Cruise report

# RRS Charles Darwin
# Cruise 84

# OMEX
# Ocean Margin EXchange Study

18 January -2 February 1994

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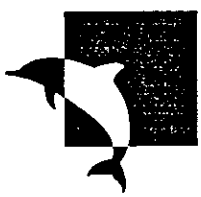
University of Southampton
Department of Oceanography
Report Number



## Synopsis

*This Darwin cruise forms part of an intensive sea time campaign on the Goban Spur and adjacent shelf break under the EEC funded project OMEX (Ocean Margin EXchange). The shelf break area has been chosen for study because of its potential importance in the flux of materials between the land and the open ocean. The main focus on this cruise was on biogeochemical processes. Despite generally poor weather conditions, the cruise was very successful, and a substantial amount of sampling and data collection was done.*

*The water column was sampled along a transect running off-shelf at the Goban Spur, with the primary sampling and data collection device being a CTD and rosette sampler of 10l Go-Flo bottles. Samples were collected for analysis of dissolved and particulate trace metals (particulate metals collected by in situ pumping systems), oxygen, nutrients, dissolved organic carbon, pigments, radionuclides, and zooplankton. Zooplankton were collected by both bottle samples, and on three occasions by plankton recorder whilst obtaining ADCP records of the water column at the same time. Hydrographic data on temperature, salinity, oxygen, fluorescence, scattering (nephelometry), and transmission were obtained from the CTD. The non-toxic pumped water supply on the ship was monitored to give data on surface T, salinity, transmission and fluorescence, as well as some nutrient and dissolved aluminium data.*

*Later in the cruise when the weather moderated, it was possible to take Kasten and Box cores from varying depths on the Shelf. Oxygen profiling and porewater collection was done on sub-cores from three of the box cores. Kasten cores were sub-sampled to provide archive material and sediment samples for a variety of sedimentological analyses including organic carbon, particle size and X-ray photography.*

*The opportunity of the cruise was taken to carry out ancillary OMEX work. Two current meter moorings were laid, which could not be deployed on the previous cruise because of bad weather. A new pop-up version of STABLE, an instrument package for measuring near-bottom current and resuspension phenomena, was successfully deployed and recovered.*

**Acknowledgements**

The Officers and Crew of RRS Charles Darwin, and in particular the Master Richard Bourne, all provided unstinting support and sound advice throughout the cruise, and provided a thoroughly professional service. The RVS personnel on board were also ever ready to help with practical advice and running of essential gear on the ship, and the input from those at RVS base who helped at various stages of preparation and with logistics also played an important role in the overall success of the cruise. The cruise brought together scientists from four European nations, most of whom had not worked together previously. I am indebted to them for their willingness to work effectively together and for their forbearance of my organisation. The smoothness of operations and the highly productive nature of the cruise despite frequent weather conditions which made working difficult or impossible, is a testament t the efforts of all those mentioned above.

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## 1. CRUISE PERSONNEL

**Officers:**

| | |
|---|---|
| Richard BOURNE | Master |
| Peter NEWTON | Chief Officer |
| Syd SYKES | Second Officer |
| Mark THOMPSON | Third Officer |
| Jeff BAKER | Radio Officer |
| Wiggy BENNET | Chief Engineer |
| Vince LOVELL | Second Engineer |
| Jason HOLMES | Third Engineer |
| Roger KEYS | Third Engineer |

**Scientists:**

| | |
|---|---|
| Peter STATHAM | Principal Scientist, SUDO |
| Ben BOORMAN | IOS |
| Lei CHOU | ULB |
| Marie-Helene COTTE | ENS |
| Helen CUSSEN | IOS |
| Ian HALL | CAMES |
| John HUMPHERY | POL |
| David HYDES | IOS |
| Nick McCAVE | CAMES |
| Axel MILLER | PML |
| Rachel MILLS | SUDO |
| Michael ORREN | UCG |
| Jane SAN-JUAN | IFREMER |
| Michel THOUARD | CEA |

**Research Vessel Services:**

| | |
|---|---|
| Bill MILLER | Instruments |
| Kev SMITH | Mechanical |
| Andy HILL | Mechanical |
| Howie ANDERSON | Computing |

Expanded abbreviations used, addresses of Institutes and groups are given on the next page.

**Participating Groups**

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IBM-ENS
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United Kingdom

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United Kingdom

SUDO
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The University of Southampton
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United Kingdom

UCG
Ryan Marine Science Centre
University College Galway
Galway
Ireland

ULB
Universite Libre de Bruxelles
Laboratoire d'Oceanographie Chimique
Campus de la Plaine CP 208
Boulevard du Triomphe
1050 Bruxelles
Belgium

## 2. CRUISE OBJECTIVES

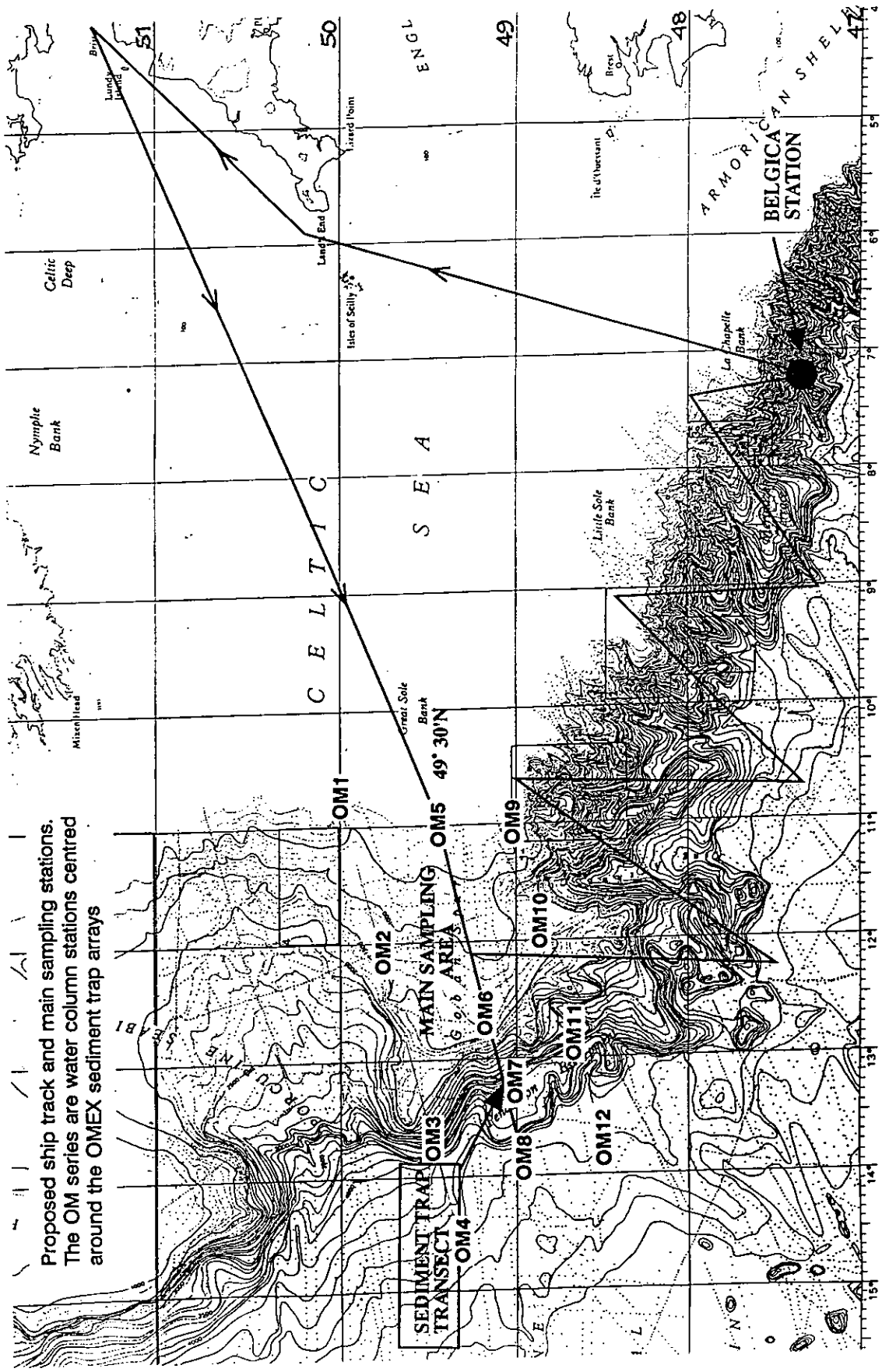
This Darwin cruise forms part of an intensive sea time campaign on this region of shelf break under the EEC funded project OMEX (Ocean Margin EXchange). The shelf break area has been chosen for study because of its potential importance in the flux of materials between the land and the open ocean. The general arguments and background are well summarised in "Ocean margin processes in global change" eds Mantoura et al (1991) Wiley, and the detailed rationale and project description are given in the proposal to MAST. The OMEX Chief Scientist is Prof. R.Wollast, Université Libre de Bruxelles, Boulevard de Triomphe, 1050. Brussels, Belgium

This cruise focused mainly on the work of the biogeochemical processes sub-Task of OMEX, and provided an opportunity to study conditions and distributions of materials of interest during a winter period at the shelf break. The general scientific objectives were:

1) To study the role of biogeochemical and hydrographic processes in controlling the distributions of dissolved trace metals in the shelf break region and adjacent waters, with due regard to temporal variability.
2) To estimate fluxes across trace metal fronts in the shelf break region and evaluate the use of trace metals as tracers of advective exchanges of waters at the shelf break.
3) Based on these and other OMEX data, to further the development of models for frontal exchange of dissolved trace metals and the linking of these models to a shelf seawater quality model.
4) In addition to the trace metal work, to collect other information and samples relevant to the aims of the OMEX project.

