Institut für Meereskunde
an der Universität Kiel

11.06.1998

Institute of Marine Research
Kiel University
Germany

Cruise Report

F.S.Poseidon **Cruise No.: 237/3**

Dates of Cruise: 02.04.1998 - 17.04.1998

Areas of Research: Physical, chemical and biological oceanography, bio-geochemical fluxes

Port Calls: Las Palmas de Gran Canaria/Spain 31.03.1998 - 02.04.1998
Las Palmas de Gran Canaria/Spain 17.04.1998 - 20.04.1998

IFMK Department: Marine Physics

Chief Scientist: Dr. Thomas J. Müller

Number of Scientists: 10

Projects: EU MAST III Regional Seas Project CANIGO
JGOFS time series station ESTOC (Spanish - German co-operation)

Cruise Report

This cruise report consists of 30 pages including cover:

1. Scientific Crew

P237/3 (02.04.1998 - 17.04.1998)

Name	Function	Discipline	Institution
1. Müller, Thomas J., Dr.	chief scientist	physical oceanogr.	IFMK
2. Bollmann, Jörg, Dr.	scientist	particle flux	ETHZ
3. Cianca, Andres	scientist	chemical oceanogr.	ICCM
4. Godoy, Juana	scientist	chemical oceanogr.	ICCM
5. Hansen, Wiebke	student	physical oceanogr.	IFMK
6. Koy, Uwe	technician	physical oceanogr.	IFMK
7. Lenz, Bernd	scientist	physical oceanogr.	IFMK
8. Pou, Jordi	student	chemical oceanogr.	ICCM
9. Martinez, Mara, Dr.	scientist	particle flux	ETHZ
10. Villagarcia, Maria, Dr.	scientist	chemical oceanogr.	ICCM

Participating institutions

IFMK: Institut für Meereskunde an der Universität Kiel
Düsternbrroker Weg 20
24105 KIEL, Germany
Phone : (0049)(0)(431)-597-3799/3891
Fax : (0049)(0)(431)-597-3891 (Secr.)
(0049)(0)(431)-567658 (central)
E-mail : tmueller@ifm.uni-kiel.de

ETHZ: Geological Institute, ETH-Z
8092 ZÜRICH, Switzerland
Phone : ++41+1 632 3684
FAX : ++41+1 632 1080
E-mail : bolle@erdw.ethz.ch

ICCM: Instituto Canario de Ciencias Marinas
Ctra. Taliarte s/n Apto. Correos 55
35200 TELDE de Gran Canaria, GC, Spain
Phone : ++34+928 133312
Fax : ++34+928 132908
marimar@iccm.rcanaria.es

2. Research Programme

This cruise was part of the European Mast-III CANIGO project (Canary Islands Azores Gibraltar Observations) as well as the ESTOC programme (European Station for Time Series in the Ocean, Canary Islands). The CANIGO project started in 1996 and will run for 3 years, while the ESTOC programme, which started in 1994, will continue its observations on a long-term basis.

Within CANIGO subproject 1 *Circulation and Dynamics of Transports through the Eastern Boundary Current System*, we want to study the Eastern Boundary Current System in the eastern subtropical North Atlantic, characterize the Azores and Canary Current, determine the mesoscale variability in the region as well as seasonal and possibly interannual variations. The data set gathered within 1997/98 will be input to nested circulation models.

The POSEIDON cruise 237/3 was the third of a total of four cruises during different seasons (M37/2b, Jan 1997; P233a, Sep 1997; P237/3, Apr 1998; M42/1b, scheduled for Jul 1998) to determine the variability of the physical environment in the eastern Canary Basin (CANIGO Task 1.2.4: *Eastern Canary Basin hydrography*, Task 1.3.2: *Mesoscale variability and seasonal variations in the Canary Islands region*). CTD/LADCP sections including biological and chemical sampling are to be carried out between the African Shelf along 32°N towards Madeira, along 18°W towards La Palma and back to the African shelf along 29°N to obtain a closed hydrographic box (see map in App. A) for budget calculations. Sampling for coccolithophorids, diatoms and planktic foraminifera are part of the CANIGO subproject 3: *Particle flux and paleoceanography in the Eastern Boundary Current*, Task 3.1.2: *Flux of organisms*. The scientific goals are (a) to obtain a better understanding of the seasonal and interannual interaction between planktonic organisms and the physical environment along a WE-transect north of the Canary Islands and (b) to compare this interaction with the long-term variability of species composition and flux into the sedimentary archives.

It should be noted that during this cruise, CANIGO moorings with current meters and particle traps were in site at positions ESTOC, EBC east of Lanzarote, and at LP north of La Palma, a site located well off the coastal and upwelling influence in an oligothrophic area in the open eastern Atlantic.

3. Narrative of cruise with technical details

Thank's to the ship's agent in Las Palmas, Flick Canarias, a spare O-ring for the lADCP that was delivered *last-minute* by the manufacturer and that did not fit, could finally be found in their ship handler's store. Although this un-exspected search for the spare caused a delay of few hours before sailing, it saved the lADCP measurements of the cruise.

On 02 April, 14:00 lt., POSEIDON sailed from Las Palmas. Course was set to north of Gran Canaria where a drifting particle trap that had been launched during the previeous leg, was recovered late evening the same day. Next day in the morning, a test station with CTD/rosette/lADCP was performed east of Lanzarote (Sta. 121) at 1000 m water depth. The

29°N section then began with CTD/rosette/lADCP and sampling for oxygen, nutrients and coccolithophores on station 122 on the African shelf (see Tab. A 1 for station information, and Tab A2 for sampling information). East of Lanzarote, the section runs parallel to 4 moorings with current meters and sediment traps that is operated by IFMK, the Instituto Espanol de Oceanografia, the University of Las Palmas, the Geoscience Department of the University of Bremen (GeoB) and the ICCM that has installed a nutrient recorder. A fluorometer was attached to the CTD on all stations with water depths less 3000 m, and at the ESTOC and LP stations. In addition, plankton hawls were performed down to 500 m on some stations.

The April ESTOC station (Sta. 140) close to which two current meter and particle trap moorings are operated by IFMK and GeoB, was taken with hydrographic parameters (ICCM) on 05 April. The western-most position on th 29°N section was reached on 07 April (Stat. 147). Next was the LP station (Stat. 148), which is close to a CANIGO mooring with particle traps and current meters operated by GeoB. Without major problems we proceeded northwards along 18°W to Station 153 southwest of Madeira where the eastbound section along 32°25'N began.

On 11 April (Sta. 159), we encountered strong northerly winds (galing up to 9 Beaufort) with high swell which forces us to constrain station work to day-light until 14 April (Stat. 163). We completed the section with station 168. The eastern side of the box was closed with ADCP along approximately the 200 m depth contour until the position of station 122.

Station work finished with a multinet hawl west of Lanzarote that repeated a hawl that had failed at the beginning of the cruise due to closing problems of the net. At this position, also the 12x2 l rosette of the ICCM was tested down to 1100 m.

POSEIDON called port of Las Palmas 17 April, 08:00 lt.

4. Scientific report and first results

4.1 Physical oceanography

T. J. Müller, B. Lenz, U. Koy, W. Hansen

4.1.1 Methods

Hydrographic sections including the sampling of chemical (see Sec. 4.2) and biological (see Sec. 4.3) parameters were carried out along 29° N between the African shelf and La Palma, along 18 °W towards Madiera and back to the African shelf along 32°N. The basic device was a Conductivity-Temperature-Depth (CTD) recording Neil Brown MKIIIB which was operated together with a General Oceanics rosette with 21x10 l Niskin bottles. Attached to the rosette was a 6000 m depth rating self contained (lowered) 150 KHz Acoustic Dopler Current Profiler (lADCP) made by RD Instruments to measure surface to bottom current profiles on station. An ADCP mounted in the ship's moon pool (vADCP) continuously measured current profiles down to ca 300 m. ADCP-measured currents will be converted to of absolute currents using the a 3-dimensional GPS/GLONASS navigational system (ADU-4) made by Ashtec that includes pitch and roll estimates. The eastern side of the above box of sections was closed with the vADCP on a course roughly along the 200 m depth contour off the African shelf.

The CTD had a laboratory calibration for pressure and temperature sensors according to the standards of the World Ocean Circulation Experiment (WOCE). Bottle samples for salinity were taken to check for correct closing of the bottles, and from the mixed layer and from the

deep ocean in low gradient zones (2000 m, 3000 m, 4000 m and 20 m above the bottom) to calibrate *in-situ* conductivity and salinity of the CTD. Salinity measurements were made with a Guildline AUTOSAL 8400 A. After processing, calibration and averaging to 2 dbar intervals, the accuracies of the CTD data are expected to be better than 5 dbar for pressure, better 0.002 mK and better 0.002 in salinity. Preliminary data of potential temperature and salinity sections are described in the following figures.

Processing of lADCP and vADCP data is ongoing.

4.1.2 CTD sections

The CTD-sections show weak upwelling processes near the African shelf within the upper 500 m indicated by coastal uprising of the isotherms and isohalines. Coastal upwelling seems stronger in the northern (32°N) section (Fig. 4.1.1, 4.1.2) than in the southern (29°N) section (Fig. 4.1.5, 4.1.6). Associated with the sloping istherms and isohalines close to the shelf break, is the Canary Current. It is confined near to the surface.

The seasonal thermocline is developing with mixed layer temperatures up to 18 to 20°C in the open ocean. Neither the northern section (Fig. 4.1.1, 4.1.2) nor the western section (Fig. 4.1.3, 4.1.4) show a clear signal of thermocline water flowing into the box far offshore. This means that the Azores Current has no southward branch just east or south of Madeira.

Two prnounced intermediate waters are present. Firstly, associated with the coastal upwelling is a poleward undercurrent that carries low saline water with rudiments of low saline Antarctic Intermediate Water (AAIW) northwards (less 35.5 at 700 to 1000 dbar at 29°N, Fig. 4.1.6; less 35.8 at the same depth level at 32 °N, Fig. 4.1.2; see also sect. 4.2.2 for oxygen and silicate distribution). In a composite TS-diagramme of typical stations from all three stations (Fig. 4.1.7), it shows up with a salinity minimum at about 7 °C with more saline water below. This station is from the channel between Lanzarote and the African shelf at 29 °N (Fig. 4.1.2). Note that the AAIW is rich in nitrate (and silicate) and low in oxygen (see sec. 4.2 for these quantities along 29° N).

