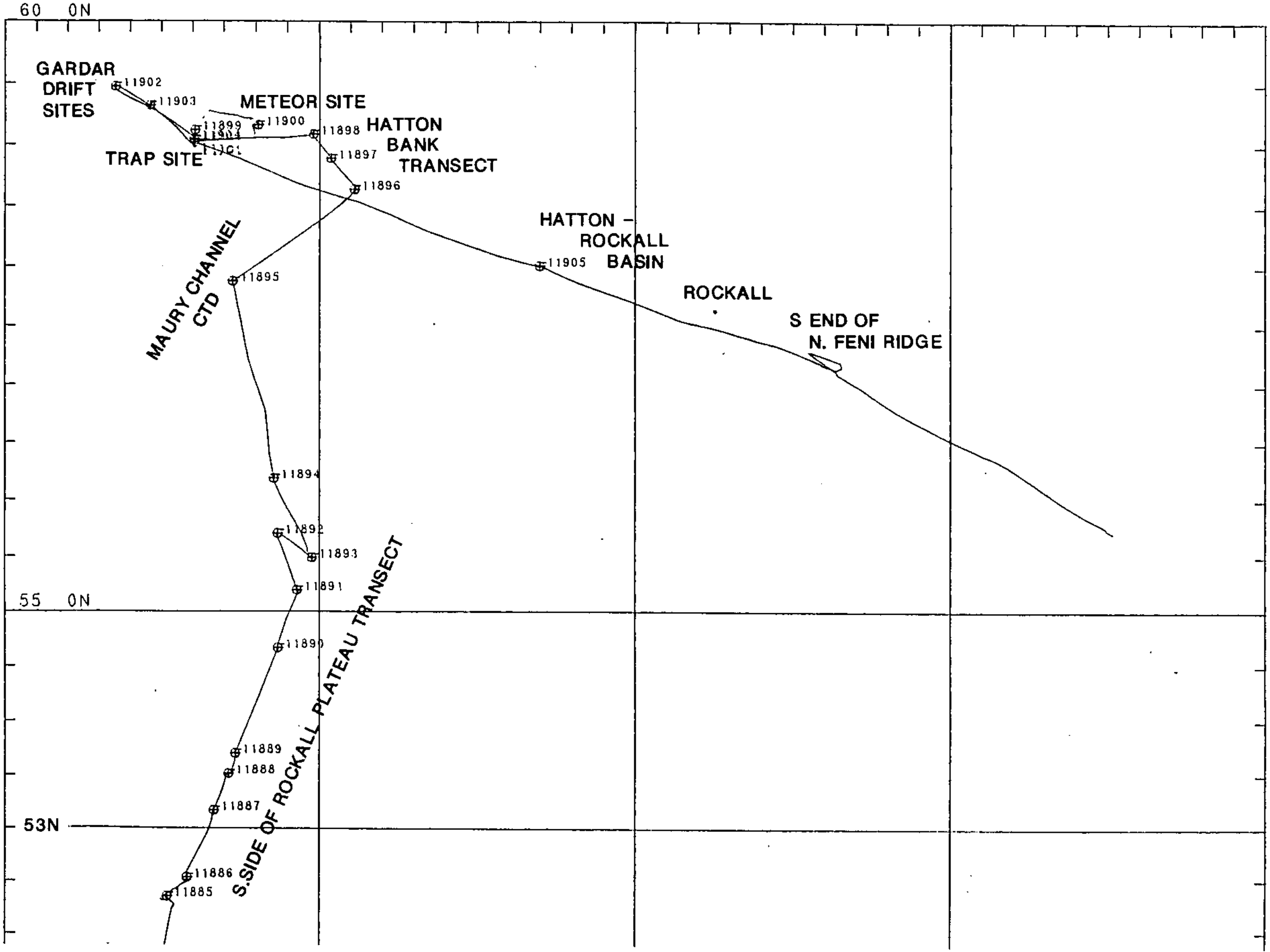
I.N. McCave


BOFS 48N
DEPLOYED
23.7.89
47°58.74 19°31.97'
IN WATER AT:-
1416 Z
RR 1419 Z
1420 Z
1500 Z
RR 1504 Z
1510 Z
ALL LENGTHS ARE MANUFACTURERS NOMINAL STRETCH TEST
300m 10mm 315m
500m 8mm 532m
300m 8mm 320m
200m 8mm 215m
100m 8mm 106m
1638 Z
W.D 4550 u/c m
1728 Z
3x11" DNC
48' SPHERE
2m 5/8' CHAIN.
PRESSURE BALANCED SWIVEL
25m KEVLAR 12mm
19m NYLON 18mm
280m
PARFLUX TRAP.
19m NYLON 16mm
ACM 9603
30m PARALINE 10mm + 300m PARALINE 10mm
4x17' GLASS SPHERES
300m PARALINE 10mm
1010m
PARFLUX TRAP
ANCHOR CUT 17.44
ON BOTTOM 18.54
BOTTOM SEP 35m
DESCENT 1.1 m/SEC
19m NYLON 16mm
ACM 9575
19m NYLON 16mm
200m PARALINE 8mm
4x17' GLASS SHERES
300M
500M
200M
500M
8mm PARALINE
2x17' GLASS SPHERES
100m PARALINE 8mm
2971m
PARFLUX TRAP
300m PARALINE 8mm
500M
300M
PARALINE 8mm
3x17' GLASS SPHERES
300M PARALINE 8mm
4467m
PARFLUX TRAP.
50m PARALINE 8mm
CR 2498 + 2510
25m NYLON 12mm
5m 13mm CHAIN
1100KG ANCHOR
2498
2510
1-08
315-321
296-302
038
316-323
275-283