The general strategy was to go from Barry to the Goban Spur area of the shelf where an array of sediment traps had been deployed as a component of the OMEX programme, and to sample at stations along three parallel transects off shelf. The intention was then to collect data and sample along a zigzag track over the shelf break, to the previously occupied BELGICA station at La Chapelle Bank, collect samples, and then return to Barry. The proposed route with sampling stations in the vicinity of the sediment trap array is shown in Figure 1.

**Figure 1.** The proposed ship track and main sampling locations.



## 3. CRUISE NARRATIVE

Most loading of heavy equipment was completed on Friday 14 January, including the RVS and IFREMER clean containers which are designed for trace metal work. The scientific complement continued to work over the week end to set up the ship, during which period only very limited support from the base was available. On Monday 17 the remaining scientific complement joined the ship, an extra 2.1 km of warp was started to be put onto the coring winch, and a wide range of other tasks needed for the full preparation of the ship for the cruise were undertaken. On the morning of 18 January the remaining warp was put onto the coring winch and the ship left the quay at 1215.

The principal scientific activities of the cruise are listed in chronological order in Appendix 1, and the actual cruise track is shown in Figure 2. Details of the science activities are given in later sections. The weather proved to be the major factor influencing what work could be done. For most of the early part of the cruise winds were force 6 and above, and there was a large swell running, making safe deployment of equipment difficult and often potentially dangerous. On 3 occasions work had to stop altogether (circa 45 h of station time lost). However, in the short windows of better weather it was possible to deploy 2 current meter arrays for the OMEX programme as requested by Robin Pingree, Principle Scientist of the earlier CD 83 cruise, when it had not been possible to deploy the arrays because of bad weather. It was also possible, in a window of good weather conditions, to deploy STABLE. CTD stations on the central, highest priority, off shelf transect were also occupied although only a limited number of the stations on the two parallel transects were worked because of weather and thus time constraints. The zigzag course along the shelf break had to be modified because of high winds which made maintaining the ship on the desired course very difficult. The modified course went directly to the Belgica station with a following wind. A further argument for following this direct track was that arrival corresponded to a good weather forecast for the area. The better weather did arrive, and allowed activities at the Belgica station to be successfully undertaken. Early attempts to use the box corer were unsuccessful because conditions were too rough. However, when a high pressure system dominated the weather in the last few days of the cruise, the swell subsided, and several box cores were successfully taken. The good weather forecasts at the end of the cruise also provided a window to attempt recovery of STABLE. The ship thus proceeded from the Belgica site to the STABLE site, and after box and Kasten coring operations, on the morning of 31 Jan STABLE was successfully recovered in a professional operation.

After a further CTD cast at station OM10, the science programme was brought to a close apart from surface underway sampling. The ship was finally berthed at Barry at circa 1000 h on the 2 February.

A satellite image of the Shelf Break region at just before the cruise was on the Sun computer on the ship, and a further part image was sent to the ship during the cruise.

Figure 2a. Actual full cruise track for Charles Darwin Cruise 84

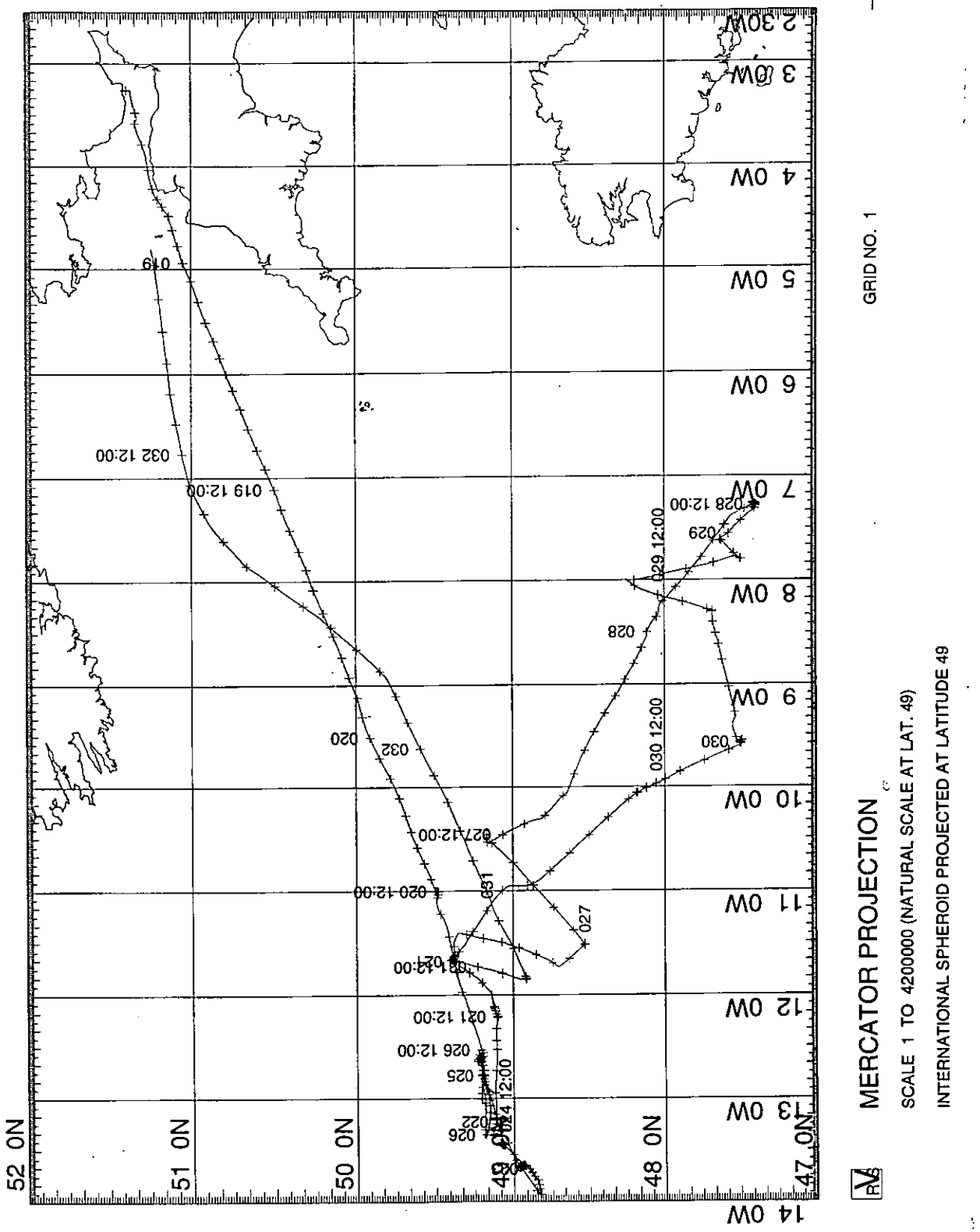
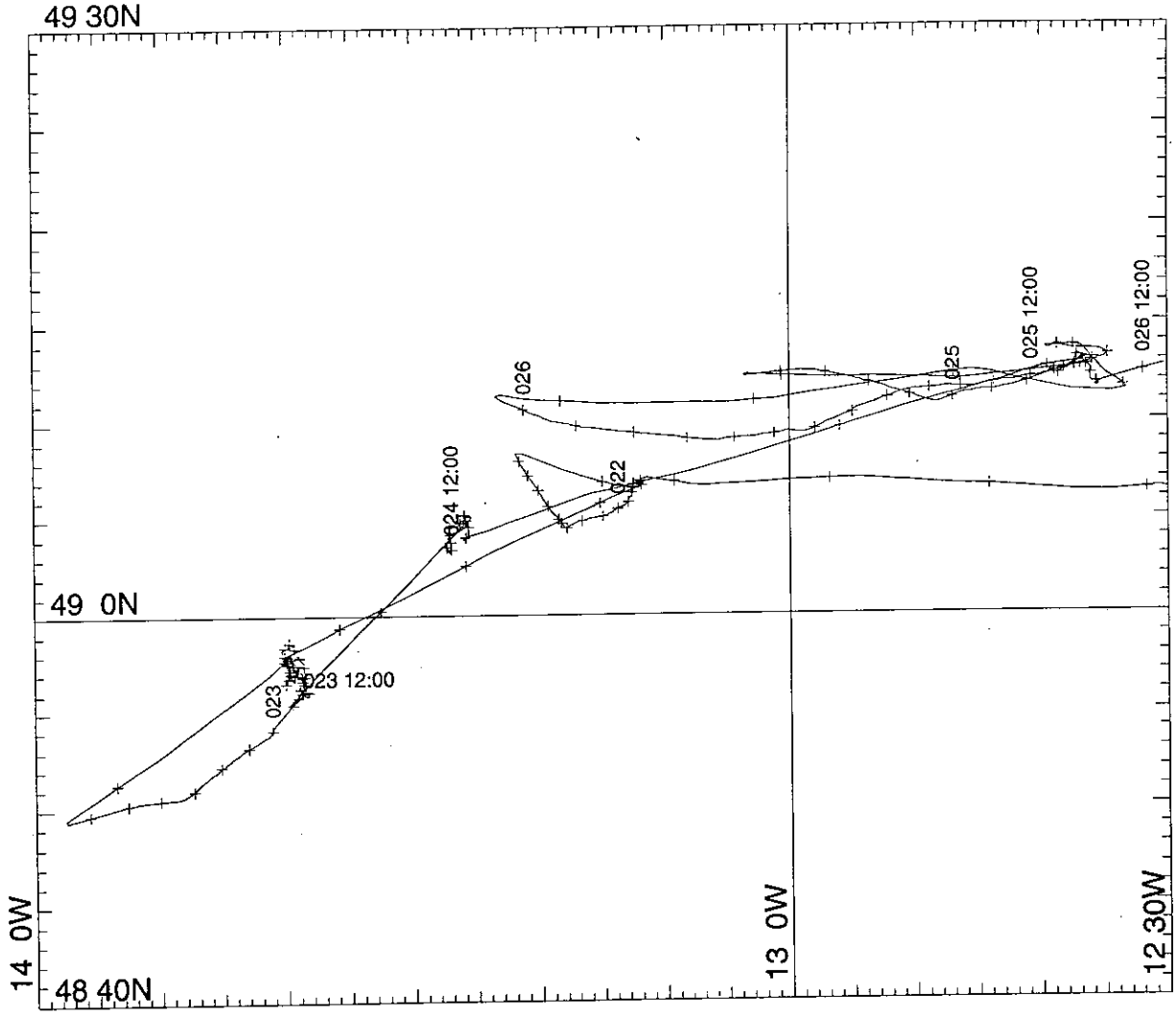


Figure 2b. Enlargement of the cruise track in the vicinity of the main off-shelf hydrographic section (OM5 to OM8).