The second intermediate water is warm and saline and origins from the Mediterranean outflow (MW). It has its core between 1000 dbar and 1200 dbar, is deepening and becoming less saline towards the south. Two Meddies are observed, one at about 32°N, 15°W (Fig. 4.1.6) with core salinity higher than 36.6, and a weaker one at 31°N, 18°W (Fig. 4.1.4) with core salinity higher than 36. The first one is most prominent in the TS-diagramme (Fig. 4.1.7).

Below the MW, the TS-curves show the characteristics of North Atlantic Deep Water (NADW). Further analysis will include the ADCP measurements to derive estimates of absolute geostrophic currents and water mass and transport balances.

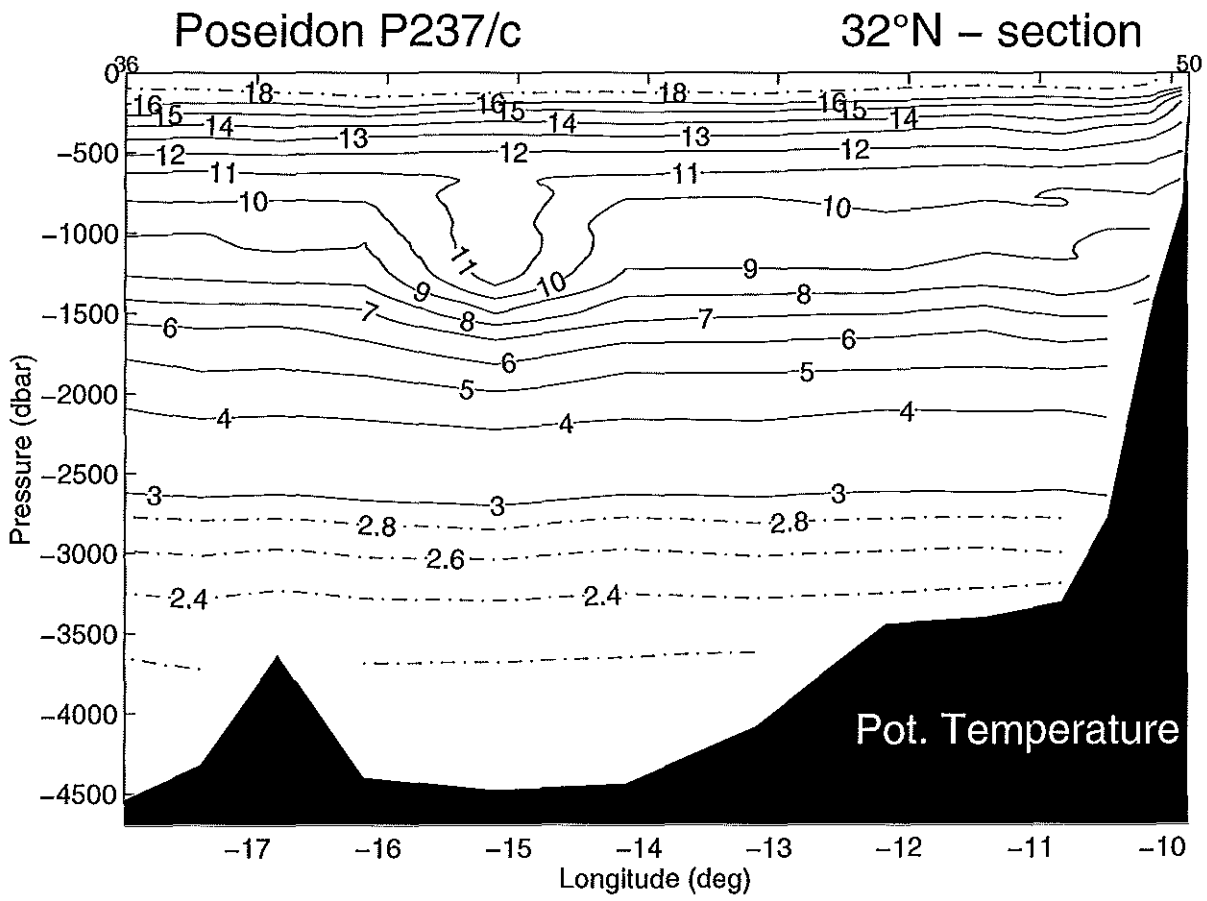


Fig. 4.1.1 Potential temperature (°C) along 32.25°N

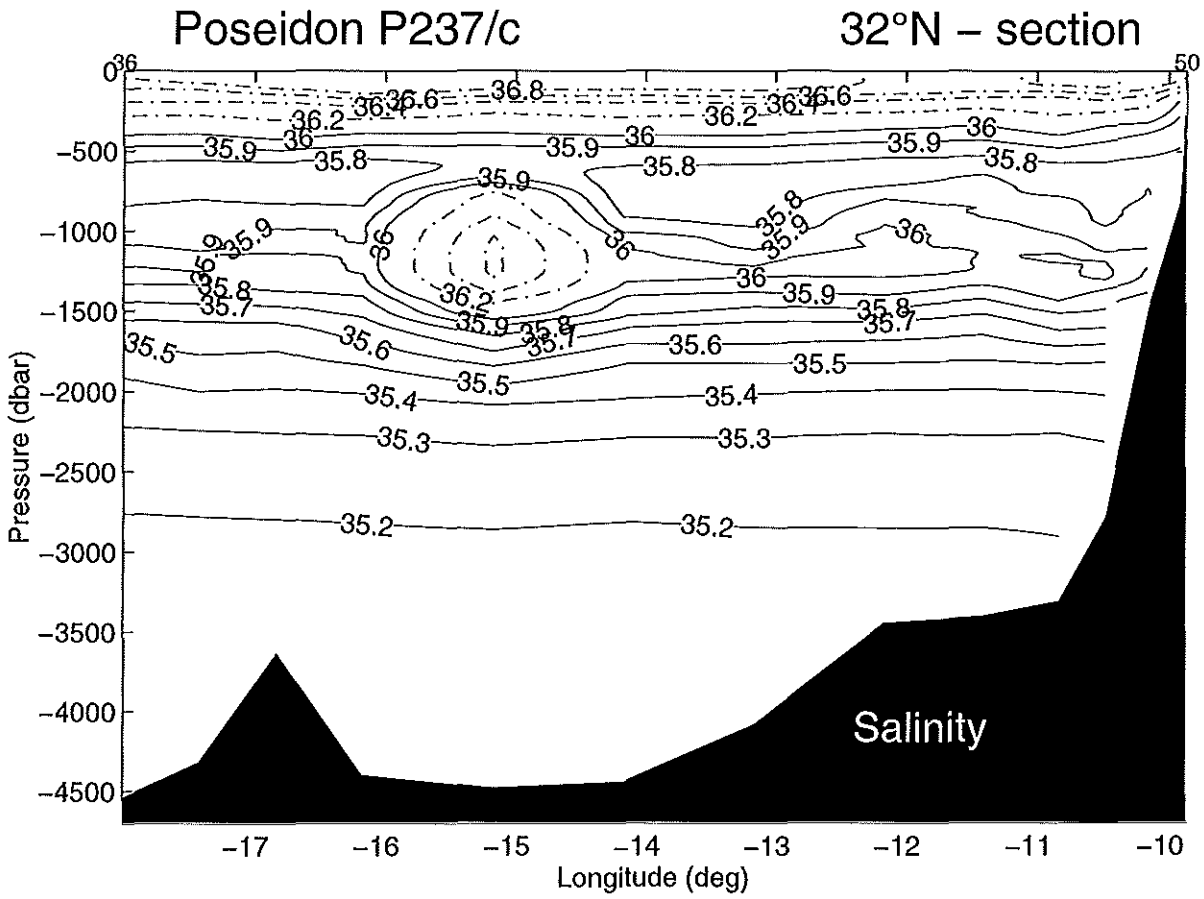


Fig. 4.1.2 Salinity along 32.25°N

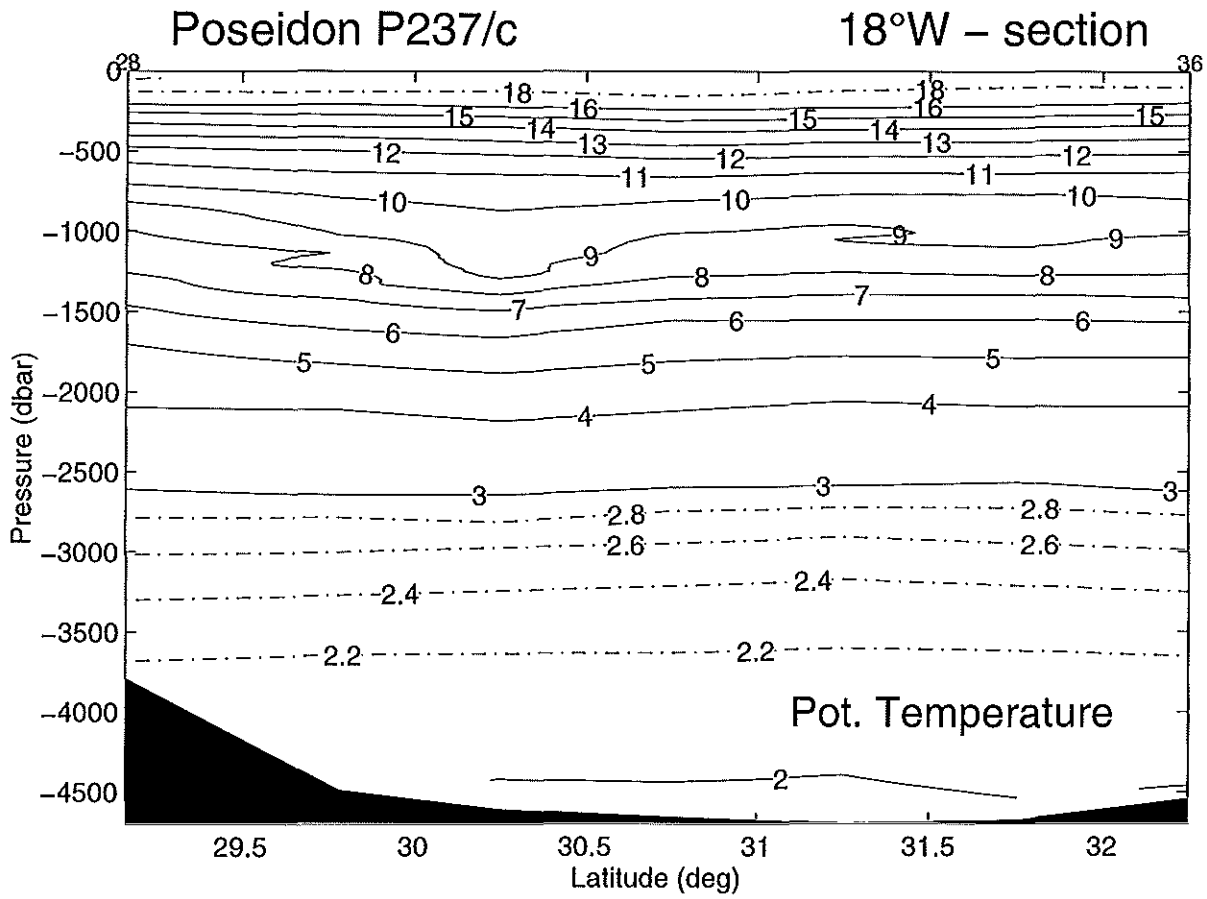


Fig. 4.1.3 Potential temperature (°C) along 18° W

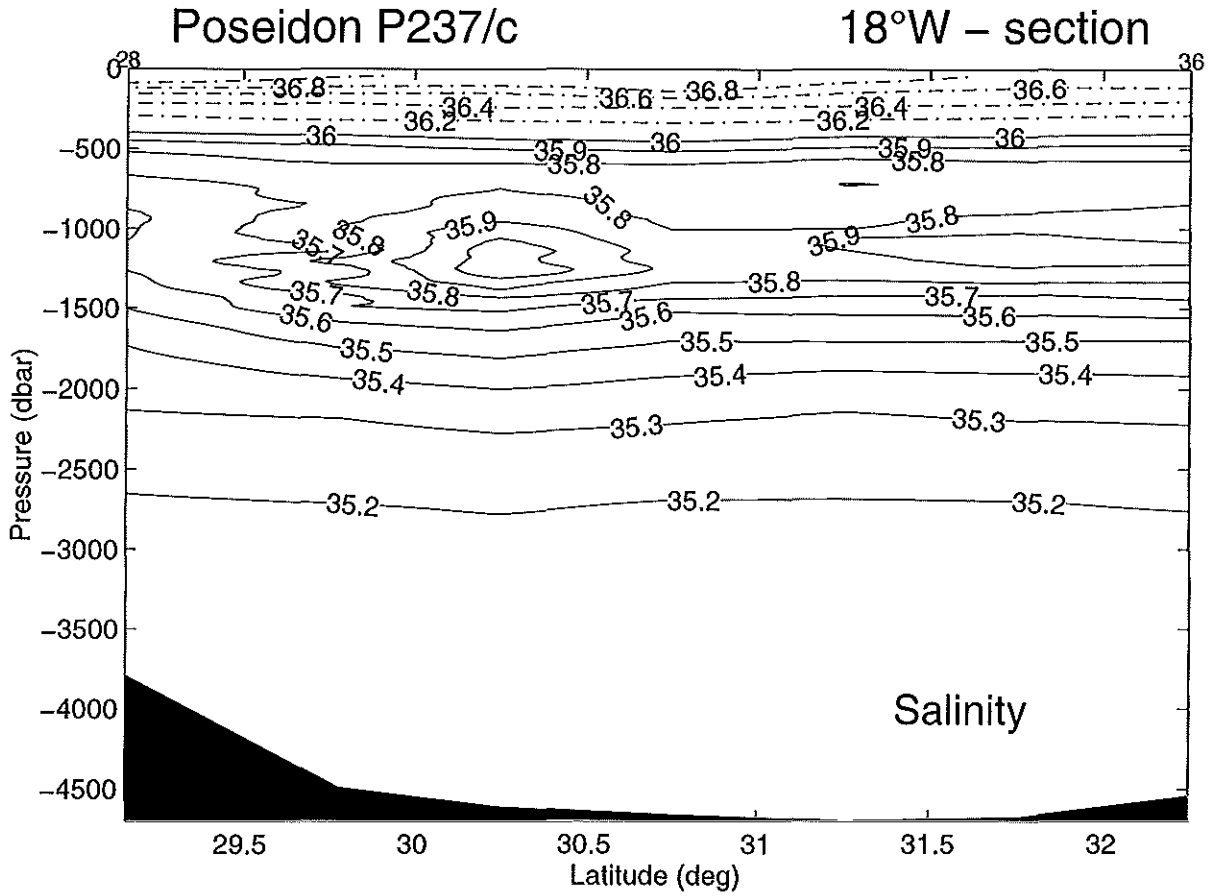


Fig. 4.1.4 Salinity along 18° W

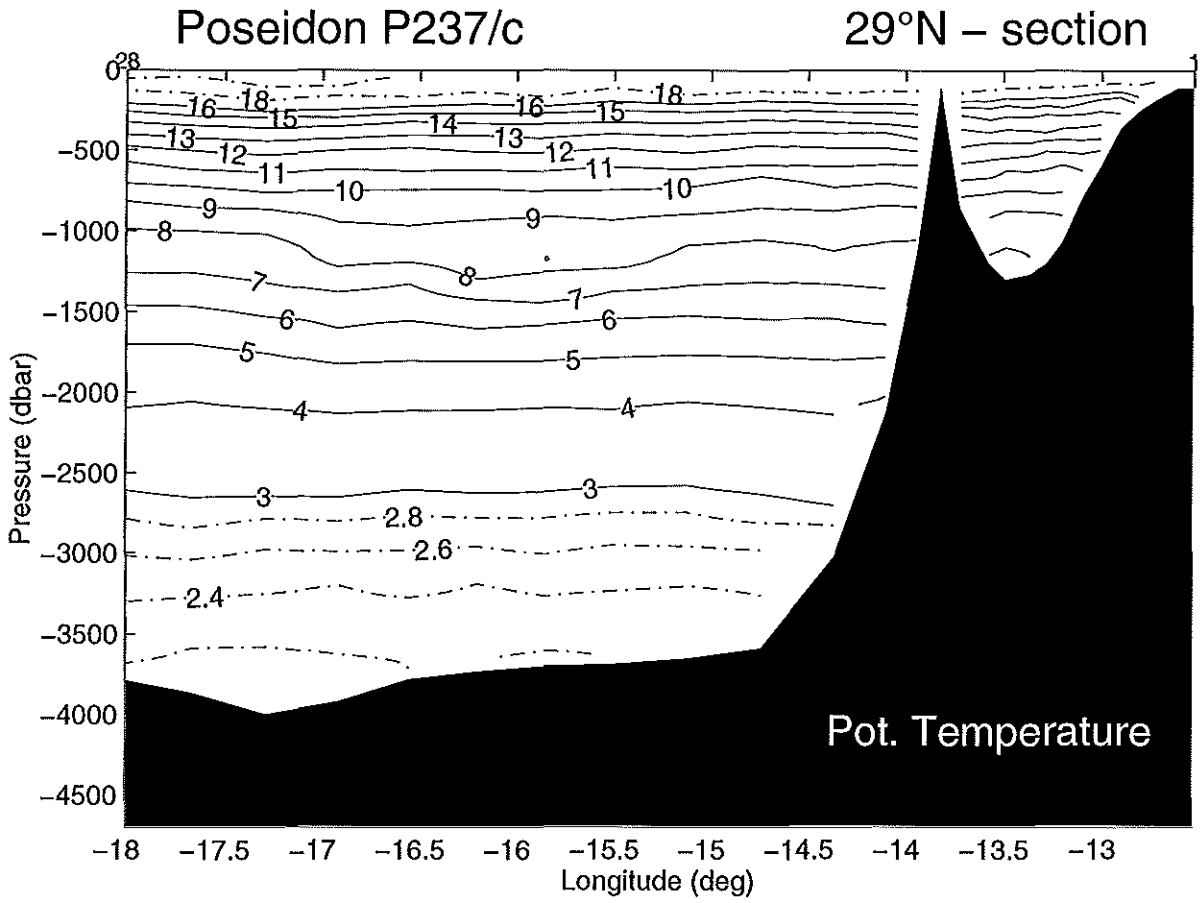


Fig. 4.1.5 Potential temperature (°C) along 29° N

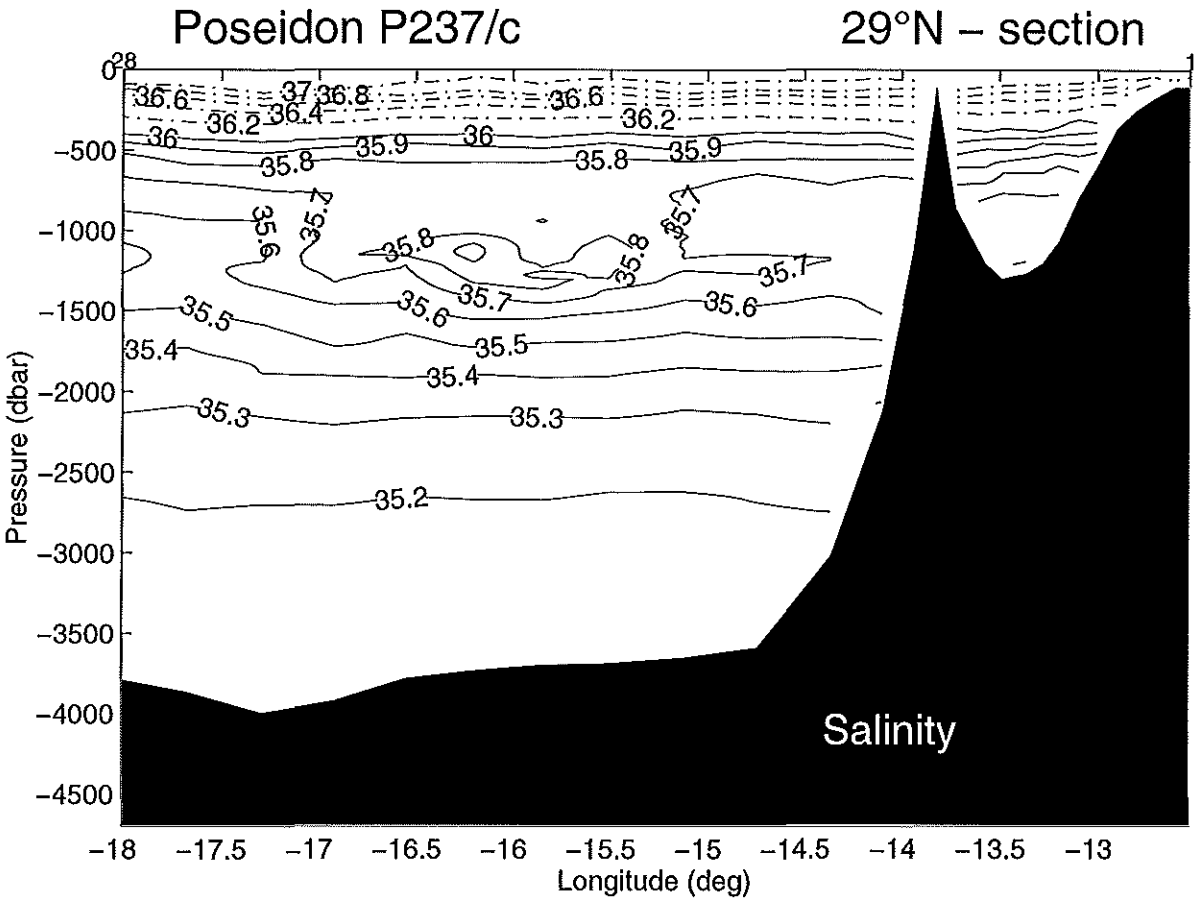


Fig. 4.1.6 Salinity along 29° N

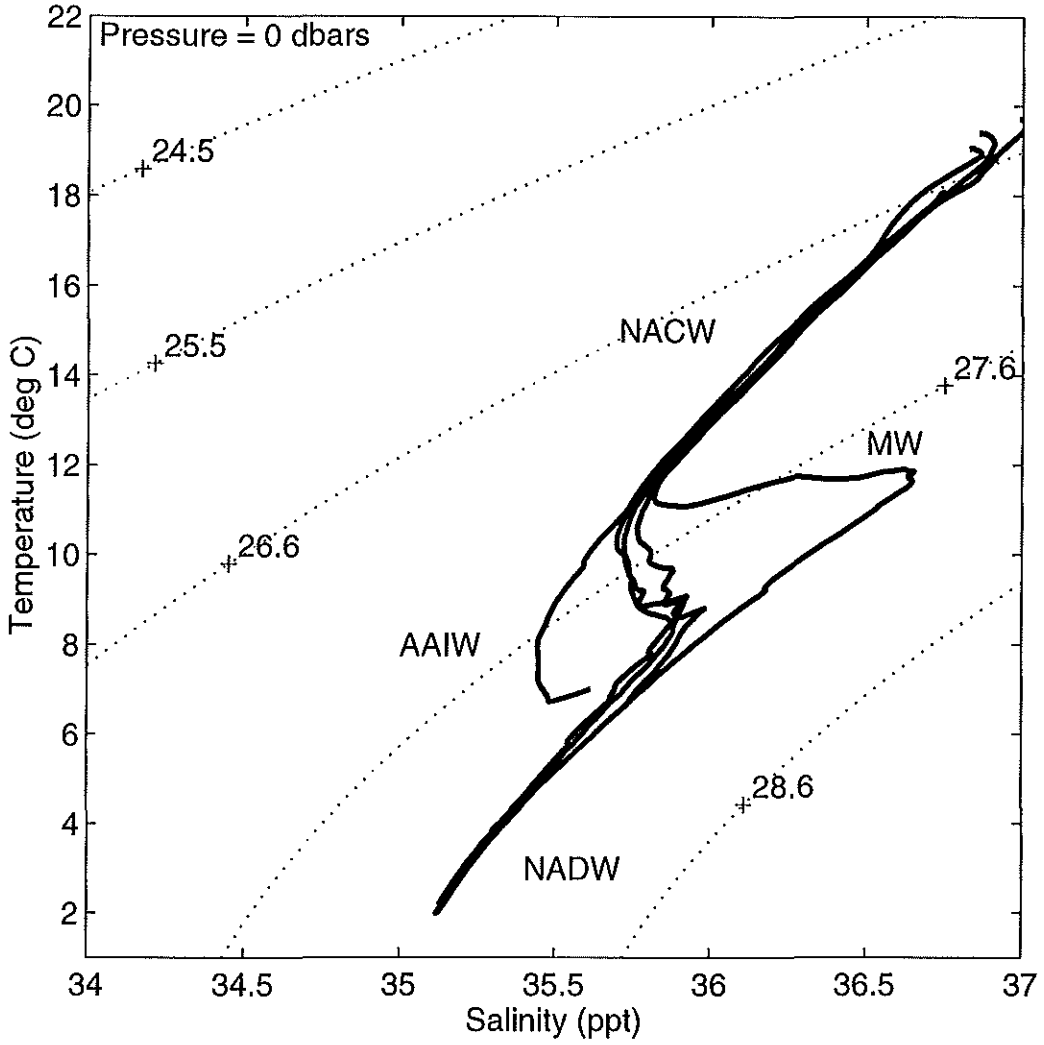


Fig. 4.1.7 Typical TS-characteristics from the three sections. See text for details.

4.2 Chemical oceanography

A. Cianca, J. Godoy, M. Villagarcia, J. Pou

4.2.1 Sampling and methods

Sampling

At each station and for each depth (except chlorophyll that is only sampled from 200 m to the surface), water samples were taken from 10 l Niskin bottles of the CTD/rosette to analyse oxygen, nutrients and chlorophyll "a". Samples were collected immediately after the bottles were on board from each depth. The sampling sequence was as follows:

- Oxygen was fixed first, then kept for further analysis at the laboratory.
- Nutrient samples were frozen immediately at -20°C for post-cruise analysis at the ICCM laboratory
- Chlorophyll samples were taken in polypropilene bottles filtering 0.5 litres inmediatelly, and the filters were frozen subsequently at -20°C for post-analysis at the ICCM laboratory