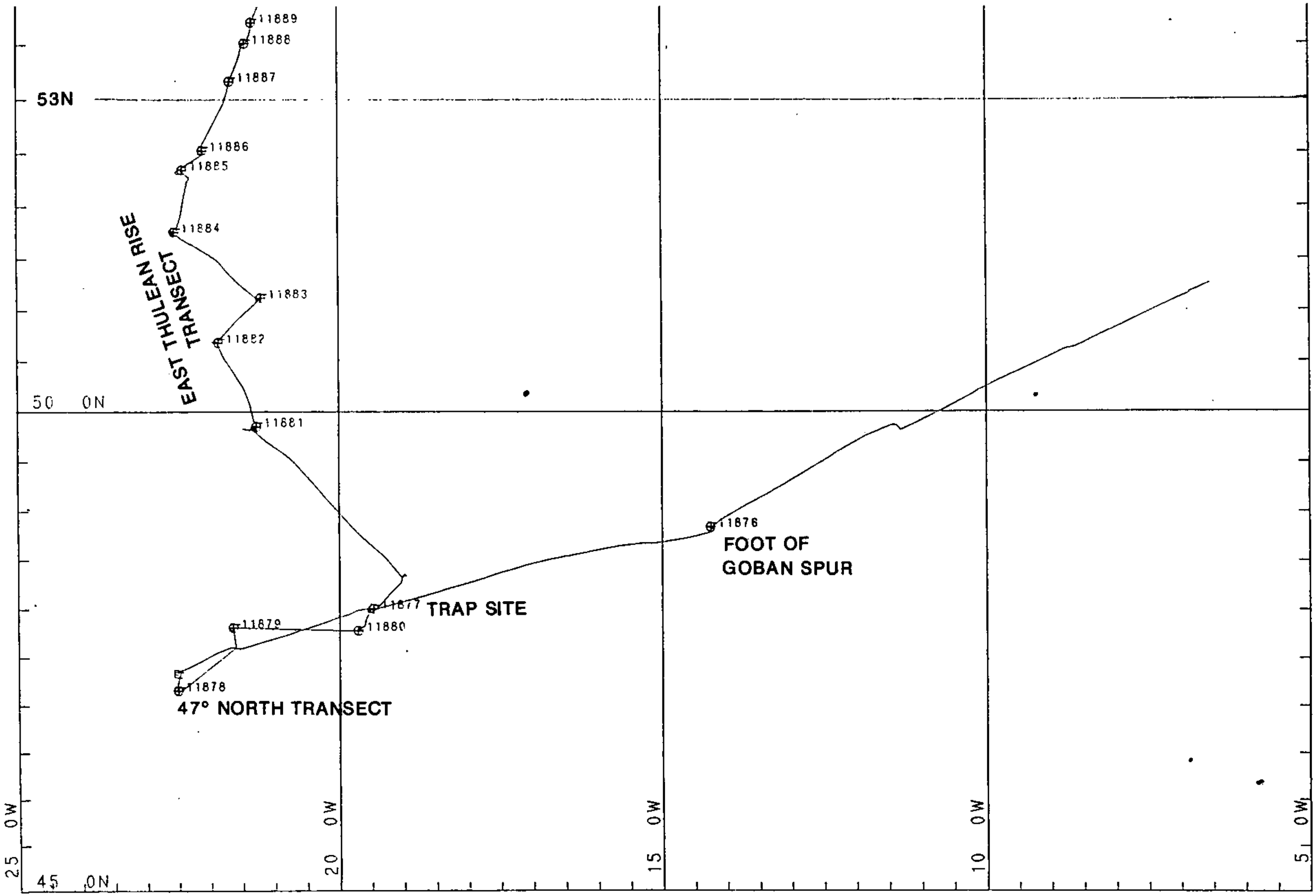


BOFS 60N
DEPLOYED 8.8.89
N59°00.2'
W21° 57.9'
IN WATER AT:-
3 x 11" FLOATS
15m x 24mm POLYPROP
+8" SPHERE
2m 5/8" CHAIN
IOS TYPE PRESSURE BALANCED SWIVEL
25m KEVLAR KT3 12mm
26m NYLON 18mm
25m KEVLAR KT3 12mm
1536Z
320m
PARFLUX TRAP
RR:- 1538Z
1541
20m NYLON 16mm
ACM 5908
321m 10mm PARALINE
4 x 17" GLASS SPHERES
127m 10mm PARALINE
1613Z
795m
TRANSPONDER SER NO 31
194m 10mm PARALINE
25m KEVLAR KT3 12mm
1630Z
1015m
PARFLUX TRAP
RR:- 1631Z
1634Z
20m NYLON 16mm
ACM 9582
103m 10mm PARALINE
533m 8mm PARALINE
4 x 17" GLASS SPHERES
209m 8mm PARALINE
105m 8mm PARALINE
30m 8mm PARALINE
1714Z
2019m
PARFLUX TRAP
20m NYLON 16mm
533m 8mm PARALINE
3 x 17" SPHERES
105m 8mm PARALINE
105m 8mm PARALINE
30m 8mm PARALINE
1802Z
2816m
PARFLUX TRAP.
WATER DEPTH
2887m u/c
1806Z
45m 8mm PARALINE
CR 2508, 2509
2508
1.14
317-321
256-262
2509
1.06
316-322
434-443
19m NYLON 16mm
4m 13mm CHAIN
1000KG