## 4. REPORT ON SHIP BOARD INSTRUMENT AND EQUIPMENT PERFORMANCE

Equipment onboard generally worked well. As usual the RVS personnel were extremely helpful, and their presence was vital to the successful collection of data and samples which took place. Specific points for comment are given below.

### 4.1 THERMOSALINOGRAPH (TSG)

Before the cruise some concern was expressed to RVS regarding the TSG unit on the RRS Charles Darwin, as with poor weather conditions likely at this time of the year, it was felt essential that a reliable TSG was aboard so that this data at least could be obtained whilst at sea. When set up on the first day at sea, the signal proved to be noisy, which seemed to be mainly due to air bubbles being drawn into the conductivity cell. The second non-toxic pump, which was not functioning, was stripped by the engineers, and repaired. However, when this pump was put on stream on 22 Jan (1511h) after a few moments of greatly improved performance, the conductivity cell went dead. On taking the TSG apart, it was found that the top of the conductivity cell was cracked, and that some foreign material was lodged in the conductivity cell. It was only due to the ingenuity and skills of Bill Miller and John Humphery that the cell was cleaned and reglued. As of 2030 h on 22 Jan the repaired cell was replaced in the housing and found to work well for the remainder of the cruise. Two salinity calibrations will be needed for the data, one before the breakdown, and one after. This event merely reemphasizes the desperate need for a reliable system with suitable spares on board.

### 4.2 CORING WINCH

Because the additional warp was wound onto the winch whilst **not** under tension at RVS, several hours of valuable time was spent at sea on station streaming the new length of cable. Clearly it would have been much preferable if this tensioning could have been done from a dock side winch whilst other preparations were underway on the ship in port.

### 4.3 INTERFERENCE FROM VHF RADIOS

Significant noise on one of the instruments used in the main laboratory was traced to the use of VHF radios on the ship. Clearly good communications are essential on the ship, but perhaps alternative means (such as the use of fixed location tannoy type units) could be investigated when critical scientific operations are underway.

### 4.4 TRANSMISSOMETER

There was some concern with the performance of the Sea Tech Transmissometer on the CTD/rosette frame in deep waters. This behaviour is discussed in detail in the report on optical transmissometry and nephelometry given later.

## 4.5 GO-FLO BOTTLES

As usual, there were intermittent problems with the Go-Flo water sampling bottles. To reduce problems with operations after the first cast, all bottles were sent down in the open position. There appears to be no data in the literature to indicate that in clean ocean waters there is any contamination potential with this procedure. The general sample recovery rate was overall high, but some samples were lost due to malfunction of the bottles. The set of bottles at Southampton has had extensive use, and even with special care and use of spares from other bottles, they are beginning to show their age and the scars of work at sea, and several have been lost during deployment. A rationalisation of the remaining stock, and an exploration of new types of bottle manufactured by General Oceanic for the same type of application, but which have improved operating principles, should be given a high priority at RVS.

# 5 REPORTS FOR INDIVIDUAL SCIENTIFIC INVESTIGATIONS

All key data from the OMEX project, including data from this cruise, will be archived with the British Oceanographic Data Centre (based at the Proudman Oceanographic Laboratory, Bidston), after careful calibration and data checking.

## 5.1 HYDROGRAPHIC PARAMETERS

Data on salinity, temperature, and fluorescence were collected from both the CTD system, and the underway pumped system on the ship (other parameters from the CTD are considered below). The CTD systems worked very well, and after initial problems with the shipboard thermosalinograph, this also gave good data. The main off shelf transect which was studied (OM5 to OM8) provided enough data to attempt contouring of the data. The changes in temperature across the shelf are shown in Figure 3, and the relatively warm Mediterranean Water at about 1000m is clearly seen.

In total there were 20 CTD casts

## 5.2 NUTRIENTS AND OXYGEN

### 5.2.1 Nitrate

Water column samples for nitrate plus nitrite were taken on all CTD casts, and from the non-toxic supply to the laboratories during passage legs of the cruise. The samples were analyzed by standard auto-analyzer methods. A specific objective of the cruise was to compare these colorimetric data with information on nitrate concentration obtained by monitoring absorbance of the ion in the UV region of the spectrum. The nitrate signal represents is small relative to the background absorbance of seawater in this part of the spectrum. Initial analysis of the data was encouraging although it was clear further development work is required. Porewater samples were also analyzed for nitrate.

David Hydes

### 5.2.2 Shipboard nutrient auto-analyzer

#### 5.2.2.1 Objectives

The object of participation was to measure the nutrients nitrate, nitrite, phosphate and silicate aboard ship, sampling from CTD casts, and from the surface (hourly) along the ships course, in order to determine nutrient distribution in the OMEX box area.

#### 5.2.2.2 Methods

An Alpkem Perstorp auto-analyzer, was purchased from non-OMEX funding sources by UCG in mid 1993 to carry out the nutrient analyses. A suitable employee was offered the nutrient determination position, but his taking up the

post was delayed to February, 1994, due to unforeseen academic problems with his M.Sc. graduation. November and December, 1993, were set aside for preparation for the cruise, including a visit to UCG by Dr David Hydes, whose experience would greatly assist setting up automatic methods. Unfortunately at the end of October, the UCG project leader contracted a persistent, debilitating infection, which despite intensive antibiotic treatment in hospital, culminated in an operation in late December. His indisposition severely disrupted preparations, Dr Hydes' visit was postponed and the auto-analyzer could only be set up correctly for $NO_3$ by the cruise date. The computer programme supplied by Alpkem proved "user unfriendly"and the "print" command while working satisfactorily in shore tests, did not operate at sea. Skills in operating the analyzer at sea developed slowly, despite helpful assistance from other scientists aboard. Samples for $NO_3$ were obtained from a CTD station before the reductor coil ceased operation after running only a few samples. No spare coil had been provided. Attempts to set up for $PO_4$ at sea were frustrating and further laboratory work is essential. The molybdate reagents for $SiO_4$ , initially colourless, became blueish in colour during the cruise and a stable baseline could not be obtained.The central shaft of the carousel spun freely around with the roll of the ship; inspection showed the shaft attachment was stripped-this was temporarily repaired with plumbers tape.

5.2.2.3 Results

Samples were collected for shore determination, preserving with a $HgCl_2$ solution (Personal communication, Dr Peter Statham), from all CTD stations, while surface samples were collected hourly in the OMEX box area. Intercalibration will be possible by comparison of these results with those measured aboard by Dr Hydes.

Work will commence immediately on return with preparing the auto-analyzer for the next OMEX cruise.

ULB has also taken nutrient samples (nitrate, nitrite, phosphate and silica) at the Belgica station. No poison was added to the samples which are kept frozen. This is for intercomparison purpose.

Mike Orren

### 5.2.3 Oxygen

Samples were taken for onboard oxygen analysis by the Winkler technique at all stations. Samples were fixed immediately and stored under water until analysis which was typically within a couple of hours. All data has been tabulated, and the oxygen concentrations were used to calibrate the oxygen sensor on the CTD. Sensor readings were systematically low for all deployments. However, the calibration is depth dependent and the offset decreases with increasing depth.

Figure 3. Contoured temperature structure across the shelf break at the Goban Spur (Stations OM5 to OM8). Vertical white lines in the water column are CTD station profiles.