All samples were taken using the procedures established in the WOCE Operations Manual, WHP Office Report WHPO 91-1/WOCE Report No.68/91.

Dissolved Oxygen
The samples were analysed on board using the method described in the WOCE Operations Manual, WHP Office Report No. 68/91; bottles with 125 ml volume were used and the final titration point was detected using a Metrohm 665 Dosimat Oxygen Auto-Titrator Analyser. Conversion of volume units to mass units is done using the sample's potential temperature.

Nutrients
Nutrients were taken in polypropylene bottles which were previously cleaned and washed with HCl acid and were completely dry, according to the instructions of the following manuals: WOCE Operations Manual. WHP Office Report WHPI 91.1., WOCE Report No.68/91. Samples were immediately frozen at -20°C, analysing them as soon as possible after arrival at the laboratory. Freezing the samples is a common practice. It does not or only in a non-significant way affect the nitrate+nitrite and the phosphate values (by a slight decrease) and is not noticeable in the silicate values (KREMLING AND WENCK,1986; MCDONALD AND MCLUNGHLIN, 1982).
The nutrient determination were performed with a segmented continuous-flow autoanalyser, a Skalar® San Plus System (ICCM). Conversion of volume units to mass units is done using laboratory temperature.

Nitrate+Nitrite
The automated procedure for the determination of nitrate and nitrite is based on the cadmium reduction method; the sample is passed through a column containing granulated copper-cadmium to reduce the nitrate to nitrite (WOOD ET AL.,1967), using ammonium chloride as pH controller and complexer of the cadmium cations formed (STRICKLAND and PARSONS, 1972). The optimal column preparation conditions are described by several authors (e.g. NYDAHL, 1976; GARSIDE, 1993).

Phosphate