CUT AWAY 1809Z


SPAR WITH LIGHT
+ RDF.
ARGOS
50m POLYPROP
18mm 8PLAIT
20m POLYPROP
18mm 8PLAIT
DHAN
RADAR REFLECTOR
JOTRON
RDF BEACON
20m POLYPROP
8PLAIT
11" DNC
BALLAST 150 Kg
46m NYLON 8PLAIT 16mm
53m
PARFLUX
51m NYLON 8 PLAIT 16mm
103m
PARFLUX
197m DACRON 12mm
300m
PARFLUX
282 Kg.
DEPLOYED
N 47° 53.8
W 19° 33.0
18.7.89 1416
RECOVERED
N 48° 20.1'
W 18° 58.0
24.7.89 0750
SPAR 156.425 MHz
DHAN 150.830 MHz
ARGOS ABRAIDED
STROP AND FREE
DRIFTING 5033



60 0N
55 0N
53N
GARDAR DRIFT SITES
11902
11903
METEOR SITE
11900
11899
11898
HATTON BANK TRANSECT
11897
TRAP SITE
11896
HATTON - ROCKALL BASIN
11905
MAURY CHANNEL CTD
11895
ROCKALL
S END OF N. FENI RIDGE
11894
11892
11893
11891
11890
S.SIDE OF ROCKALL PLATEAU TRANSECT
11889
11888
11887
11886
11885



MERCATOR PROJECTION

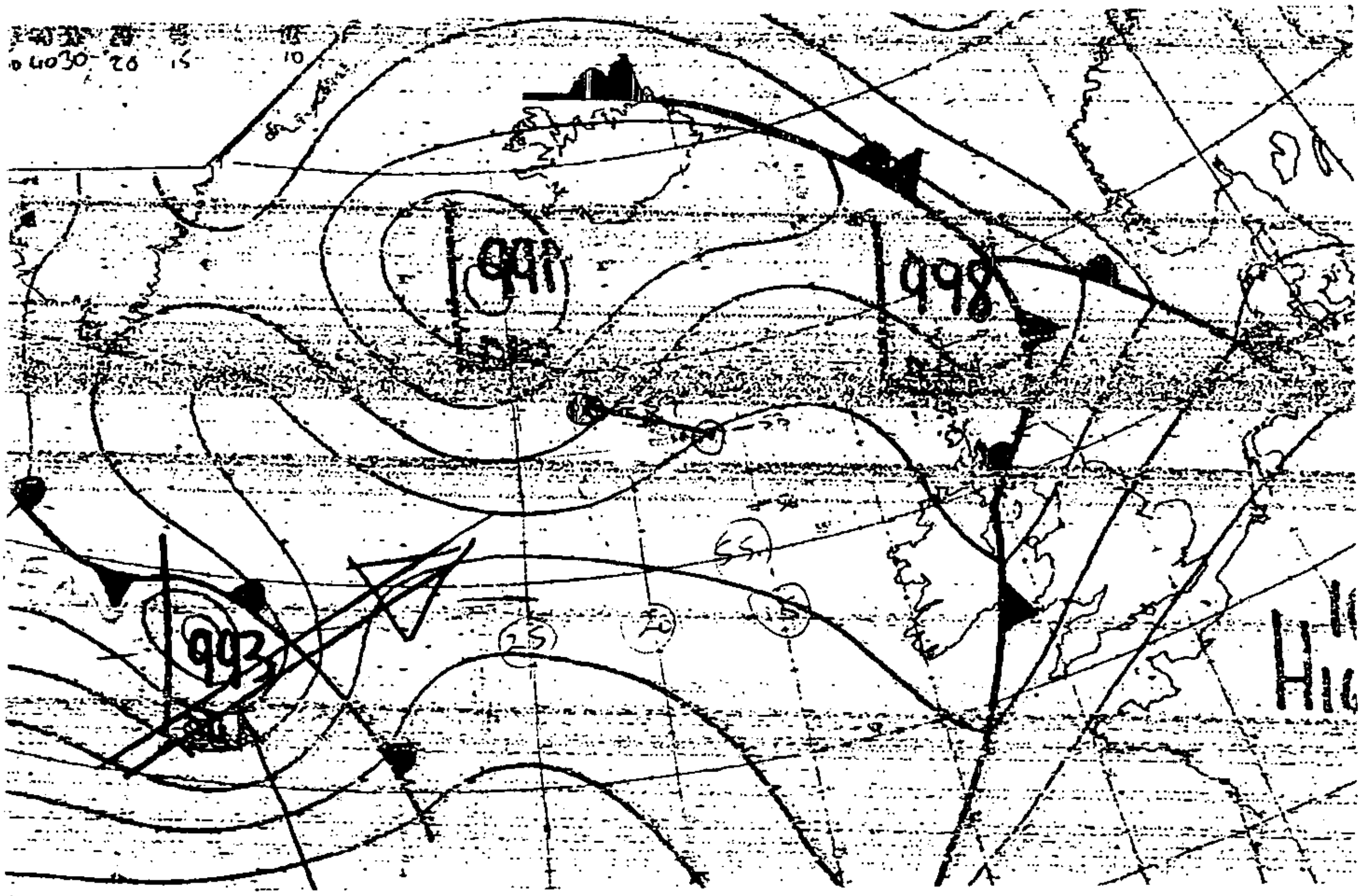
SCALE 1 TO 5000000 (NATURAL SCALE AT LAT. 46)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