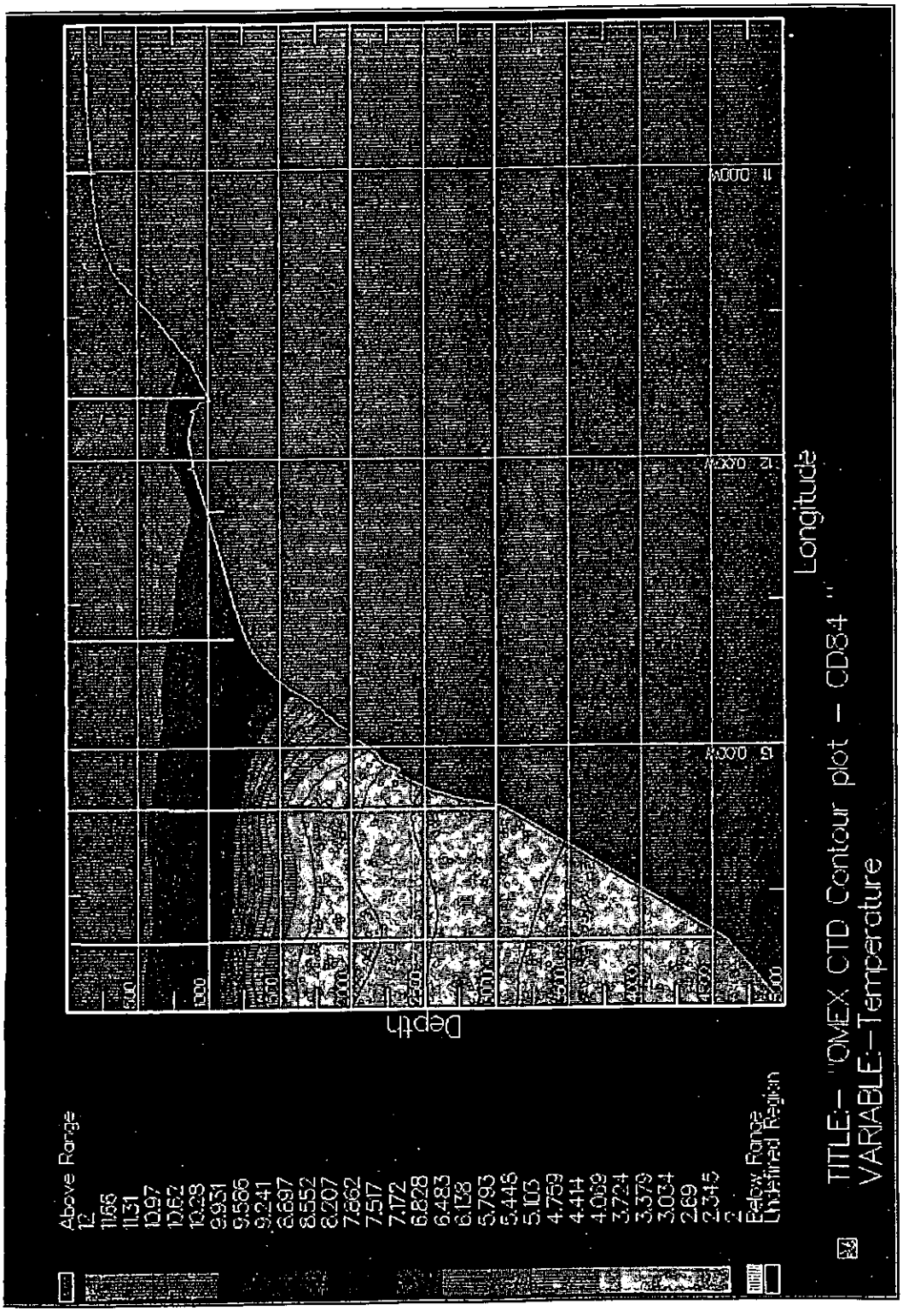


Figure 3. Contoured temperature structure across the shelf break at the Goban Spur (Stations OM5 to OM8). Vertical white lines in the water column are CTD station profiles.

Oxygen values fall in the range 4.49-6.41 ml/L (200-286 $\mu$mol/L). The oxygen minimum falls consistently at approximately 900 m at all sites that were profiled. The maximum occurs at a depth of 1700-1800 m.

Rachael Mills

## 5.3 PLANT PIGMENTS AND MICRO ZOOPLANKTON

### 5.3.1 Plant pigments

This winter cruise provided a good opportunity to obtain information on background levels of plant pigments and zooplankton activity, at a time in the year when biological activity is expected to be at a minimum. Two litre samples of water from the upper 200 m of the water column were filtered for pigments, and the filter was immediately stored in a dewar of liquid nitrogen to inhibit decomposition. Several additional surface non-toxic pumped samples were collected for pigments to allow the calibration of the underway fluorometer. Pigment analysis will be performed by high-performance liquid chromatography (HPLC) at the Plymouth Marine Laboratory (Barlow and Cummings).

**Samples taken for pigments (PML)**

| Date | Station | Sample (m) | Comments |
|---|---|---|---|
| 20/01/94 | CTD2 (OM5) | 170 | Fully mixed water column |
| | 130 | | |
| | 90 | | |
| | 50 | | |
| | 10 | | |
| 22/01/94 | CTD6 (OM7) | 300 | Fully mixed (inc. fluorescence) to 300m |
| | 200 | | |
| | 100 | | |
| | 50 | | |
| 24/01/94 | CTD8 (OM8) | - | No water left for pigments |
| 26/01/94 | CTD10 (OM6) | 200 | |
| | 150 | | |
| | 50 | | |
| | 2 | | Non-toxic pump |
| 28/01/94 | CTD14 (Belgica) | 200 | |
| | 150 | | |
| | 100 | | |
| | 50 | | |
| | 2 | | Non-toxic pump |
| *Samples for calibration of fluorescence signal* | | | |
| 29/01/94 | CTD16 (Calib.) | 2 | Non-toxic pump |
| 30/01/94 | CTD18 (Calib.) | 2 | Non-toxic pump |

### 5.3.2 Micro-zooplankton

Samples collected in the upper 200m of the water column were preserved with Lugols iodine. Micro-zooplankton analysis will be performed at the Plymouth Marine Laboratory (Edwards).

**Samples taken for micro-zooplankton (PML)**

| Date | Station | Sample (m) | Comments |
|---|---|---|---|
| 20/01/94 | CTD2 (OM5) | 170 | Fully mixed water column |
| | | 130 | |
| | | 90 | |
| | | 50 | |
| | | 10 | |
| 22/01/94 | CTD6 (OM7) | 300 | Fully mixed to 300m |
| | | 200 | |
| | | 100 | |
| | | 50 | |
| 24/01/94 | CTD8 (OM8) | 150 | Only samples above 200m |
| | | 50 | |
| 26/01/94 | CTD10 (OM6) | 200 | |
| | | 150 | |
| | | 50 | |
| | | 2 | Non-toxic pump |
| 28/01/94 | CTD14 (Belgica) | 200 | |
| | | 150 | |
| | | 100 | |
| | | 50 | |
| | | 2 | Non-toxic pump |

## 5.4 DISSOLVED ORGANIC CARBON

### 5.4.1 Introduction

Rapid and precise techniques are now available for the determination of dissolved organic carbon (DOC). Increasingly used for this purpose is high temperature catalytic oxidation (HTCO). Such techniques involve direct injection of acidified and decarbonated sea water onto a catalyst at high temperatures (680 - 900°C), and measuring DOC-derived $CO_2$ by a non-dispersive infrared gas analyzer (IRGA). The Plymouth Marine Laboratory has recently purchased a *Shimadzu TOC-5000* HTCO

analyzer, which has been sponsored by the UK Department of the Environment, . Integral components of the debate over oceanographic application of this methodology are the veracity of detection and signal processing during field measurements. Traditional IRGA technology, with *Luft*-type, membrane-based detection mechanisms, is prone to interference resulting from the motions associated with sea-going research platforms. We have purchased a *Licor Li6252* IRGA, incorporating a solid state detector, reported to be insensitive to such effects; it was used in conjunction with a dedicated integrator (Spectra-Physics).

### 5.4.2 Objectives

1.Determination of HTCO-DOC across the continental shelf, to obtain 'winter baseline' DOC concentrations, against which to reference subsequent OMEX filed studies.
2.Assessment of the performance of the *Li6252* IRGA, relative to the dedicated *TOC-5000* system, under seasonal field conditions.
3.Investigation of sampling and preservation protocols, for improved methodological precision and extension of sample collection capabilities, respectively.

### 5.4.3 Samples Collected

The following samples were collected, and in some cases sub-samples were stored in ampoules for assessment of preservation techniques:

| Station | CTD | Ampoulated |
|---|---|---|
| OM 5 | 002 | Yes |
| OM 7 | 004 | No |
| | 005 | No |
| | 006 | No |
| OM 8 | 007 | No |
| | 008 | Yes |
| OM 6 | 009 | Yes |
| | 010 | No |
| Belgica | 013 | No |
| | 014 | No |
| OM 10 | 020 | Yes |

Samples were also taken in glass ampoules pre-cleaned at 550°C for ULB at the above stations except for OM10. They have been preserved with 1% $HgCl_2$ solutions (100$\mu$l/100ml) and sealed. These samples will be analyzed in Brussels using a Shimadzu TOC 5000 HTCO analyzer.

Samples were also collected by PML each hour on passage to the *Belgica* station, along the transect from 49°04'N, 10°28'W to 47°33'N, 7°23'W. Aliquots were

archived for analysis in the laboratory.

### 5.4.4 Observations

1. Preliminary DOC concentrations ranged from 30-90$\mu$M C, generally falling between 50-75$\mu$M C. There were no well defined vertical gradients through surface waters, although samples were seldom collected above 50m depth.
2. Significantly high baseline noise to signal ratio for *TOC-5000* IRGA rendered determination of instrument blank and low-carbon waters unfeasible.
3. Results confirm that the solid state IRGA is most suited for use at sea - providing significantly lower baseline noise to signal ratios at sea water DOC concentrations. Measurements from this system were suitable for determination of the instrument blank ($\sim$10$\mu$M C) and low-carbon waters ($\sim$8$\mu$M C).
4. Application of a stand-alone integrator allowed more thorough observation of the IRGA signal; compared to the 'black-box' *TOC-5000* system. Anomalous signals and incorrectly defined baselines could be observed and, where required, corrected.
5. Oceanographic DOC profiles showed considerable, non-systematic differences between the *TOC-5000* (Figure 4a) and *Licor* (Figure 4b) systems; signals from the latter producing less 'spiking' through the water column.

### 5.4.5 Fluorescence of Dissolved Organic Matter

The collection of samples across the shelf break provided an excellent opportunity to obtain material for fluorescence studies of dissolved organic material in the interface zone between the open ocean and the land influenced shelf waters. Samples collected were preserved by the addition of mercuric chloride solution. The samples will be analyzed by a two dimensional scanning fluorometry technique at Southampton University, Department of Oceanography by Adrian McDonald, which allows the qualitative identification of different groups of organic materials. It is intended to compare the fluorescence data with total organic carbon measurements of the same samples made on board ship by Axel Miller.