Orthophosphate concentration is understood as the concentration of reactive phosphate (RILEY AND SKIRPOW,1975). According to KOROLEFF (1983a), it is a synonym of "dissolved inorganic phosphate". The automated procedure for the determination of phosphate is based on the following reaction: ammonium molybdate and potassium antimony tartrate react in an acidic medium with diluted solution of phosphate to form an antimony-phospho-molybdate complex. This complex is reduced to an intensely blue-coloured complex, ascorbic acid. The complex is measured at 880nm. The basic methodology for this anion determination is given by MURPHY and RILEY (1962); the used methodology is the one adapted by STRICKLAND AND PARSONS (1972).

Silicate
The determination of the soluble silicon compounds in natural waters is based on the formation of the yellow coloured silicomolybdic acid; the sample is acidified and mixed with an ammonium molybdate solution forming molybdosilicic acid. This acid is reduced with ascorbic acid to a blue dye, which is measured at 810nm. Oxalic acid is added to avoid phosphate interference. The used method is described in KOROLEFF (1983b).

Phytoplankton pigments

Pigments were measured on board using fluorimetric analysis, following the methodology described by WELSCHMEYER (1994). The determination was achieved using a fluorometer TURNER 10-AU-000.

4.2.2 Preliminary results

The preliminary results of the nutrients and oxygen determination obtained from this cruise for the 29°N section (Fig. 4.2.1, 4.2.2, 4.2.3 below for oxygen, nitrate+nitrite and silicates, respectively) show the presence of Antarctic Intermediate Water (AAIW) very well pronounced by the maxima of nitrate+nitrite and the oxygen minimum close to the shelf break. The core of oxygen minimum is present along the whole section at about 700 dbar to 900 dbar, deepening to the west. It coincides with a maximum of nitrate+nitrie. On the other hand, it lies well above the core of the salinity maximum (1100 dbar to 1200 dbar; see Fig. 4.1.2) which coincides with a weak gradient in silicate (ca. 16 µmol/l). More detailed analysis will show if rudiments of AAIW are present along the whole section.

The signal of the Labrador Water (LW) found in earlier cruises does not appear this time. One may speculate that the North-South transport of LW has weakened.