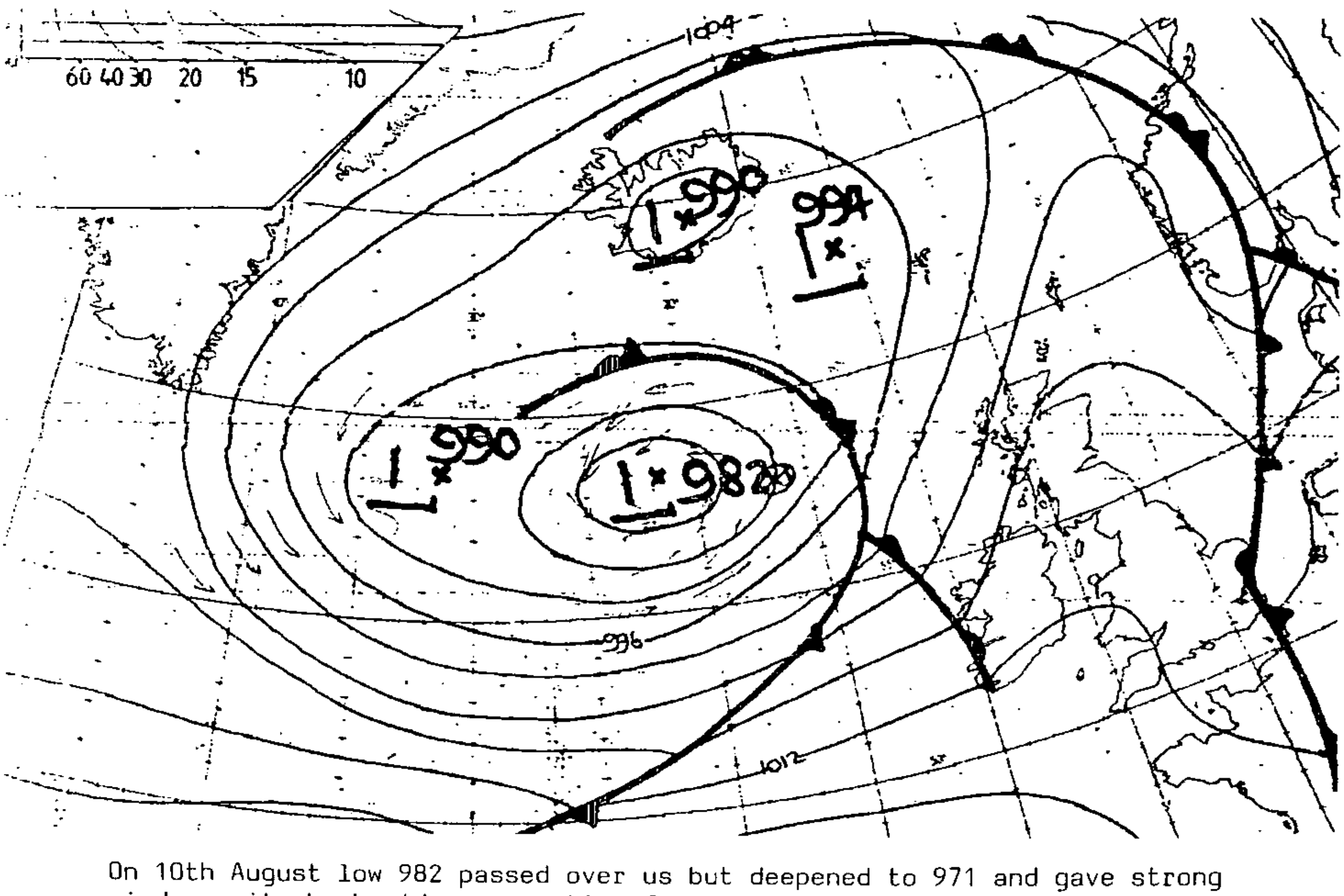
GRID NO. 1

— Track plotted from bestnav

Discovery 184 BOFS 3/89 Station Positions



On 9th August low 993 was the end of hurricane Dean. Although on a convergent path with Discovery it was a spent force.



On 10th August low 982 passed over us but deepened to 971 and gave strong winds on its back side, preventing further work.

R.R.S. DISCOVERY CRUISE 184 - STATION LOG

Station No./		CTD/ Core No	Instrument /Operation	Day	Date	Time(Z)	Latitude(N)	Longitude(W)	Depth(m) (uncorr)	Remarks
11876	/1		SAP test	197	16/7	20.05-21.20	48° 50'	14° 15'	4545	
	/2	290	CTD	"	"	21.40-	48° 49.5'-	14° 12.1'	4535	Deep cast
	/3	291	CTD	198	17/7	01.17-01.59	48° 48.2'	14° 11.8'	"	Shallow cast
11877	/1		Apstein net	198	17/7	22.25-	47° 59.4'	19° 29.6'	4550	
	/2		Apstein net	"	"	23.25	"	"	"	
	/3		Apstein net	"	"		"	"	"	
	/4		Harris net	"	"	23.30-	"	"	"	
	/5		Harris net	"	"	23.55	"	"	"	
	/6	292	CTD	199	18/7	00.17-03.12	48° 00.3'	19° 28.7'	4555	Deep cast
	/7	293	CTD	"	"	04.14-04.51	48° 01.4'	19° 27.5'	"	Shallow cast
	/8		Recover mooring	"	"	08.00-11.48			"	only part of trap array present.