CTDs from which samples were taken:

| | OM 5 | OM 7 | OM 8 | OM 6 | Belgica |
|---|---|---|---|---|---|
| DOM Fluorescence | 002 | 004-006 | 008 | 009-010 | 013-014 |

Axel Miller

Figure 4 Differences in DOC profiles using a) the TOC-5000, and b) the Licor, carbon dioxide analysers.

**Figure 4a**
Mean error, as covariance: 13.2%; range 1.1 - 40.9%.
Baseline noise to signal ratio, expressed relative to signal: 18.8 - 37.5%

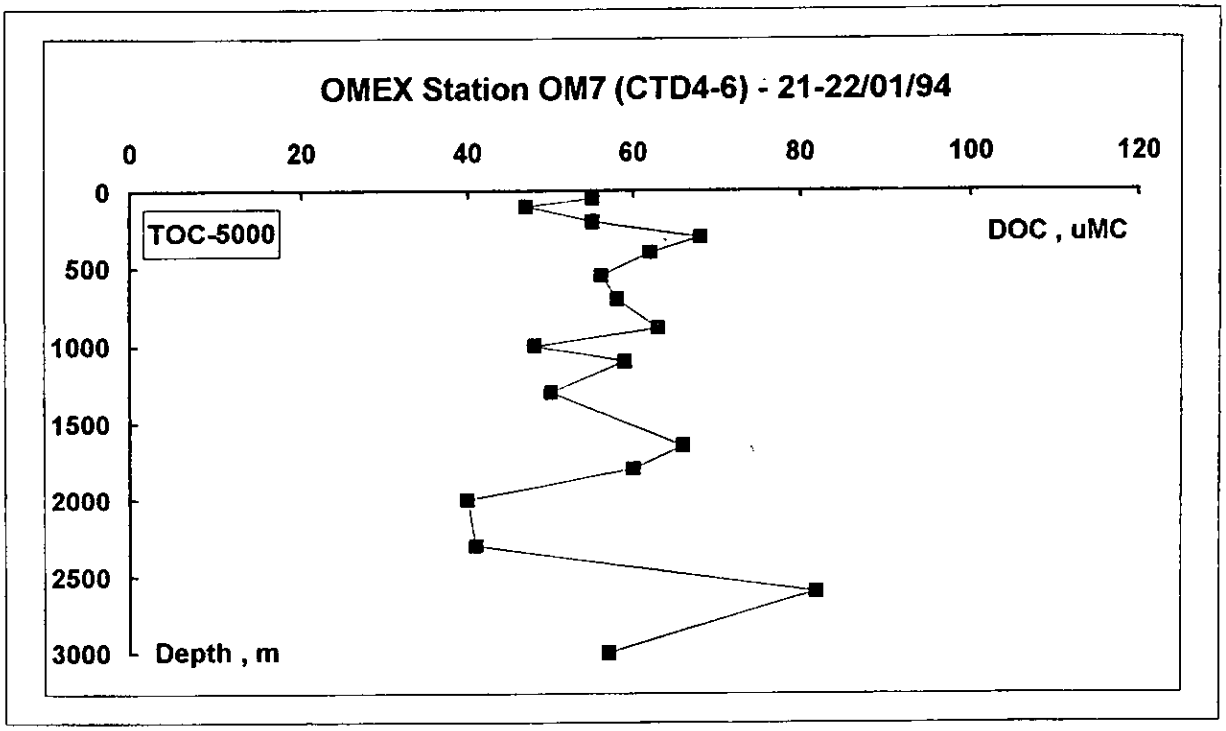
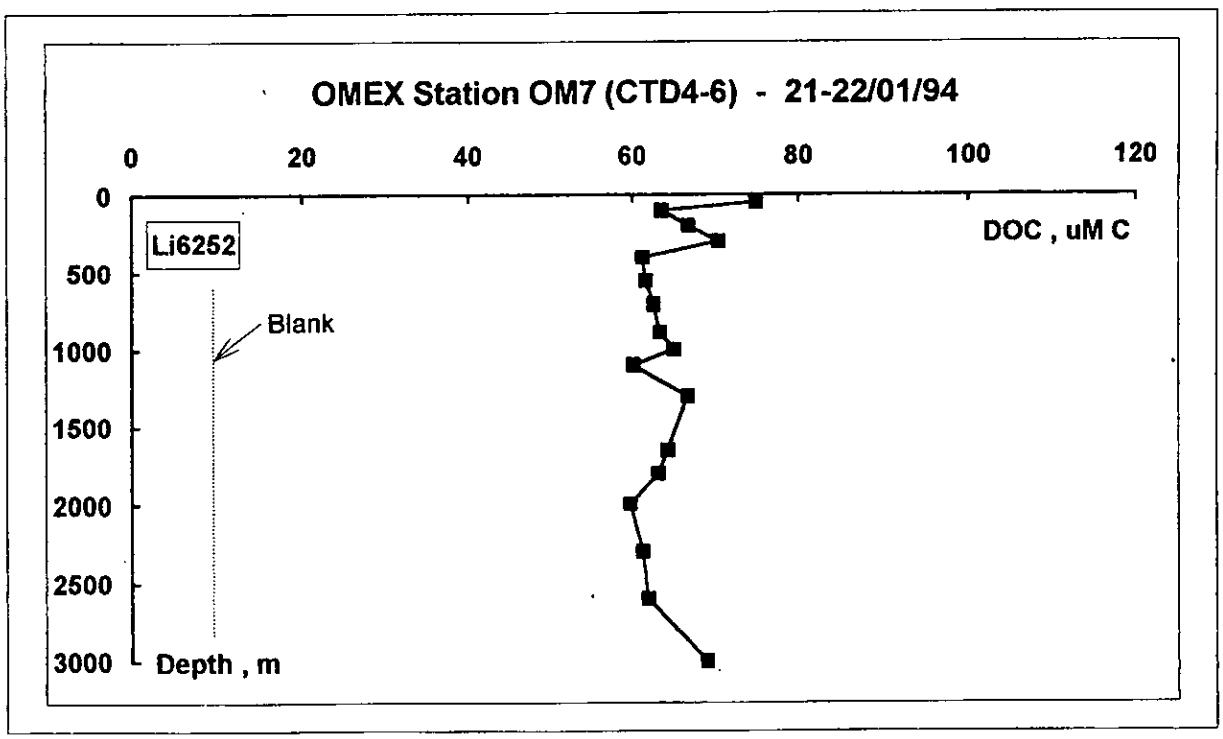



**Figure 4b**
Mean error, as covariance: 2.7%; range 1.0 - 6.4%.
Baseline noise to signal ratio, expressed relative to signal: 2.4 - 5.1%



## 5.5 DISSOLVED TRACE METALS

### 5.5.1 Aluminium

Dissolved and reactive particulate aluminium were determined by the lummogallion technique onboard, in unfiltered samples of seawater collected by the ship's non-toxic supply, and by Go-Flo bottle. In general concentrations were in the same range as has been noted previously in this region. A strong aluminium signal was evident in the mediterranean outflow water, which was clear feature in all CTD casts over 1km (see Figure 3). It appears that the non toxic supply did not significantly contaminate the samples collected for aluminium analysis.
Aluminium in a limited number of samples was also determined by the same technique with filtered and un-acidified samples by Lei Chou, also collected filtered seawater samples at the same stations and depths where samples were taken for other trace metal analysis. These samples are acidified with 50 $\mu$l HCl/100 ml and will be determined for dissolved Al in the shore laboratory.

Lei Chou
David Hydes

### 5.5.2. Other trace metals

Most sampling for trace metals in the water column was done using 10 litre teflon lined GoFlo bottles, which had been modified for trace metal work. The sampling rosette and CTD was also carefully cleaned, zinc sacrificial electrodes removed, and all exposed corrodible metal parts either epoxy painted or coated in parafilm, prior to the cruise. All handling of samples was done inside the RVS or IFREMER clean containers. Samples were pressure filtered (circa 0.8 bar) through acid washed 0.4 $\mu$m Nuclepore membranes.

#### 5.5.2.1. Southampton University

The Southampton work, in parallel with dissolved studies at IBM , and particulate trace metal studies at ULB, has the objective of measuring distributions of trace metals across the shelf break, and to assess this data for i) use of metals as tracers of cross shelf water movement ii) in improving our understanding of the biogeochemical cycling and fate of trace metals in the shelf break zone.

Southampton samples will be acidified (1 ml of concentrated nitric acid per litre of seawater) to ensure no changes in concentration during transport and storage. The metals Cd, Co, Cu, Mn, Ni, Pb and Zn will be determined in the shore laboratory by graphite furnace atomic absorption spectrometry after pre-concentration and separation from the salt matrix by chelation and solvent extraction procedures, using the specialised facilities, including a dedicated clean laboratory, at Southampton.

### 5.5.2.2 Institut Biogeochimie Marine

*Aims* The main object was to take water samples in order to measure the total dissolved trace metals (TDTM) and to study speciation of trace metals by using Sep-Pak columns (to measure the percent of TDTM complexed by hydrophobic organic matter).

*Procedures* The samples were collected using Go-Flo bottles associated with CTD instrumentation and filtered immediately through Nuclepore filters (0.4 $\mu$m pore diameter) using nitrogen pressure. The filtered samples were collected in 500ml polyethylene bottles, previously cleaned in an acid bath, and rinsed with Milli-Q water.

The TDTM samples were acidified to pH of about 2.5 for storage and another 500ml of filtered sample was passed through a Sep-Pak column; adsorbed metal-organic complexes were eluted by methanol/Milli-Q water solution (1/1) on board.

The seawater samples will be analyzed at Montrouge by GFAAS after freon extraction, and the methanol water eluates directly by GFAAS.