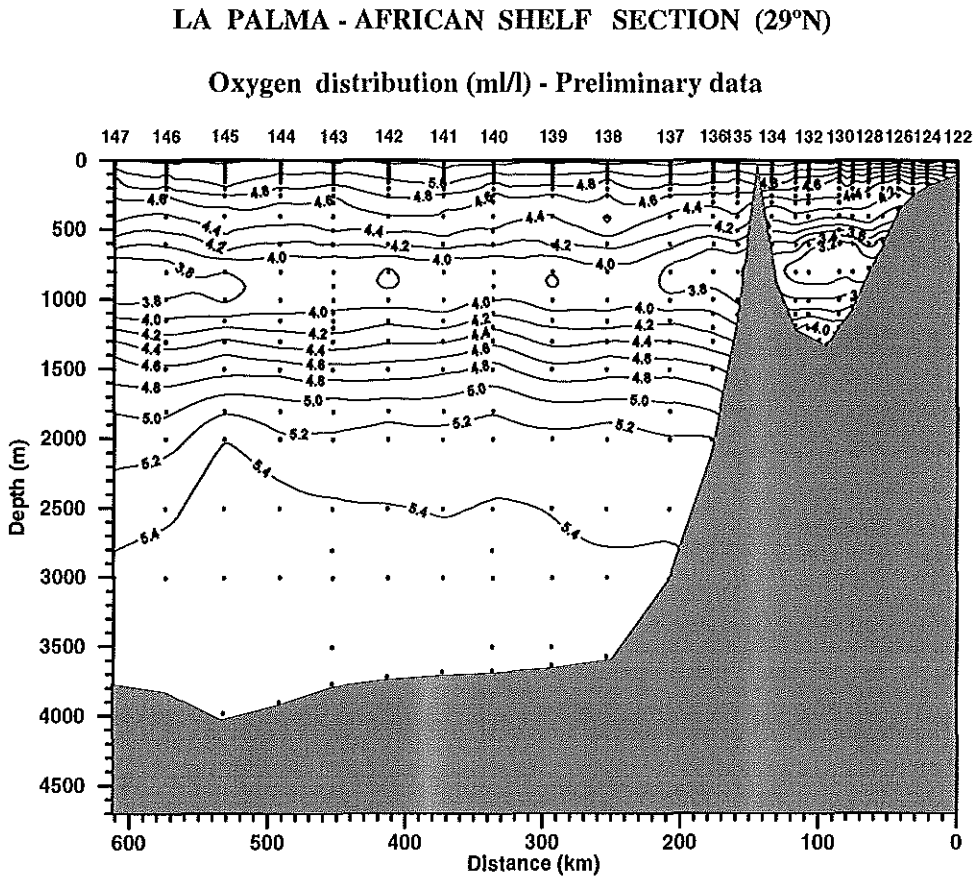


Figure 4.2.1 Dissolved oxygen along 29°N

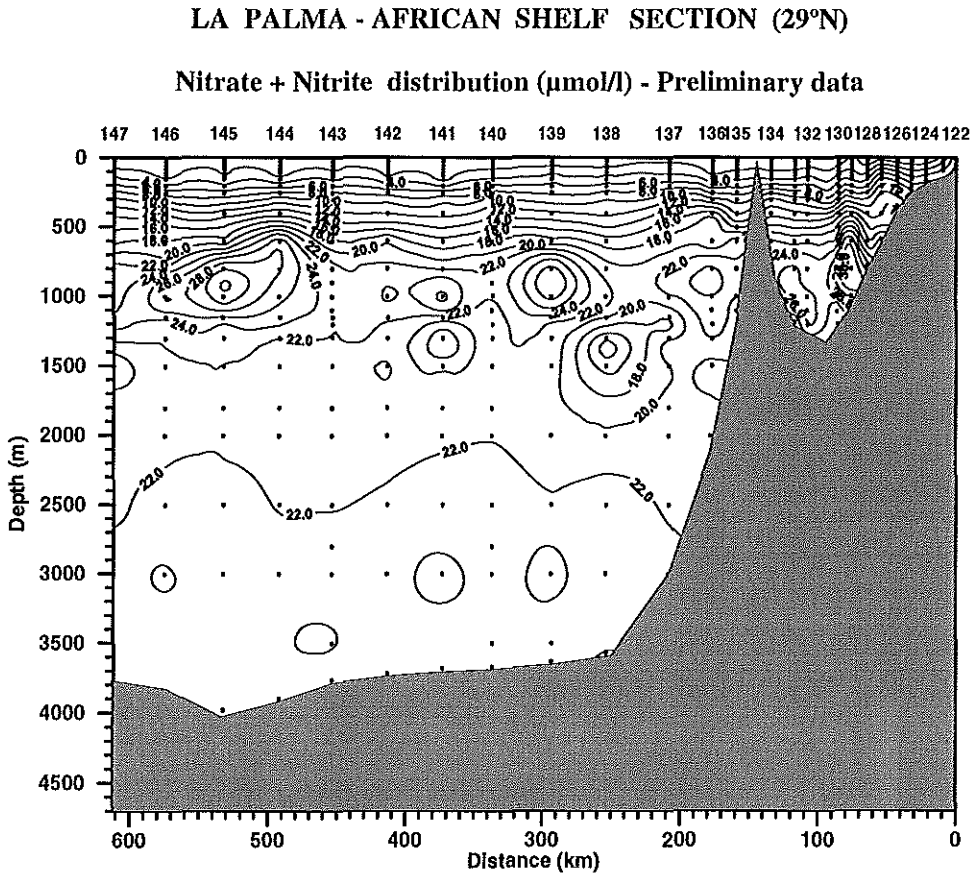


Figure 4.2.2 Nitrate/nitrite along 29°N

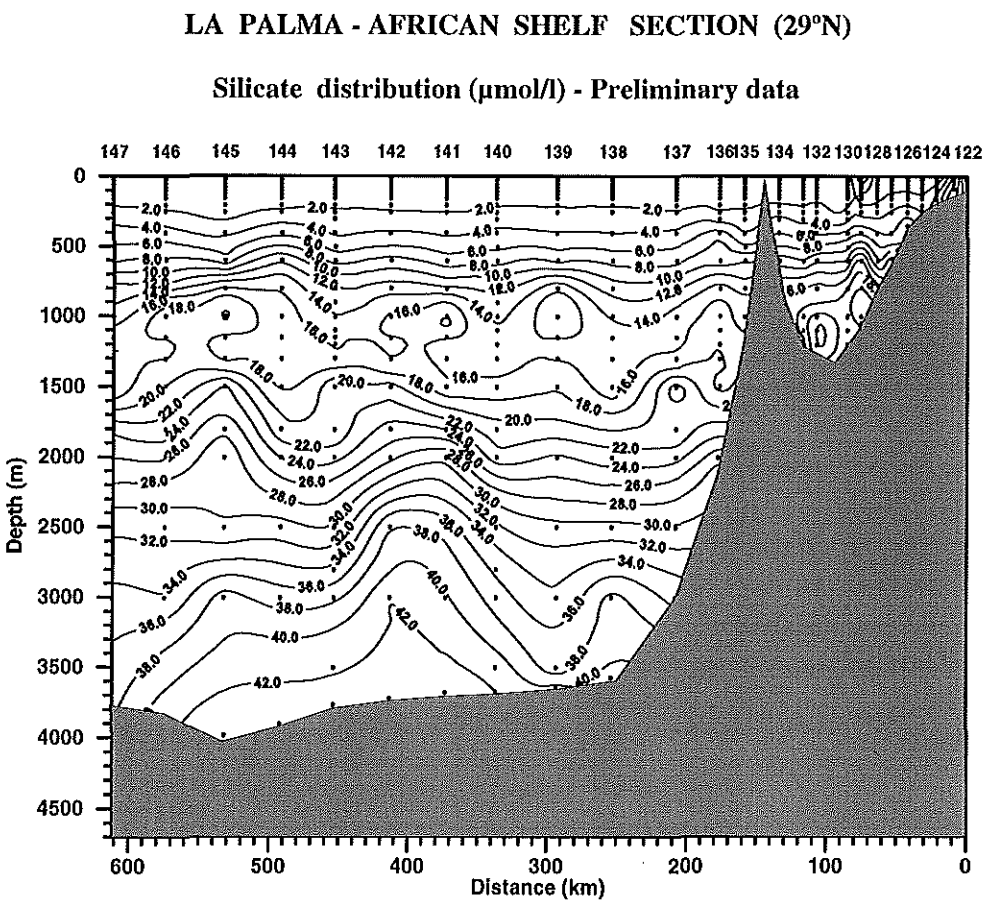


Figure 4.2.3: Silicate along 29°N

4.2.3 References

DETERMAN, S., R. REUTER, P. WAGNER AND R. WILLKOMM (1994): Fluorescent matter in the eastern Atlantic Ocean. Part 1: method of measurement and near-surface distribution. Deep-Dea Research I, 41 (4), 659-675.

DETERMAN, S., R. REUTER AND R. WILLKOMM (1996): Fluorescent matter in the eastern Atlantic Ocean. Part 2: vertical profiles and relation to water masses. Deep-Dea Research I, 43 (3), 345-360.

KOROLEFF, F. (1983b): Determination of dissolved inorganic silicate. In Methods of Seawater Analysis. K. Grasshoff, A. Ehrhardt and K. Kremling (eds), Verlag Chemie, 175-180.

KREMLING, K. AND A. WENCK (1986): On the storage of dissolved inorganic phosphate, nitrate and reactive silicate in Atlantic Ocean water samples. Kieler Meeresforsch, 31, 69-74.

MCDONALD, R.W. AND F.A. MCLAUGHLIN (1982): The effect of starege by freeging of disolute inorganic phosphate, nitrate and reactive silicate for samples from coastal and internal water. Water Research, 16, 95-104.

MURPHY, J. AND J.P. RILEY (1962): A modified single solution method for the determination of phosphate in natural waters. Anal. Chim. Acta, 27, 31-36.

RILEY, J.P. AND J.P. SKIRROW (1975): The Micronutrient Element. Chemical Oceanography, 2, 245-297.

STRICKLAND, J.D.H AND PARSONS (1972): A practical handbook of seawater analysis. Fisheries Research Board of Canada, 167 pp.

UNESCO (1984): La escala de salinidades practicas de 1978 y la ecuacion internacional de estado del agua de mar de 1980. Documentos tecnicos de la Unesco sobre Ciencias del Mar, no. 36.

WELSCHMEYER, N.A. (1994): Fluorimetric Analysis of Chlorophyll a in presence of Chlorophyll b and Phaeopigments. Limnol. Oceanog. 39 (8), 1985-1992.

WOCE OPERATIONS MANUAL (1994): WHP office report. WHP-O 91.1. WOCE report no. 68/91.

WOODS, E.D., F.A.J. ARMSTRONG AND F.A. RICHARDS (1967): Determination of nitrate in seawater by cadmium-cooper reduction to nitrate. J. Mar. Biol. Ass. U.K., 47, 31-43.