	/9		Deploy drifting rig	"	"	14.16	47° 59.8'	19° 33.0'	"	
	/10	294	CTD	"	"	14.56-15.40	48° 00.6'	19° 32.2'	4495	radiochemical water cast

Station No./	CTD/ Core No	Instrument /Operation	Day	Date	Time(Z)	Latitude(N)	Longitude(W)	Depth(m) (uncorr)	Remarks
11878 /1	Cam 1	Camera	200	19/7	10.51-14.28	47° 11.1'	22° 31.1'	3700	
/2	#1C	IOS Box Corer	"	"	15.11-18.42	47° 09.2'	22° 30.3'	3855	
/3	#1K	Kasten	"	"	20.18-22.55	47° 11.4'	22° 31.7'	3700	
/4	#1M	Multi-corer	" 201	" 20/7	23.45-02.55	47° 09.6'	22° 30.2'	3945	
11879 /1	Cam 2	Camera	201	20/7	11.06-14.37	47° 46.4' 47° 46.4'	21° 38.2' 21° 38.0'	4105	
/2	#2K	Kasten	"	"	15.58-18.38	47° 46.2'	21° 37.3'	4100	Winch snarl up @ 1500 (wire crossed on drum)
/3	#2C	IOS Box Corer	"	"	19.07-21.50	47° 48.4'	21° 38.6	4053	
/4	#2M	Multi-corer	" 202	" 21/7	23.40-02.22	47° 47.1'	21° 40.2'	4080	
11880 /1		SAP	202	21/7	10.04-15.39	47° 48.3' 47° 46.4'	19° 42.3' 19° 42.2'	4540	
/2	#3K	Kasten	"	"	17.34-19.03	47° 48.3'	19° 42.4'	4545	
/3		SAP	" 203	" 22/7	21.19-03.43	47° 47.6'	19° 41.1	4545	
/4	#3M	Multi-corer	" 203	" 22/7	04.32-07.24	47° 47.2'	19° 41.2'	4540	