Samples collected and processed are shown in the following table:

| date | station | depth (m) | number of samples for total metals | number of samples for sep-pak separation |
|---|---|---|---|---|
| 20/1/94 | OM5 | 200 | 5 | 5 |
| 25/1/94 | OM6 | 1200 | 17 | 6 |
| 21-22/1/94 | OM7 | 3000 | 17 | 10 |
| 23-24/1/94 | OM8 | 4500 | 23 | 12 |
| 28/1/94 | BELGICA | 2000 | 19 | 12 |
| 29-30/1/94 | OM13 | 4300 | 21 | 0 |
| 31/1/94 | OM10 | 1480 | 8 | 0 |
| | | Totals | 100 | 45 |
| Unfiltered samples at station OM8 | | | 11 | |

Marie-Helene Cottee

### 5.5.2.3 IFREMER- Mercury

The main objective was to collect water column samples for the determination of total dissolved mercury, and to see if there are concentration gradients

across the shelf break zone, in relation to other important variables (e,.g. nutrients, DOC, pigments, metals, T, currents and SPM). Samples taken from GoFlo bottles were filtered using an all teflon pump, and acidified on board in an ultra clean container, and stored in hermetically sealed teflon bottles. Some samples have been both filtered and left unfiltered to check on contamination potential from the filtration procedure. The analysis will be done with an auto-analyzer, equipped with an atomic fluorescence detector.

Samples of sediment were also collected from some box cores for the determination of total mercury .

Samples collected for mercury analysis are given in the following table.

| location | sample |
|---|---|
| OM5 **water column** | 5 |
| OM7 | 18 |
| OM8 | 23 |
| OM6 | 18 |
| OM10 | 9 |
| Belgica station | 20 |
| Total water samples | 114 |
| OMEX 1B box core **sediments** | surface only |
| OMEX 3B | core, 30 cm |
| OMEX 4B | core, 30 cm |
| OMEX 5B | core, 30 cm |

Jane San-Juan

5.5.2.4 Hafnium

Further sub-samples were filtered and stored acidified (hydrochloric acid)for the later determination of Hafnium by Dr Linda Godfrey at Cornell University, USA. If adequate sample is available, Hafnium isotopes may also be determined

5.5.2.5 Use of gels for the collection of dissolved trace metals

The CD84 field work also provided an opportunity to help develop a gel technique for the collection of metals from natural waters, which is being developed by Prof. Bill Davison at Lancaster University. Gels of 4 differing thicknesses were deployed at depth on two occasions when stand al;one pumps were being used. Metals can diffuse through the gel and become trapped in a chelating resin embedded within it. The technique thus has potential for monitoring application and providing long term measurements of metals in natural waters. The exposed gels will be returned to Lancaster for analysis, and comparison with dissolved trace metal data from the same water column,

generated by other laboratories.

Marie-Helene Cottee
Jane San Juan
Peter Statham

## 5.6 PARTICULATE TRACE METALS

There exist very few data on the trace metal composition of particulate material in the oceanic water column. The objective of this study is to investigate the vertical profile of suspended matter trace metal contents in the OMEX study area.

Particulate matter was collected by in-situ filtration of large volume of seawater at various depths using the Stand Alone Pumps (SAPs) where a polypropylene filter holder is housed directly on top of the pump. Nuclepore filters of 293 mm diameter and 0.4 $\mu$m porosity were used. In general, 200-500 litres of seawater were filtered. Sampling depths were chosen so that concentrations of dissolved trace metals would also be available and the distribution coefficient of trace metals between the dissolved and particulate phase could be calculated. Owing to the constraints of wire time, suspended matter mainly in the upper 700 meters of water column was collected. The table on the following page shows the sampling stations and depths.

Unfortunately many filters were torn due to the swells encountered in the sampling region.

Filters are kept frozen until analysis. Suspended material will be detached from the filter ultrasonically. Solid materials will be dried. Particulate Mn, Zn, Fe, Cd, Co, Ni and Pb will be analyzed by direct injection of solid samples suspended in an acidic medium using graphite furnace electrothermal atomic absorption spectrometry with Zeeman correction. Particulate aluminium will also be determined because it is a good indicator for terrestrial particles and can be used for normalization.

Suspended materials were also collected on 47 mm 0.4 $\mu$m Nuclepore filters at Station Belgica at all depths for VUB (Vrei University Brussels). They will be analyzed for particulate Al, Si, Ba, Sr and Ca.

| Operation No. | Date | Sampling Station | Sampling Depth (m) |
|---|---|---|---|
| SAP1 | 21-22/1 | OM7 | 20<br>40<br>100<br>200 |
| SAP2 | 22/1 | OM7 | 300<br>400<br>550<br>700 |
| SAP3 | 24/1 | OM6 | 50<br>100<br>150<br>200 |
| SAP4 | 28/1 | BELGICA | 50<br>100<br>150<br>200 |
| SAP5 | 28/1 | BELGICA | 200<br>300<br>400<br>500 |

Lei Chou

## 5.7 RADIONUCLIDES

In order to determine with the maximum precision the concentration of artificial radionuclides contained in sea water, the laboratory "CEA Service Mixte de Securite Radiologique" needs for each analysis a large volume sample of seawater.

A 300 litre capacity sampling bottle, especially designed and built by the Society "nereides-France", was used. The bottle is closed by messenger. The collected sample was transferred to 10 polyethylene bottles, each of 30 litre capacity. Filtration through 0.45 $\mu$m porosity membranes of 293 mm diameter, was carried out as rapidly as possible. The filtrate was acidified to pH 1.7 with hydrochloric acid to stabilize the radionuclides in the polyethylene containers.

A radiochemical treatment specific to each radionuclide is applied in our laboratory, followed by low level counting. Specific nuclides to be determined are: Cs-137, Sr-90, Pu-238, and 239/240 Pu.
Samples collected are given in the table on the following page.

| Station | Location in the water column |
|---|---|
| OM 6 | surface, non-toxic pump supply |
| OM6 | 10 m |
| OM8 | 270 m |
| OM8 | 640 m |
| OM8 | 850 m |
| OM8 | 1175 m |
| OM8 | 1350 m |
| Belgica | surface, non-toxic pump supply |
| Belgica | 1000 m |

## 5.8 OPTICAL TRANSMISSOMETRY, NEPHELOMETRY AND SUSPENDED SEDIMENTS

The transmissometer (RVS unit 99D) appeared to perform satisfactorily in producing internally consistent profiles for depths less than 2000 m. However, the minimum value ( above 1100 m) on each profile is variable but probably a function of the initial conditions on deployment as there is an excellent correlation with the transmission recorded in air immediately prior to the cast (as per manufacturers recommendation ), as the Table on the following page make apparent.

The relationship between minimum voltage and air voltage is

$$\text{min V} = 0.921 \text{ Air V} + 0.215, \quad r = 0.994$$

These data reinforce the conclusions a) the air value must be recorded and entered in the computer before every cast, b) the displayed quantity should not be volts but attenuation coefficient or (as a less desirable alternative) percent transmission.

In all of the deeper casts, where they go below 2000 m, the transmission signal shows large and unrealistic excursions. By unrealistic I mean that the low values yield attenuation coefficients lower than for absolutely pure sea water at 660 nm. In addition the up-traces for those casts (04, 12, 16, 18) bear virtually no resemblance to the down casts, but do appear to be better behaved. This fault was not recognised until rather late in the cruise (CTDs 16 and 18 confirmed the suspicion). By that time we had an initial air value correction and attenuation coefficient running routinely on the computer. It then became plain to see that something was wrong. the Sea Tech transmissometer is in principle capable of yielding good data. In order to do this the following steps are

necessary:

a. The air value should be measured prior to every time the CTD is put in the water
b. This value should immediately be entered in the computer
c. The computer should already have on file the other required parameters - manufacturers air value and zero offset.
d. Output should be as attenuation or (less desirably) percent transmission. The latter is less desirable because it is dependent on path length.
e. in theses days of WOCE standards for other hydrographic parameters, theses procedures should at least allow easier judgement about the acceptability of the data.
f. RVS unit 99D should be taken out of service and returned to the manufacturer for checking.

*Transmissometer data (clear water minimum and air values are in volts)*

| CTD cast | CTD depth (m) | Water Depth (m) | clear water minimum | Air value | Minimum-air |
|---|---|---|---|---|---|
| 04 | 3000 | 3350 | 4.526 | 4.683 | 0.157 |
| 06 | 550 | 3750 | 4.521 | 4.683 | 0.162 |
| 07 | 4495 | 4500 | 4.520 | 4.670 | 0.150 |
| 08 | 1100 | 4500 | 4.526 | 4.673 | 0.147 |
| 09 | 1120 | 1180 | 4.546 | 4.705 | 0.159 |
| 10 | 400 | 1180 | 4.542 | 4.700 | 0.158 |
| 12 | 3475 | 3480 | 4.597 | 4.761* | 0.164 |
| 13 | 1920 | 1935 | 4.599 | 4.763* | 0.164 |
| 14 | 600 | 1892 | 4.575 | 4.739 | 0.164 |
| 16 | 4285 | 4275 | 4.524 | 4.683 | 0.159 |
| 18 | 2895 | ~2905 | 4.605 | 4.763* | 0.158 |
| 19 | 900 | 900 | 4.600 | 4.763* | 0.163 |
| 20 | 1472 | 1480 | 4.617 | 4.775* | 0.159 |
| | | | | | 0.159 ± 0.005 |

*It is worth noting that the manufacturer's air value for 99D is 4.738

The results of tests is that determination of the suspended sediment structure - the location and intensity of the nephloid layers will be tricky. However, we also have the output of the nephelometer (a Chelsea instruments Aquatraka MkII) to compare to the transmissometer , from which some idea of congruent behaviour and likely acceptability of the transmissometer data can be obtained. The Aquatraka is a 90° scattering instrument with a pulsed light source ate he UV end of the spectrum. Results will therefore be qualitatively different from the transmissometer due to differing response to particle size as well as light wavelength.