4.3 Plankton Observations on the hydrographic box

J. Bollmann and M. Y. Cortés

4.3.1 Coccolithophores

Sampling

During POSEIDON cruise 237/3 water casts of 10 litres were taken at 38 stations at the following levels: 0, 10, 25, 50, 75, 100, 125, 150, 200, 250, 300 meters. 19 stations were sampled along a zonal transect from the African coast to La Palma, 5 stations were sampled during the meridional transect from La Palma to Madeira and 14 stations during the zonal transect from Madeira towards the African coast.

Up to 8 l of water were transferred from the Niskin bottles for each depth level into the carboys after rinsing the carboys with tap water. Within one hour the water was filtered onboard through Nucleopore PC filters (0.8µm, 47 mm diameter) using a low-vacuum filtration device. Filtration was terminated if the filter became clogged and the volume of remaining water was measured.

After filtration, the filters were rinsed with 50ml buffered distilled water (NH_4OH, PH8.5) in order to eliminate all traces of sea salt. Rinsed filters were transferred to labelled petri-dishes, dried immediately in an oven at 40°C.

Ongoing analysis
In subsequent analyses, a Scanning Electron Microscope cell density (#/l) will be used, and the taxonomic composition of the coccolithophore populations will be determined. In addition, morphological features of *Gephyrocapsa* sp. and *Calcidiscus leptoporus* will be analysed..

4.3.2 Diatomes
Sampling
During the cruise, water casts of 10 litres were taken at 11 stations along 29 °N section from La Palma to the African coast. The the following depth levels were sampled: 0, 10, 25, 50, 75, 100, 125, 150, 200, 250, 300 m. 300 ml water were transferred from Niskin bottles into plastic bottles with 30 ml of Formol and Hexamathyl-Tetramine.

Ongoing analyses
In subsequent analyses a light microscope and if necessary a Scanning Electron Microscope (SEM) will be used to determine the diatom standing stock and its assemblage composition.

4.3.3 Planktic foraminifera
Sampling
Planktic foraminifera were collected with a multi-closing-net (mesh size 64µm) at five depth intervals (500-300, 300-150, 150-50, 50-25, 25-0) at 7 stations along the 29 ° N section including the three mooring stations LP1, ESTOC and EBC2. The multinet-samples were preserved on board with a saturated solution of $HgCl_2$ and stained with Bengalrosa. In addition sea water was taken at the base of each net-interval for stable isotope analyses ($\delta^{18}O$- and $\delta^{13}C$). These samples were preserved with $HgCl_2$ and the glass bottles were sealed with Paraffin to prevent the oxidation of organic matter. All samples were stored at 4° C in a refrigerator

Ongoing analysis
In future analyses, the assemblage composition of foraminifera will be determined. Stable isotopes of selected foraminifera species as well as the stable isotope composition of sea water will be analysed.

4.4 Drifting particle trap
A drifting particle trap (Fig. 4.4.1) to determine particulate carbon flux that originates directly from the euphotic zone was deployed during leg P237/2 and recovered at the beginning this leg on 02.04.1998. For drifting track and scientific results see the cruise report of 237/2.

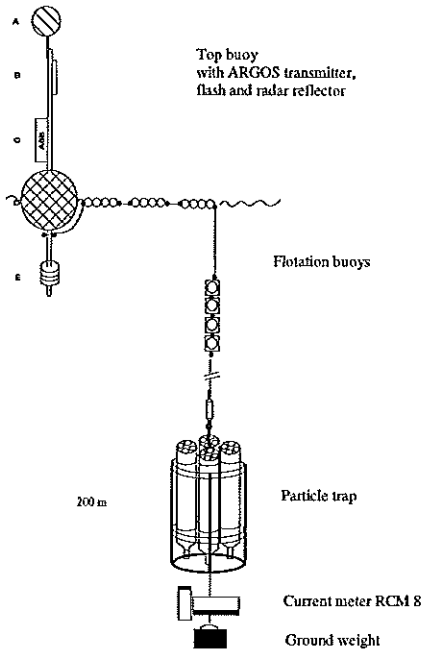


Fig. 4.4.1 Drifting particle trap at 200 m tethered to to the surface. Trap drifting from 30.03 to 02.04.1998 north of Gran Canaria. Track and scientific results see cruise report of P237/2.

5. Scientific equipment, instruments and moorings

- CTD Neil Brown Mk.IIIB (IFMK code NB4) equipped with a polarographic oxygen sensor (Beckman) and an in-situ flourometer (down to 3000 m only, Haardt)
- Lowered Acoustic Doppler Current Profiler (RDI 150 kHz), full depth
- GO-rosette including 21x10 l Niskin bottles
- vessel-mounted Acoustic Doppler Current Profiler (RDI 150 kHz)
- multinet
- salinometer (Autosal Guildline)
- Metrohm 682 Titroprocessor
- Laboratory fluorometer
- Drifting particle trap, 200 m depth, 30.03. - 02.04.1998

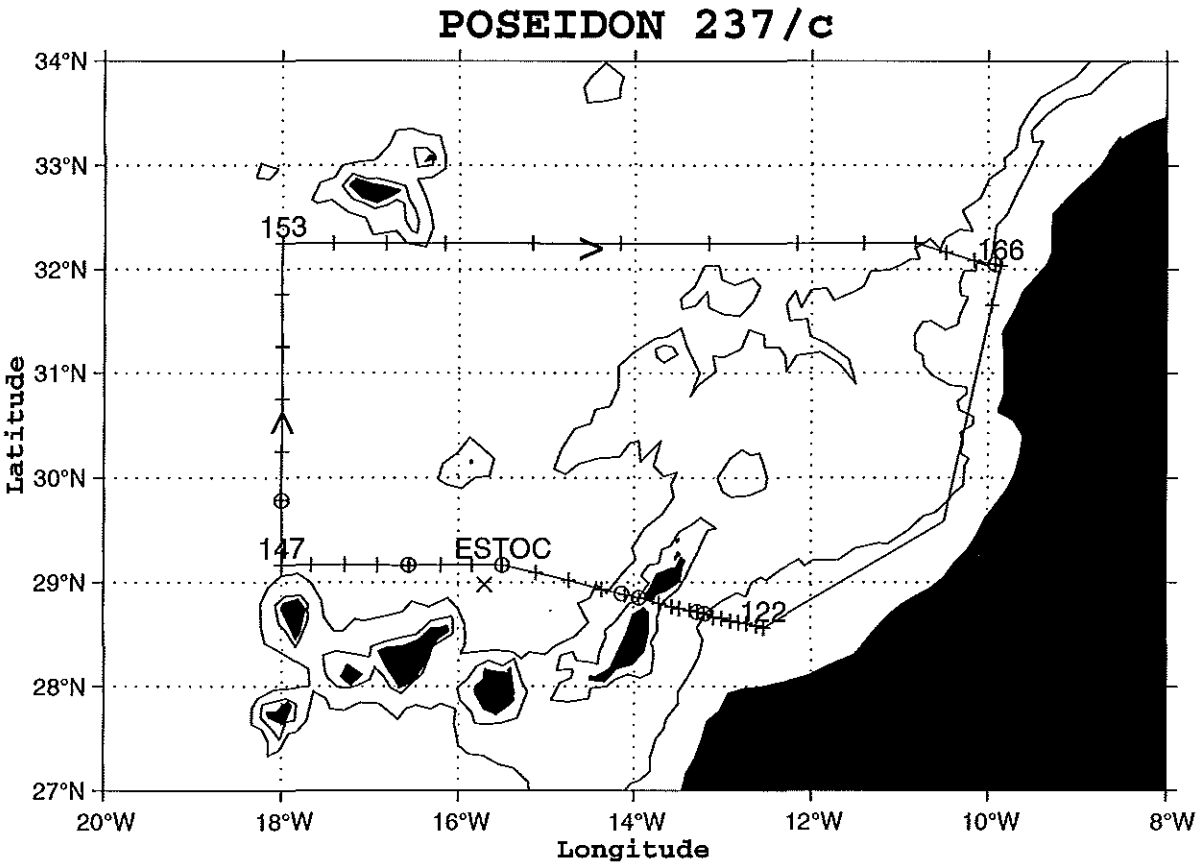
6. Additional Remarks

We want to thank the crew of POSEIDON with captain Matthias Gross for their excellent help in gathering this data set.

Problems occurred with the GO-rosette, which on station 138 stuck below the vessel while lifting the rosette on board so that 8 Niskin bottles broke.

7. Appendix

Appendix A



Cruise track and stations during P237/1: CTD (+), multinet (o), recovery of drifting trap (x). Moorings at LP, ESTOC and ECC had been deployed in September 1997 and were in site during this cruise.

Appendix C.
Table C1: Station List P237/3

POSEIDON 237/3 station and sample log
Status: 04 June 1998, including corrections given by Marimar (email 04 June)

List of abbreviations:

St : Station no.
Pr : CTD profile no., monotonically increasing during the cruise
Wd : Water Depth
Instr : Type of instrumentation or mooring or equipment
DTRAP: Drifting sediment traps
MN : Multiple closing plankton net
NBX : Neil Brown CTD probe no X with 21x10 l bottle rosette

Additional sensors on and samples taken from CTD/rosette:

1 F Fluorometer attached to CTD
2 A lowered ADCP (lADCP) profile taken, ADCP attached to CTD/rosette
3 C selfcontained CTD of ICCM attached to rosette
4 O oxygen
5 N nutrients
6 C chlorophyll
7 S salt
8 C coccolithophores
9 D diatomes
10 I stable isotopes