Station No./	CTD/ Core No	Instrument /Operation	Day	Date	Time(Z)	Latitude(N)	Longitude(W)	Depth(m) (uncorr)	Remarks
11880 /5	#3C	IOS Box Corer	203	22/7	08.17-11.05	47^{o} 46.5'	19^{o} 42.8'	4540	
/6		Harris nets	"	"	12.33-13.10	47^{o} 47.2'	19^{o} 42.9'	4540	
/7	295	CTD	"	"	13.20-16.48	47^{o} 48.3'	19^{o} 41.8'	4550	Sheave siezed up. Deep cast.
/8		Apstein nets	"	"	16.57-17.38	47^{o} 47.7'	19^{o} 40.2'	"	
/9		SAP	" 204	" 23/7	18.38-00.58	47^{o} 48.2'	19^{o} 42.5'	4550	
/10	#3P	Piston corer	204	23/7	08.57-12.31	47^{o} 48.0'	19^{o} 40.1'	4550	
/11		Mooring deployment	204	23/7	14.07-17.44	47^{o} 58.7' 47^{o} 58.8'	19^{o} 31.7' 19^{o} 32.7'	4550	Closest approach pos^{n}. Best pos^{n}. by 1/3 rule
/12	296	CTD	"	"	21.40-22.52	47^{o} 58.9'	19^{o} 27.00'	"	Mid meter cast
/13	297	CTD	" 205	" 24/7	23.37-00.20	47^{o} 59.0'	19^{o} 27.0'	"	Shallow cast
no number		recover drifting trap array	205	24/7	06.42-07.52	48^{o} 20.1'	18^{o} 58.0'		Argos buoy lost.
11881 /1	Cam 3	Camera	206	25/7	07.28-11.12	49^{o} 50.3'	21^{o} 19.5'	4200	
/2	298	CTD	"	"	11.52-14.19	49^{o} 49.2'	21^{o} 16.6'	4187	Deep cast

Station No./		CTD/ Core No	Instrument /Operation	Day	Date	Time(Z)	Latitude(N)	Longitude(W)	Depth(m) (uncorr)	Remarks
11881	/3	299	CTD	206	25/7	15.12-15.55	49° 48.2'	21° 15.5'	"	Shallow cast
	/4	#4C	IOS Box Corer	"	"	16.05-19.00	49° 47.5'	21° 14.0'	4067	
	/5	#4K	Kasten Corer	"	"	20.40-23.07	49° 50.8'	21° 16.3'	4207	
	/6	#4M	Multi-corer	207	26/7	00.19-03.11	49° 51.4'	21° 17.1'	4220	
11882	/1	Cam 4	Camera	207	26/7	10.50-14.17	50° 41.7'	21° 54.6'	3540	
	/2		Kasten Corer	"	"	15.53-18.41	50° 40.8'	21° 52.7'	3540	Empty barrel.
	/3	#5C	IOS Box Corer	"	"	19.13-21.50	50° 40.7'	21° 51.5'	3547	
	/4	#5K	Kasten Corer	" 208	" 27/7	22.24-01.09	50° 40.9'	21° 52.0'	3547	
	/5	#5M	Multi-corer	"	"	03.24-05.43	50° 40.4'	21° 51.6'	3560	
11883	/1	#6C	IOS Box Corer	208	27/7	10/56-13.15	50° 07/3'	21° 12.0'	2865	
	/2	Cam 5	Camera	"	"	14.17-16.43	51° 07.1' 51° 07.0'	21° 13.2' 21° 13.3'	2870	
	/3	#6K	Kasten Corer	"	"	17.31-19.15	51° 07.0'	21° 11.9'	2865	

Station No./		CTD/ Core No	Instrument /Operation	Day	Date	Time(Z)	Latitude(N)	Longitude(W)	Depth(m) (uncorr)	Remarks
11883	/4	#6M	Multi-corer	208	27/7	19.50-21.40	51° 06.1'	21° 11.4'	2865	Corer hit side of ship on recovery
11884	/1	Cam 6	Camera	209	28/7	07.57-10.10	51° 43.9'	22° 32.9'	2327-2350	
	/2	#7C	IOS Box Corer	"	"	11.10-12.52	51° 44.4'	22° 35.0'	2365	
	/3		Multi-corer	"	"	13.32-15.30				Corer failed - bent shaft @ last sta.
	/4	#7K	Kasten Corer	"	"	16.00-17.51	51° 45.3'	22° 32.5'	2327	
	/5	#7M	Multi-corer	"	"	18.57-20.49	51° 45.0'	22° 31.6'	2340	Partial failure, poor recovery, disturbed.
11885	/1		SAP	210	29/7	01.03-06.24	52° 18.1'	22° 20.9'	4335	
	/2	300	CTD	"	"	07.12-10.00	52° 20.5'	22° 25.0'	4290	Deep cast
	/3		Apstein net	"	"	10.47	52° 19.8'	22° 23.1'		
	/4		Apstein net	"	"	-	-	-		
	/5		Apstein net	"	"	11.46	52° 20.3'	22° 24.3'		
	/6	301	CTD	"	"	11.58	52° 20.4'	22° 24.4'	4305	Radionuclide cast
	/7		Harris nets	"	"	12.52 13.10	"	"		
	/8	301B	CTD	"	"	13.33-14.25	52° 20.7'	22° 26.8'	4300	Shallow 900m cast.