Two deep casts (12 and 18) were made with 12 10 L Niskin bottles on each for filtration to determine suspended material concentration gravimetrically. Bottles were fired in pairs and 20 L filtered through 0.4 $\mu$m pore size Cyclopore membranes. These will be weighed and examined by scanning electron microscopy for particle types at Cambridge.

*Sampling depths (m) for Niskin CTD casts for suspended particulate material*

| Cast 12 | Cast 18 |
|---|---|
| 710 | 877 |
| 1034 | 1140 |
| 1855 | 1470 |
| 2751 | 2316 |
| 3322 | 2519 |
| 3442 | 2895 |

I. N. McCave
I.R. Hall

## 5.8 BIO-ACOUSTICS

Throughout the duration of the cruise the Acoustic Doppler Current Profiler (ADCP), was used to detect acoustic backscatter from the midwater biology. In conjunction with these studies a PML owned Longhurst-Hardy Plankton Recorder (LHPR), was fished to try to provide real-time evidence of the animals causing this backscatter. This work is a continuation of work carried out on three previous cruises, CD72 and D204 on NERC ships, and one on the German ship RV "Poseidon".

The quality of the ADCP records was greatly affected by the weather. This instrument can detect animals down to c.400m in perfect conditions. However, in light of the poor weather and often large swell, good records on this cruise

were limited to the top 275m and this was greatly reduced whenever the ship headed into this swell. The records taken on this cruise have been stored for future assessment at IOSDL.

Due to the inclement weather only three tows of the LHPR were possible, each lasting for three hours. The configuration used for these tows was as used on the previous cruises, a 200 micron mesh net and similar gauze in the cod-end, and the wind-on set for two minutes. For all three tows the net was payed out at twenty metres/minute to a depth of 275m and then hauled in at ten metres/minute. Any interesting features on the ADCP screen were sampled by allowing the net to fish for periods of ten minutes at the relevant depth.
The second and third tows, 53102 and 53103, worked perfectly, providing the full three hours of sampling. Unfortunately, the first tow, 53101, failed after 1Hr20mins due to the mechanism jamming on a small bolt from the net's flowmeter.
The three samples were preserved in 5% formalin and seawater for future examination at IOSDL.

B. Boorman. IOSDL.

## 5.9 KASTEN CORING

The following Kasten cores were obtained using the 4 m Cambridge barrel (3 m barrel for OMEX 3K) on a 1 tonne core head.

| Core | Lat (N) | Long (W) | Depth (m) | Wire out | time/ date | length (m) |
|---|---|---|---|---|---|---|
| OMEX 1K | 48°58.00′ | 13°39.20′ | 4494 | 4550 | 1728/23 /1/94 | 3.18 + 0.19CC |
| OMEX 2K | 49°04.72′ | 13°25.63′ | 3658 | 3680 | 1535/24 /1/94 | 2.45 + 0.09CC |
| OMEX 3K | 49°22.70′ | 11°37.34′ | 805 | 810 | 0530/31 /1/94 | 2.65 + 0.19CC |

OMEX 1K recovered a sloppy foram ooze at the top suggesting only slight loss of the surface. The material resembles the OMEX 1B surface skim from that site. The upper 38 cm of the core is foram and nano ooze underlain by grey muds with two obvious turbidites at 65 and 85 cm. Beneath that is grey mud with glacial dropstones to the bottom of the core.

OMEX 2K lost the top of the core due to a slight gap in the side of the barrel about half-way down, resulting in the overlying water flushing down the soft material when the corer was lifted out of the water. The upper material is firm foram ooze which is replaced below 44 cm by grey mud with dropstones below

66 cm. No obvious turbidites are present.

OMEX 3K has a 10 cm thick sandy top with uniform olive grey muds beneath, varying only in water content and abundance of dropstones. It seems likely that the Holocene here is rather thick due to winnowing by a current, or internal waves. We shall see.
The cores are held at the Department of Earth Sciences, Cambridge by Prof. I.N. McCave. They will be used to assess the changing storage of terrigenous, carbonate and organic carbon components of the sediment on the continental margin from late glacial through the Holocene. Comparison will also be made with fluxes at sites at the same latitude but away from continental margin influence. Analyses will be made of water content, magnetic susceptibility, carbonate and terrigenous material content and grain size, organic carbon content, delta18O and delta13C on pelagic and (if sufficient) benthic foraminifera. One subcore from each core has been frozen and is available for organic geochemical analyses.

## 5.10 BOX CORING

Attempts to take box cores early in the cruise were fruitless. The rule of thumb that the probability of getting good box cores declines markedly with sea state above 5 was again demonstrated. The first two attempts resulted in very thin surface skims, and another un-numbered in getting any thing at all. In a calm period on 29th January, we obtained cores SW of La Chapelle Bank, and on the Meriadzek Terrace. Entry speed was 30m/min. Later we obtained a core (5B) from the STABLE deployment site.

*Box core sampling data*

| Core | Lat N | Long W | Depth (m) | Wire out (m) | time/ date | length of core |
|---|---|---|---|---|---|---|
| OMEX 1B | 48° 57.75′ | 13° 40.57′ | 4490 | 4600 | 20.58 22/1/94 | skim/ 1cm |
| OMEX 2B | 49° 03.79′ | 13° 26.95′ | 3630 | 3645 | 11.08 24/1/94 | skim/ <1 cm |
| OMEX 3B | 47° 37.81′ | 7° 36.94′ | 620 | 621 | 01.55 29/1/94 | 0.40 m |
| OMEX 4B | 47° 41.00′ | 8° 17.58′ | 1333 | 1348 | 15.12 29/1/94 | 0.45 m |
| OMEX 5B | 49° 23.12′ | 11° 38.34′ | 837 | 840 | 03.37 30/1/94 | 0.30-0.35 m |

*Sub-sampling of cores*

| Core | Sub-samples |
|---|---|
| OMEX 1B | two bags. One to Cambridge one to IFREMER Nantes |
| OMEX 2B | not enough to sample; surface washed forams |
| OMEX 3B | 3 tubes IOS/SUDO for oxygen, porewater nutrients & metals<br>2 tubes Cambridge for sedimentology/ archive<br>1 tube of 30 cm IFREMER Nantes; total Hg analysis.<br>3 bags surface 0-3 cm; 2 Cambridge, 1 bag CEA/SMSR Paris for artificial radionuclides<br>1 bag surface store Cambridge |
| OMEX 4B | 2 tubes IOS/SUDO for oxygen, porewater nutrients & metals<br>2 tubes Cambridge for sedimentology / archive<br>1 tube of 30 cm IFREMER Nantes; total Hg analysis. |
| OMEX 5B | 2 tubes IOS/SUDO for oxygen, porewater nutrients & metals<br>2 tubes Cambridge for sedimentology / archive<br>1 tube of 30 cm IFREMER Nantes; total Hg analysis<br>1 tube University Algarve for amino acids and clays |

### 5.10.3 Oxygen Measurements

A new dissolved oxygen sensor has been developed at I.O.S., which is designed to be used for measuring oxygen in sediment pore waters. A computer controlled profiling system has been built which pushes the electrode into the core from above. The electrode is moved a set increment and the computer monitors the response until a stable reading is obtained. This is then logged, the electrode is moved another step and the process is repeated.

The profiling system is a very recent development and has been used only once previously. The aims of the work on this cruise was to check the system works correctly and to provide high resolution dissolved oxygen profiles to correlate with the nutrients and trace metal data obtained from the extracted pore waters.

#### 5.10.3.1. Oxygen profiling procedures

10cm diameter sub-cores of the retrieved box cores were taken with 2-3cm of the overlying water still in place. If a large enough volume of bottom water was trapped over the core, samples were taken for Winkler oxygen determination and used for calibration of the electrode. In general the bottom water was not retrieved using the RVS box corer.

The electrode was then positioned in the overlying water and the distance from the electrode tip to the sediment surface was noted. The increment step size and total distance to be profiled were then entered into the computer and the profile programme was started.

Calibration of the electrode was carried out using sea-water from the non-toxic supply. Samples were taken for the electrode measurement and for Winkler analysis and the temperature and salinity were noted down from the thermo-salinograph. A zero point was obtained by adding a small quantity of sodium sulphite to the sea-water.

5.10.3.2. Observations

It was noticed that on the first two profiles the carriage holding the electrode did not move the full distance it was programmed to move. The reason for this was found to be weak batteries in the profiler control box. These batteries were replaced and the profiler worked correctly for all subsequent profiles.

5.10.4. **Pore Waters**

Cores extruded into a nitrogen filled glove bag and sectioned at 1 or 2 cm resolution. The material was spun down in a refrigerated centrifuge on board ship, and the supernatant filtered through 5$\mu$m and 0.2 $\mu$m membrane filters in series. Nitrate was analyzed on board ship, and other nutrients and metals (to include Mn and Fe) will be determined at the shore laboratory. Metal samples were preserved by addition of sub-boiling distilled hydrochloric acid. The solid phase will be analyzed for major and minor elements by ICP-AES, U and Th series isotopes by radiochemical methods, calcium carbonate and organic carbon by coulometric methods.

Preliminary results of nitrate determinations suggest that nitrate is present to a depth of 6cm in OMEX B3 and 8 cm in OMEX B4. The colour change in OMEX B4 occurs at a depth of 7 cm. Oxygen profiles for these cores suggest that oxygen falls to zero concentration at a depth of 5 cm in OMEX B3 and 5-6 cm in OMEX B4.
OMEX B5 exhibits a double nitrate peak, one at the surface which falls to zero within 4 cm, this coincides with the colour change in the core. A second nitrate peak occurs within the 8-10 cm interval which falls to zero at 16 cm. A 1.5 cm diameter stone was found in the 8-10 cm interval. Oxygen data for this core shows a steep gradient from the surface to a low reading at 3-4 cm depth. The oxygen content then increases slightly and remains constant with a shallow gradient, falling to zero concentration at approximately 12 cm.