Date 1998 UTC MMDD	Time UTC hhmm	St	Pr	Latitude North GG MM.MM	Longitude West GGG MM.MM	Wd [m]	Inst	Parameter no 1 2 3 4 5 6 7 8 9 10 F A C O N C S C D I 0 not sampled 1 sampled
0402	1530							Sail from Las Palmas, begin of P237/3
0402	2112	120	-9	28 58.74	015 42.02	3610	DTRAP	Drifting sediment trap GeoB recovered
0403	1000	121	-9	28 44.52	013 25.99	1311	NB4	Test Station
0403	1705	122	1	28 33.99	012 31.93	98	NB4	1 0 1 0 1 1 1 1 1 0
0403	1817	123	2	28 35.07	012 36.95	99	NB4	1 0 1 1 1 1 1 0 0 0
0403	2013	124	3	28 36.55	012 43.49	175	NB4	1 0 1 1 1 1 1 0 0 0
0403	2104	125	4	28 37.06	012 48.88	246	NB4	1 0 1 1 1 1 1 1 1 0
0403	2248	126	5	28 37.91	012 54.36	357	NB4	1 0 0 1 1 1 1 0 0 0
0404	0108	127	6	28 39.51	013 00.46	588	NB4	1 1 0 1 1 1 1 1 0 0
0404	0315	128	7	28 40.02	013 05.82	784	NB4	1 1 0 1 1 1 1 0 0 0
0404	0533	129	8	28 42.14	013 11.97	1053	NB4	1 1 0 1 1 1 1 1 1 1
0404	0657	129	-9	28 42.1	013 11.6	1050	MN	500 m
0404	0841	130	9	28 43.16	013 17.02	999	NB4	1 1 0 1 1 1 1 1 1 1
0404	0955	130	-9	28 43.0	013 16.8	1010	MN	500 m
0404	1135	131	10	28 43.97	013 21.94	1233	NB4	1 1 0 1 1 1 1 1 0 0
0404	1455	132	11	28 45.05	013 29.10	1279	NB4	1 1 0 1 1 1 1 0 0 0
0404	1705	133	12	28 46.06	013 34.00	1185	NB4	1 1 0 1 1 1 1 1 1 0
0404	1930	134	13	28 48.05	013 42.98	846	NB4	1 1 0 1 1 1 1 0 0 0
0404	2213	135	-9	28 51.0	013 56.0	978	MN	500 m
0404	2328	135	14	28 51.28	013 56.49	1115	NB4	1 1 0 1 1 1 1 1 1 1
0405	0217	136	15	28 52.99	014 06.12	2082	NB4	1 1 0 1 1 1 1 1 0 0
0405	0600	137	16	28 56.01	014 22.00	2966	NB4	0 1 0 1 1 1 1 1 0 0
0405	1040	138	17	29 01.29	014 44.60	3513	NB4	0 1 0 1 1 1 1 1 1 0
0405	1705	139	18	29 05.63	015 07.01	3577	NB4	0 1 0 1 1 1 1 1 0 0
0405	2215	140	19	29 09.98	015 30.10	3609	NB4	1 0 0 1 1 1 1 1 1 1
0405	0010	140	-9	29 09.54	015 29.42	3608	MN	500 m
0406	0155	140	20	29 10.00	015 30.57	3609	NB4	0 1 0 1 1 0 1 0 0 0
0406	0650	141	21	29 10.05	015 50.08	3623	NB4	0 1 0 1 1 1 1 0 0 0
0406	1150	142	22	29 10.00	016 12.04	3653	NB4	0 1 0 1 1 1 1 1 0 0
0406	1913	143	23	29 10.03	016 33.93	3701	NB4	0 0 0 1 1 1 1 1 1 1
0406	2018	143	-9	29 09.8	016 33.1	3702	MN	500 m
0406	2155	143	24	29 09.54	016 33.07	3702	NB4	0 1 0 1 1 0 1 0 0 0
0407	0314	144	25	29 10.00	016 55.00	3833	NB4	0 1 0 1 1 1 1 0 0 0
0407	0820	145	26	29 10.17	017 17.12	3913	NB4	0 0 0 1 1 1 1 1 0 0
0407	1320	146	27	29 09.99	017 39.98	3739	NB4	0 1 0 1 1 1 1 1 0 0
0407	1718	147	28	29 10.00	018 00.00	3690	NB4	0 1 0 1 1 1 1 0 0 0
0408	0108	148	29	29 47.02	018 00.03	4368	NB4	0 1 0 1 1 1 1 1 1 1
0408	1213	148	-9	29 47.11	018 00.0	4367	MN	500 m
0408	0340	148	30	29 47.28	018 00.71	4368	NB4	0 1 0 1 1 0 1 0 0 0
0408	0925	149	31	30 14.99	018 00.09	4486	NB4	0 1 0 1 1 1 1 0 0 0
0408	1620	150	32	30 44.94	018 00.00	4536	NB4	0 1 0 1 1 1 1 1 0 0
0408	2355	151	33	31 14.98	017 59.93	4573	NB4	0 1 0 1 1 1 1 1 0 0
0409	0136	151	-9	31 14.75	017 59.2	4574	ICCM	Rosette, test 600 m
0409	0240	151	34	31 15.31	017 59.85	4574	NB4	0 1 0 1 1 0 1 0 0 0
0409	0941	152	-9	31 44.95	018 00.01	4550		no data, CTD down cast failure
0409	1405	152	35	31 45.56	018 00.58	4551	NB4	0 1 0 1 1 1 1 1 0 0
0409	2045	153	36	32 14.97	017 59.94	4422	NB4	0 1 0 1 1 1 1 1 0 0
0410	0327	154	37	32 14.96	017 25.51	4219	NB4	0 1 0 1 1 1 1 1 0 0
0410	0956	155	38	32 15.05	016 49.95	3561	NB4	0 1 0 1 1 1 1 1 0 0
0410	1615	156	39	32 15.05	016 10.05	4297	NB4	0 1 0 1 1 1 1 1 0 0
0411	0110	157	40	32 15.08	015 10.22	4358	NB4	0 1 0 1 1 0 1 0 0 0
0411	0552	157	41	32 15.06	015 09.89	4355	NB4	0 0 0 1 1 1 1 1 0 0
0411	1148	158	42	32 15.02	014 10.07	4330	NB4	0 1 0 1 1 1 1 1 0 0
0411	2025	159	43	32 15.03	013 09.91	3995	NB4	0 1 0 1 1 1 1 1 0 0
0412	1420	160	44	32 14.90	012 10.01	3379	NB4	0 1 0 1 1 1 1 1 0 0
0413	0737	161	45	32 14.95	011 24.91	3255	NB4	0 1 0 1 1 1 1 1 0 0
0413	1500	162	46	32 15.11	010 50.07	3242	NB4	0 1 0 1 1 1 1 1 0 0
0414	0554	163	47	32 09.96	010 29.03	2740	NB4	1 1 0 1 1 1 1 1 0 0
0414	1007	164	48	32 05.12	010 09.90	1458	NB4	1 1 0 1 1 1 1 1 0 0
0414	1318	165	49	32 02.94	009 55.29	831	NB4	1 1 0 1 1 1 1 1 1 0

Date 1998 UTC MMDD	Time UTC hhmm	St	Pr	Latitude North GG MM.MM	Longitude West GGG MM.MM	Wd [m]	Inst	Parameter no 1 2 3 4 5 6 7 8 9 10 F A C O N C S C D I (0 not sampled, 1 sampled)
0414	1421	165	-9	32 02.71	009 55.0	640	MN	500 m
0414	1547	166	50	32 02.01	009 52.09	114	NB4	1 0 0 1 1 1 1 1 0 0
0414	1817	168	51	31 59.19	009 57.73	94	NB4	1 0 0 1 1 1 1 1 0 0
0416	0500	170	-9	28 53.6	014 08.2	2161	MN	500 m
0416	0612	170	-9	28 54.0	014 08.9	2189	ICCM	Rosette, test 1100 m
0417	0800							Call port of Las Palmas, end of P237/3

Table C2: Sampling Levels for Each Station P237/3

P237/3: Sampling Levels for Each Station

(Status 04 June 1998, including corrections given by Marimar, email 04 June 1998)

Samples: O (oxygen), N (nutrients), Cl (chlorophyll), S (salinity), Co (Coccolithophorids), D (diatoms), I (stable isotopes), - no bottle closed at that level, * bottle failed closing

Station / Profile										
Pres. (dbar)	**121 Test**	**122 1**	**123 2**	**124 3**	**125 4**	**126 5**	**127 6**	**128 7**	**129 8**	**130 9**
bucket		Co D			Co D		Co		Co D I	Co D I
10	S	O N Cl S Co D	N Cl S	O N Cl S	O N Cl S Co D	O N Cl S	O N Cl S Co	O N Cl S	O N Cl S Co D	O N Cl S Co D
25		O N Cl Co D	N Cl S	O N Cl	O N Cl S Co D	O N Cl	O N Cl Co	O N Cl	O N Cl Co D I	O N Cl Co D I
50		O N Cl Co D	N Cl S	O N Cl	O N Cl S Co D	O N Cl	O N Cl Co	O N Cl	O N Cl Co D I	O N Cl Co D I
75				O N Cl	O N Cl Co D	O N Cl	O N Cl Co	O N Cl	O N Cl Co D	O N Cl Co D
100				O N Cl	O N Cl Co D	O N Cl	O N Cl Co	O N Cl	O N Cl Co D	O N Cl Co D
125				O N Cl	O N Cl Co D	O N Cl	O N Cl Co	O N Cl	O N Cl Co D	O N Cl Co D
150					O N Cl Co D	O N Cl	O N Cl Co	O N Cl	O N Cl Co D I	O N Cl Co D I
200					O N Cl S Co D	O N Cl	O N Cl Co	O N Cl	O N Co D	O N Cl Co D
250						O N	O N Co	O N	O N Co D	O N Co D
300										O N Co D I
400							O N	O N	O N Co D I	O N
500										O N I
600								O N	O N	O N
800									O N	O N
900										
1000	S								O N	
1100										
1150										
1200										
1300										
1500										
1800										
2000										
2500										
2800										
3000										
3500										
Bottom		O N Cl Co D	N Cl	O N Cl	O N S	O N S	O N S	O N	O N S	O N S
Depth		100	99	175	246	350	592	780	1052	995

P237/3: Sampling Levels for Each Station (continued)

Samples: O (oxygen), N (nutrients), Cl (chlorophyll), S (salinity), Co (Coccolithophorids), D (diatoms), I (stable isotopes), - no bottle closed at that level, * bottle failed closing