Station No./	CTD/ Core No	Instrument /Operation	Day	Date	Time(Z)	Latitude(N)	Longitude(W)	Depth(m) (uncorr)	Remarks
11885 /9		SAP	210	29/7	15.03 20.50	52° 18.6' 52° 18.8'	22° 24.0' 22° 27.7'	4330	
11886 /1	Cam 7	Camera	211	30/7	00.51- 06.13	52° 29.6' 52° 29.6'	22° 03.6' 22° 09.	4065	
/2	#8K	Kasten Corer	"	"	07.47- 10.15	52° 30.1'	22° 04.2'	4045	
/3	#8M	Multi-corer	211	30/7	10.53- 13.20	52° 31.4'	22° 05.6'	4025	
/4	#8C	IOS Box Corer	"	"	13.33- 16.00	52° 33.0'	22° 06.0'	4005	
11887 /1	302	CTD	211	30/7	20.54- 23.25	53° 09.7'	21° 39.7'	3733	Deep cast
11888 /1	303	CTD	212	31/7	02.13- 04.30	53° 30.4'	21° 26.0'	3325	Deep cast
11889 /1	Cam 8	Camera	212	31/7	06.59- 09.45	52° 41.2'	21° 19.0'	3240- 3230	
/2	#9K	Kasten Corer	"	"	10.40- 13.08	53° 41.6'	21° 19.5'	3268	
/3	#9M	Multi-corer	"	"	14.42-	53° 41.8'	21° 19.7'	3275	
/4	#9C	IOS Box Corer	"	"	16.00- 18.07	53° 42.2'	21° 19.6'	3275	
11890 /1	304	CTD	213	1/8	01.29- 03.25	54° 39.1'	20° 39.1'	2780	Deep cast

Station No./	CTD/ Core No	Instrument /Operation	Day	Date	Time(Z)	Latitude(N)	Longitude(W)	Depth(m) (uncorr)	Remarks
11890 /2	#10K	Kasten Corer	213	1/8	03.55-05.42	54° 39.9'	20° 39.0'	2777	
11891 /1	Cam 9	Camera	213	1/8	10.20-12.32	55° 11.5' 55° 11.1'	20° 19.8' 20° 19.5'	2000-2030	
/2	#11M	Multi-corer	"	"	13.08-14.30	55° 11.3'	20° 21.0'	2080	
/3	#11C	IOS Box Corer	"	"	14.50 16.15	55° 11.5'	20° 21.0'	2017	
/4	#11K	Kasten Corer	213	1/8	16.31-17.53	55° 11.5'	20° 21.1'	2004	
11892 /1	305	CTD	213	1/8	21.55-23.32	55° 41.7'	20° 42.6'	2030	Deep cast
/2		Apstein net	" 214	" 2/8	23.40-00.40				
/3	306	CTD	"	"	00.45-01.32	55° 42.0'	20° 39.3'	2030	Radionuclide cast
/4		Harris nets	"	"	01.37-01.52	55° 42.0'	20° 38.8'		
/5	307	CTD	"	"	02.15-03.00	55° 41.9'	20° 38.5'	2030	Shallow cast.
11893 /1	Cam 10	Camera	214	2/8	06.30-07.48	55° 29.0' 55° 28.8'	20° 08.3' 20° 08.8'	746-775	
/2	#12M	Multi-corer	"	"	08.57	55° 29.1'	20° 07.0'	890	5mm of sand

Station No./	CTD/ Core No	Instrument /Operation	Day	Date	Time(Z)	Latitude(N)	Longitude(W)	Depth(m) (uncorr)	Remarks
11893 /3	#12K	Kasten Corer	214	2/8	10.59	55° 31.2'	20° 09.4'	1058	A few stones.
11894 /1	#13M	Multi-corer	"	"	17.54	56° 11.0'	20° 43.4'	1265	
/2	#13K	Kasten Corer	"	"	19.00	56° 12.5'	20° 45.9'	1320	1 stone bent core-catcher.
/3	#13C	IOS Box Corer	"	"	20.37	56° 11.8'	20° 43.6'	1305	Fell over,a few stones
11895 /1	309	CTD	215	3/8	07.33-09.25	57° 52.3'	21° 21.1'	2980	Deep cast
/2	310	CTD	"	"	10.14-	57° 52.4'	21° 22.7'	2975	Shallow cast.
11896 /1	#14K	Kasten Corer	215	3/8	19.18	58° 37.2'	19° 26.2'	1756	
/2		Multi-corer	"	"	21.06	58° 37.3'	19° 26.2'	1756	Empty.
/3	#14C	IOS Box Corer	"	"	22.39	58° 37.8'	19° 26.9'	1756	
/4	#14M	Multi-corer	216	4/8	00.38	58° 39.0'	19° 26.8'	1756	
/5	Cam 11	Camera	"	"	02.04-04.32	57° 38.0'	19° 24.9'	1756-	
/6	311	CTD	"	"	04.48-06.13	58° 38.4'	19° 24.1'	1757	Deep cast
11897 /1	312	CTD	216	4/8	08.30-10/30	58° 52.8'	19° 49.1'	2853	Deep cast
/2	313	CTD	"	"	11.02-11.45	58° 53.0'	19° 49.9'	2853	Shallow cast