Cores taken for oxygen profile work were later sectioned at 2 cm intervals and stored, this material will be archived at I.O.S.

### 5.10.5 Cambridge Analyses

Samples will be analyzed for Pb-210 excess, Cs -137 (as an indicator of mixing), carbonate, organic carbon, water content, and grain size.

Helen Cussen
Rachel Mills
Nick McCave
Ian Hall

## 5.11 POP-UP STABLE II.

The new aluminium tripod benthic lander POP-UP STABLE II was deployed for the first time. It carried electromagnetic current meters and a pressure sensor for measuring seabed turbulence and pressure fluctuations at 8Hz. Tidal flow sensors, tidal pressure, sea-temperature, pitch, roll and compass were all logged once a minute. An acoustic back-scatter system measured suspended sediment concentrations concurrently with the turbulence records; working at high speed with large amounts of data meant that endurance was only about 4 days.

The frame carried expendable ballast: this was be released by acoustic command. The releases were by Benthos, with release- codes 4C and 5C, corresponding to ship-transmission frequencies of 11.5kHz and 13.5kHz respectively, using code C. In transpond mode, the releases transmitted on 12kHz. The frame carried syntactic foam bouyancy to bring it to the surface.

STABLE II was deployed (in conditions of some swell) in 879m water, in position 49° 23.49' North, 11° 40.03' West at 23.17GMT on 20th January, 1994.

Ranging onto the two transponders was performed at 1517GMT on 26th January. Good signals, giving about 950m slant range, were obtained from both.

Bad weather, with westerly gales and heavy swell, precluded recovery at the scheduled time. The ship moved away from the STABLE area at about 1200GMT on 27th January. The cruise-programme was altered during the second phase however, which meant that there was another chance to recover on the 31st January. Despite indifferent weather, STABLE was released at 0807, and was spotted on the surface at 0838. It was recovered on deck without damage at 0856.

John Humphery.

## 5.12 CURRENT METER MOORINGS

The OMEX physical cruise Charles Darwin CD83, immediately prior to the current cruise, was unable to lay two OMEX moorings at the Shelf break because of bad weather and time constraints. Fortunately it was possible to deploy both moorings during CD84, as indicated in the table below.

| Mooring | Location | Water Depth (m) | Time of deployment |
|---|---|---|---|
| Goban Spur 154 | 49 06.48 N 12 10.85 W | 996 | 21 Jan 1994 1059h |
| Goban Spur 150 | 49 09.93 N 10 31.28 W | 145 | 27 Jan 1994 1040h |

## 5.13 STANDARD SEAWATER COLLECTION

A collection of circa 3000 litres of seawater was made for the Standard Seawater Service, using the shipboard fire-fighting pump system. The collection took place at circa 48.964 N 13.664 W. Approximate salinity and temperature were 35.50 and 11.06°C respectively.

**APPENDIX 1** Station locations and operations carried out. (All times in GMT). Unless other wise indicated, all CTD casts are with 10 L Go-Flo bottles.

| Date/time | Lat. N, Long. W | Activities |
|---|---|---|
| 18 Jan 1300 | | depart Barry |
| 20 Jan 0956 | 49 29.95 11 00.22 | Station OM5; CTD 1 Shake down for GoFlo bottles. Water depth 188 m. |
| 1111 | 49 29.30 11 00.14 | CTD 2; to 170 m. Water depth 187 m. |
| 1337 | 49 28.26 11 03.0 | 300L water bottle (radio nuclides) deployed and tested |
| 1754 | 49 22.15 11 46.86 | CTD 3; full water column (1003 m) to provide data for STABLE deployment |
| 2010 | 49 23.26 11 39.12 | Shipek grab and bottom bounce photography of STABLE location |
| 2317 | 49 23.19 11 40.03 | STABLE deployed |
| 21 Jan 1059 | 49 06.48 12 10.85 | 1000 m OMEX Goban Spur current mooring deployed |
| 1146 | 49 06.25 12 11.22 | Longhurst-Hardy Plankton Recorder (LHPR) deployed |
| 1441 | 49 06.5 12 30.4 | LHPR in board |
| 1915 | 49 06.93 13 11.94 | OM7 CTD 4; 3021 m. Water depth 3350 m. |
| 2256 | 49 05.92 13 12.96 | Stand alone pumps (SAPs) x 4 deployed |
| 22 Jan 01:34 0156 | | SAPs recovered |

| | | |
|---|---|---|
| 0233 | 49 04.6 13 17.6 | OM7 CTD 5; to 1300 m. Water depth 3550 m. |
| 0447 | 49 04.93 13 18.41 | SAPs deployed |
| 0915 | 49 08.21 13 21.72 | SAPs recovered |
| 1041 | 49 06.65 13 11.91 | OM7 CTD 6; to 553 m. Water depth 3750 m. |
| 1428 | 48 50.0 13 40.0 | arrive OM8; stream coring wire |
| 1816 | 48 53.95 13 40.15 | Deployed box corer to 4600 m; only trace of sediment in bucket |
| 2242 | | Science suspended due to bad weather |
| 23 Jan 0800 | | resume science |
| 0925 | 48 57.26 13 39.82 | OM8 CTD 7; to 4495 m. Water depth 4490 m. |
| 1543 | 48 58.6 13 39.9 | Kasten corer deployed |
| 2022 | 48 57.79 13 39.89 | large SMSR bottle to 250 m |
| 2055 | 48 57.81 13 39.70 | large SMSR bottle to 640 m failed to close |
| 2137 | 48 57.61 13 39.36 | repeat large SMSR bottle to 640 m |
| 2226 | 48 57.14 13 39.10 | large SMSR bottle to 840 m |
| 2331 | 48 56.69 13 38.71 | large SMSR bottle to 1140 m |
| 24 Jan 0034 | 48 56.3 13 38.6 | large SMSR bottle to 1350 m |
| 0323 | 48 56.40 13.39.0 | OM8 CTD 8; to 1113 m, water depth 4480 m. |

| | | |
|---|---|---|
| 0935 | 49 04.39 13 27.11 | OMEX III site (as occupied by Pelagia), box core deployed to 3713 m |
| 1355 | 49 05.1 13 25.9 | Kasten corer deployed; penetrated in 3680 m of water |
| 2030 | | Science suspended due to bad weather |
| 25 Jan 0830 | | Resume science |
| 0855 | 49 13.16 12 37.11 | CTD 9; to 1171 m. Water depth 1183 m. |
| 1027 | 49 12.57 12 37.26 | Commence Stand Alone Pump deployment to 200 m |
| 1320 | | Science suspended due to bad weather |
| 26 Jan 0800 | | resume science |
| 0836 | 49 12.91 12 36.65 | OM6 CTD10; to 400 m. Water depth 1180 m. |
| 1108 | 49 11.75 12 35.95 | CTD 11; dip aborted due to bad weather |
| 1513 | 49 23.6 11 40.2 | At STABLE site; unit operating OK but unable to recover because of poor weather |
| 27 Jan 0027 | 48 31.8 11 31.7 | CTD 12; 3422 m. Niskin cast for nephels. Water depth at start of cast- 3442 m. |
| 1040 | 49 09.93 10 31.28 | OMEX Goban Spur 150 mooring deployed in 145 m of water |
| 1700 | | Because of heavy swell and winds, course changed from zigzag to direct line to BELGICA station |
| 28 Jan 0840 | 47 24.93 7 16.0 | BELGICA Station; CTD 13 to 1930 m. Water depth about 1950m, very steep bottom topography |

| | | |
|---|---|---|
| 1056 | 47 23.76 7 15.96 | SAPs deployment |
| 1440 | 47 25.0 7 18.4 | large SMSR bottle to 1000 m |
| 1642 | 47 24.98 7 15.66 | BELGICA, CTD 14; to 600 m. Water Depth 1892 m |
| 1850 | 47 24.18 7 16.00 | BELGICA, SAPs fully deployed |
| 29 Jan 0046 | 47 37.85 7 37.09 | Box core deployment started |
| 0131 | 47 37.74 7 36.92 | Box core redeployed |
| 0508 | 47 29.63 7 47.79 | CTD 15. CTD cast only (one bottle for salinity/temperature). Water depth 950 m. |
| 1426 | 47 41.1 8 17.19 | Box core deployment started |
| 1632 | 47 40.88 8 21.53 | LH Plankton Recorder deployed |
| 1932 | 47 38.12 8 39.72 | LH Plankton Recorder retrieved |
| 2345 | 47 29.9 9 34.8 | CTD 16. Deployed to 4326 m |
| 30 Jan 0536 | 47 29.98 9 34.97 | CTD 17. Deployed to 1258 m |
| 1040 | 47 58.15 9 55.18 | LH Plankton Recorder deployed |
| 1341 | 48 09.4 10 02.4 | LH Plankton Recorder retrieved |
| 1421 | 48 10.94 10 03.90 | CTD 18. Deployed to 2918 m |
| 31 Jan 0315 | 49 23.0 11 38.6 | Box corer deployed |

| | | |
|---|---|---|
| 0502 | 49 22.7 11 37.62 | Kasten corer deployed |
| 0856 | 49 23.9 11 39.78 | STABLE recovered and inboard |
| 0955 | 49 24.25 11 39.99 | CTD 19. Deployed to 800 m ? |
| 1429 | 48 55.0 11 50.6 | CTD 20. OM10. Deployed to 1490 m. |
| 1552 | 48 54.7 11 50.0 | Precision Echo Sounder fish inboarrd; end of science |
| 2 Feb 0900 | Arrive Barry Lock Gate | |