	Station / Profile									
Pres. (dbar)	**131 10**	**132 11**	**133 12**	**134 13**	**135 14**	**136 15**	**137 16**	**138 17**	**139 18**	**140 19**
bucket	Co		Co D		Co D I	Co	Co	Co D	Co	Co D
10	O N Cl S Co	O N Cl S	O N Cl S Co D	O N Cl S	O N Cl S Co D	O N Cl S Co	O N Cl S Co	O N Cl S Co D	O N Cl S Co*	O N Cl S Co D I
25	O N Cl Co	O N Cl	O N Cl Co D	O N Cl	O N Cl Co D I	O N Cl Co	O N Cl Co	O N Cl Co D	O N Cl Co	O N Cl S Co D I
50	O N Cl Co	O N Cl	O N Cl Co D	O N Cl	O N Cl Co D I	O N Cl Co	O N Cl Co	O N Cl Co D	O N Cl Co	O N Cl S Co D I
75	O N Cl Co	O N Cl	O N Cl Co D	O N Cl	O N Cl Co D	O N Cl Co	O N Cl Co	O N Cl Co D	O N Cl Co	O N Cl S Co D
100	O N Cl Co	O N Cl	O N Cl Co D	O N Cl	O N Cl Co D	O N Cl Co	O N Cl Co	O N Cl Co D	O N Cl Co	O N Cl S Co D
125	O N Cl Co	O N Cl	O N Cl Co D	O N Cl	O N Cl Co D I	O N Cl Co	O N Cl Co	O N Cl Co D	O N Cl Co	O N Cl S Co D
150	O N Cl Co	O N Cl	O N Cl Co D	O N Cl	O N Cl Co D I	O N Cl Co	O N Cl Co	O N Cl Co D	O N Cl Co	O N Cl S Co D I
200	O N Cl Co	O N Cl	O N Cl Co D	O N Cl	O N Cl Co D	O N Cl Co	O N Cl Co	O N Cl Co D	O N Cl Co	O N Cl S Co D
250	O N Co	O N	O N Co D	O N	O N Co D	O N Co	O N Co	O N Co D	O N Cl Co	O N S Co D
300	O N Co	O N	O N Co D	O N	O N Co D I	O N Co				O N S Co D I
400	O N	O N	O N	O N	O N	O N	O N	O N	O N Co	O N S
500					O N I					O N S I
600	O N	O N	O N	O N	O N	O N	O N	broken	O N Co	O N S
800	O N	O N	O N	O N	O N	O N	O N	O N	O N	O N S
900										O N S
1000	O N	O N	O N		O N	O N	O N	open	O N	O N S
1100	O N	O N	O N			O N				O N S
1150							O N	O N	O N	
1200	O N	O N				O N				O N S
1300						O N	O N	O N	O N	O N S
1500						O N	O N	broken	O N S	O N S
1800							O N			O N S
2000						O N	O N	O N	O N S	
2500							O N	O N S	O N	
2800										
3000								O N	O N S	
3500									O N	
4000										
Bottom	O N S	O N S	O N S	O N S	O N S	O N S	O N S	O N S	O N S	
Depth	1250	1280	1185	848	1180	2080	2968	3520	3575	3610

P237/3: Sampling Levels for Each Station (continued)

Samples: O (oxygen), N (nutrients), Cl (chlorophyll), S (salinity), Co (Coccolithophorids), D (diatoms), I (stable isotopes), - no bottle closed at that level, * bottle failed closing

	Station / Profile									
Pres. (dbar)	**140 20**	**141 21**	**142 22**	**143 23**	**143 24**	**144 25**	**145 26**	**146 27**	**147 28**	**148 29**
bucket			Co	Co D I				Co		
10	O N S	O N Cl S	O N Cl Co	O N Cl S Co D	O N S	O N Cl S Co	O N Cl S Co	O N Cl S Co	O N Cl S	O N Cl S Co D
25	O N S	O N Cl	O N Cl S Co	O N Cl Co D I		O N Cl Co	O N Cl Co	O N Cl Co	O N Cl	O N Cl Co D I
50	O N S	O N Cl	N Cl Co	O N Cl Co D I		O N Cl Co	O N Cl Co	O N Cl Co	O N Cl	O N Cl Co D I
75	O N S	O N Cl	O N Cl Co	O N Cl Co D		O N Cl Co	O N Cl Co	O N Cl Co	O N Cl	O N Cl Co D
100	O N S	O N Cl	O N Cl Co	O N Cl Co D		O N Cl Co	O N Cl Co	O N Cl Co	O N Cl	O N Cl Co D
125	O N	O N Cl	O N Cl Co	O N Cl Co D		O N Cl Co	O N Cl Co	O N Cl Co	O N Cl	O N Cl Co D
150		O N Cl	O N Cl Co	O N Cl Co D I		O N Cl Co	open	O N Cl Co	O N Cl	O N Cl Co D I
200		O N Cl	O N Cl Co	O N Cl Co D		O N Cl Co	O N Cl Co	O N Cl Co	O N Cl	O N Cl Co D
250		O N	O N Co	O N Co D		O N Co	O N Co	O N Co	O N	O N Co D
300				O N Co D I						O N S Co D I
400		O N	O N	O N		O N	O N	O N	O N	O N S
500				O N I						O N S I
600		O N	O N	O N		O N	O N	O N	O N	
800		O N	O N	O N		O N	O N	O N	O N	
900				O N						
1000		O N	O N	O N		O N	O N	O N	O N	
1100					O N					
1150		O N	O N		O N	O N	O N	O N	O N	
1200					O N					
1300		O N	O N		O N	O N	O N	O N	O N	
1500		O N	O N		O N	O N	O N	O N	O N	
1800	O N	O N	O N		O N	O N	O N	O N	O N	
2000	O N S	O N S	O N S		O N S	O N S	O N S	O N S	O N S	
2500	O N S	O N	O N		O N	O N	O N	O N	O N S	
2800	O N S				O N					
3000	O N S	O N S	O N		O N S	O N S	O N S	O N S	O N	
3500	O N S				O N					
4000										
Bottom	O N S	O N S	O N S		O N S	O N S	O N S	O N S	O N S	
Depth	3610	3623	3660	3703	3702	3832	3914	3780	3691	4370

P237/3: Sampling Levels for Each Station (continued)

Samples: O (oxygen), N (nutrients), Cl (chlorophyll), S (salinity), Co (Coccolithophorids), D (diatoms), I (stable isotopes), - no bottle closed at that level, * bottle failed closing

	Station / Profile									
Pres. (dbar)	**148 30**	**149 31**	**150 32**	**151 33/34**	**152 35**	**153 36**	**154 37**	**155 38**	**156 39**	**157 40/41**
bucket			Co	Co	Co	Co	Co	Co	Co	Co
10	O N S	O N Cl S	O N Cl S Co	O N Cl S Co	O N Cl S Co	O N Cl S Co	O N Cl S Co	O N Cl S Co	O N Cl S Co	O N Cl S Co
25		O N Cl	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co
50		O N Cl	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co
75		O N Cl	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co
100		O N Cl	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co
125		O N Cl	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co
150		O N Cl	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co
200		O N Cl	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co
250		O N	O N Co	O N Co	O N Co	O N Co	O N Co	O N Co	O N Co	O N Co
300										O N Co
400		O N	O N	O N	O N	O N	O N	O N	O N	O N
500	O N									O N (double)
600	O N	O N	O N	O N	O N	O N	O N	O N	O N	O N also 700
800	O N	O N	O N	O N	O N	O N	O N	O N	O N	O N
900	O N			O N						O N
1000	O N	O N	O N	O N	O N	O N	O N	O N	O N	O N
1100	O N			O N						O N
1150		O N	O N		O N	O N	O N	O N	O N	O N
1200	O N			O N						O N also 1250
1300	O N	O N	O N	O N	O N	O N	O N	O N	O N	O N also 1400
1500	O N	O N	O N	O N	O N	O N	O N	O N	O N	O N also 1600
1800	O N	O N	O N	O N (double)	O N	O N	O N	O N	O N	O N
2000	O N S	O N S	O N S	O N S	O N S	O N S	O N S	O N S	O N S	O N
2500	O N			O N S						O N
2800	O N	O N	O N S	O N	O N	O N S	O N	O N S	O N	O N S
3000	O N S			O N S						
3500	O N	O N S	O N	O N (double)	O N S	O N S	O N S	O N	O N S	O N S
4000	O N S			O N S						
Bottom	O N S	O N S	O N S	O N S	O N S	O N S	O N S	O N S	O N S	O N S
Depth	4368	4490	4334	4600	4549	4420	4210	3560	4300	4360

P237/3: Sampling Levels for Each Station (continued)

Samples: O (oxygen), N (nutrients), Cl (chlorophyll), S (salinity), Co (Coccolithophorids), D (diatoms), I (stable isotopes), - no bottle closed at that level, * bottle failed closing

	Station / Profile									
Pres. (dbar)	**158 42**	**159 43**	**160 44**	**161 45**	**162 46**	**163 47**	**164 48**	**165 49**	**166 50**	**168 51**
bucket	Co	Co	Co	Co	Co	Co	Co	Co D	Co	Co
10	O N Cl S Co	O N Cl S Co	O N Cl S Co	O N Cl S Co	O N Cl S Co	O N Cl S Co	O N Cl S Co	O N Cl S Co D	O N Cl	O N Cl Co
25	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co D	O N Cl	O N Cl Co
50	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co D	O N Cl	O N Cl Co
75	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co D	O N Cl	O N Cl Co
100	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl	
125	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co		
150	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl Co	O N Cl S Co	O N Cl Co	O N Cl Co	O N Cl Co		
200	O N Cl Co	O N Cl Co	O N Cl Co	open	O N Cl S Co	O N Cl Co	O N Cl Co	O N Cl Co		
250	O N Co	O N Co	O N Co	O N Co	O N Co	O N Co	O N Co	O N Co		
300							O N Co	O N Co		
400	O N	O N	O N		O N	O N	O N	O N		
500				O N				O N		
600	O N	O N			O N	O N	O N	O N		
800	O N	O N	O N	O N S	O N	O N	O N	O N		
900										
1000	O N	O N	O N	O N S	O N	O N	O N			
1100					O N	O N	O N			
1150	O N	O N	O N							
1200				O N	O N	O N	O N			
1300	O N	O N	O N	O N	O N	O N	O N			
1500	O N	O N	O N	O N	O N	O N				
1800	O N	O N	O N	O N	O N	O N				
2000	O N	O N S	O N S	open	O N S	O N S				
2500			O N			O N				
2800	O N S	O N		O N S	O N S					
3000			O N S							
3500	O N S	O N S								
4000										
Bottom	O N S	O N S	O N S	O N S	O N S	O N S	O N S	O N S	O N Cl	O N Cl Co
Depth	4330	3995	3380	3255	3242	2742	1467	830	100	99