Station No./		CTD/ Core No	Instrument /Operation	Day	Date	Time Z	Latitude(N)	Longitude(W)	Depth(m)	Remarks
11898	/1	#15K	Kasten Corer	216	4/8	14.42	59° 06.0'	20° 08.0'	2785	
	/2	#15M	Multi-corer	"	"	17.27	59° 04.9'	20° 05.8'	2790	
	/3	#15C	IOS Box Corer	"	"	19.56	59° 06.8'	20° 08.5'	2790	
	/4	Cam 12	Camera	"	"	2100-23.15	59° 06.3' 59° 05.1'	20° 08.5' 20° 08.6'	2790	
11899	/1		SAP	217	5/8	06.32-11.20	58° 58.8' 59° 02.2'	21° 58.4' 21° 58.5'	2885	
	/2	314	CTD	"	"	11.52-13.45	59° 05.6'	21° 58.0'	2858	Deep cast
	/3		Net hauls	"	"	14.00	59° 06.8'	21° 57.3'	2858	
	/4	315	CTD	"	"	14.55-15.40	59° 07.9'	21° 56.9'	2853	Radionuclide cast
	/5		Net hauls	217	5/8	15.46-16.13	59° 08.9'	21° 55.3'	2853	
	/6	316	CTD	"	"	16.22-16.59	59° 09.5'	21° 54.7'	2848	Shallow cast
	/7 /11		Five Apstein net deployments	"	"	17.02-20.08	59° 10.9'- 59° 13.4'	21° 53.5' 21° 51.6'	2848	
11900	/1	317	CTD	218	6/8	07.34-09.32	59° 13.0'	21° 02.8'	2884	Simultaneous cast with Meteor.
	/2		Multi-corer	"	"	17.36-19.35	59° 09.4'	20° 58.1'	2884	Corers failed (calm sea).

Station No./	CTD/ Core No	Instrument /Operation	Day	Date	Time(Z)	Latitude(N)	Longitude(W)	Depth(m) (uncorr)	Remarks
11900 /3		SAP	218 219	6/8 7/8	23.24- 04.15	59° 07.4' 59° 05.2'	21° 02.4' 21° 01.4'	2887	
11901 /1		Recovery of mooring	219	7/8	09.05- 11.55	59° 01.2- 59° 02.6	21° 59.2' 21° 57.4'	2880	Whole rig recovered
11902 /1	#16K	Kasten Corer	219	7/8	16.43- 18.18	59° 28.2'	23° 24.2'	2370	
/2	318	CTD	"	"	18.47- 20.23	59° 28.5'	23° 14.8'	2366	Deep cast
/3	319	CTD	"	"	20.45- 21.30	59° 28.5'	23° 14.8'	2366	Shallow cast
11903 /1	320	CTD	220	8/8	00.01- 01.57	59° 19.9'	22° 40.6'	2610	Deep cast
/2	Cam 13	Camera	"	"	02.16- 05.07	59° 21.6' 59° 21.8'	22° 36.79' 22° 36.3'	2597	
/3 & /3B		Kasten corer	"	"	06.24- 07.33	59° 19.0'	22° 42.0'	2597	Abandoned.Spooling wheel on winch siezed.
11904 /1	321	CTD	220	8/8	11.15- 13.19	58° 59.9'	21° 59.7'	2870	Deep cast.
/2	322	CTD	220	8/8	13.58- 14.50	58° 59.7'	21° 59.8'	2870	Shallow cast.
/3		Mooring(traps) deployment	"	"	15.24- 18.10	59° 01.0' 58° 59.9'	21° 57.9' 21° 59.1'	2890	Wind 6-7 from 250° weight drop positn.
/4		SAP	" 221	" 9/8	22.30- 04.23	59° 02.5'	21° 59.8'	2875	Half-cast because of weather (6).

Station No./	CTD/ Core No	Instrument /Operation	Day	Date	Time(Z)	Latitude(N)	Longitude(W)	Depth(m) (uncorr)	Remarks
11904 /5		Kasten Corer	221	9/8	09.17-11.36	59° 02.6'	21° 59.3'	2870	Empty
/6		SAP	"	"	12.30-15.07	59° 01.4'	21° 57.3'	2870	Shallow half-cast.
11905 /1	#17K	Kasten Corer	222	10/8	08.20-09.22	58° 00.2'	16° 30.3'	1150	
/2	#17M	Multi-corer	"	"	10.25	57° 59.6'	16° 29.8'	1150	
/3	#17C	IOS Box Corer	"	"	12.00	57° 59.5'	16° 30.4'	1150	
/4	323	CTD	"	"	13.43-15.15	58° 00.2'	16° 33.2'	1150	Deep cast.
/5	Cam 14	Camera	"	"	15.40-17.33	58° 00.6' 58° 00.8'	16° 34.2' 16° 34.6'	1150	