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REPORT AND PRELIMINARY RESULTS OF POSEIDON CRUISE 237/2, VIGO - LAS PALMAS, 18.3. - 31.3. 1998

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Rosiak, Uwe	GeoB	Instrument testing, moorings	—	

Institutions

GeoB : Geosciences FB5, University of Bremen, Klagenfurter Straße, 28359 Bremen, Germany

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ULPGC: Universidad de Las Palmas, Facultad de Ciencias del Mar, Las Palmas de Gran Canaria, Spain

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UBMCh: Marine Chemistry FB2, University of Bremen, Leobener Straße, 28359 Bremen, Germany

ETHZ: Geological Institute, Eidgenössiche Technische Hochschule, Sonneggstr. 5, 8092 Zürich, Switzerland

2) Research Programme

During Poseidon cruise 237/2, work was carried out for the Spanish-German time-series programme ESTOC (European Station for Time-series in the Ocean, Canary Islands), the EU programme CANIGO (Canary Islands Azores Gibraltar Observations) and the German project DOMEST (Data Transmission in the Ocean and High Resolution Registration Techniques for Transport Processes in the Deep Sea).

ESTOC (located 60 nm north of Las Palmas at 29°10 N, 15°30 W) was initiated in 1994 as a joint Spanish -German initiative which is funded in Germany by the ministry for research and development (BMBF). The station is sampled monthly, supplemented by current meter and sediment trap moorings at the site. As often as possible, the monthly sampling stations are covered by German vessels in conjunction with regional cruises that aim at the validation of time-series observations for the larger region.

ESTOC is also a reference station for the EU project CANIGO which started in fall of 1996. In CANIGO, researchers from 51 European institutions study the regional hydrography and water mass structure in the northern Canary Islands, Azores and Gibraltar regions, as well as particle flux and paleoceanography north of the Canaries and along the Moroccan shelf. The purpose is to obtain an integrated view of oceanographic processes in this region both in the present and of the past.

An intensive sampling programme at ESTOC was conducted during leg 237/2 covering the month of March. The sampling also included tracer gases and components of the CO_2-system, as well as pCO_2 measurements on the way. Rate measurements were carried out with respect to primary production (dilution and oxygen incubations) and short-term particle flux using different free-floating particle trap arrays. The particle trap mooring CI close to ESTOC was exchanged. Furthermore, water column sampling was carried out along a transect from ESTOC towards the Moroccan upwelling region to check for upwelling-generated influences on the region and to localise Antarctic Intermediate Water in the surroundings of the islands.

The aim of DOMEST, a R&D project between the University of Bremen and the Communication and Technology Company OHB Teledata, Bremen is the development of a moored sensor network in the deep sea. The advanced sensors (autonomous Digital Camera System, Multi Pump System, enhanced Sediment Trap, etc.) will provide high-resolution data on particle fluxes and element concentrations in the open ocean. All sensors can be accessed from land via bi-directional satellite and acoustic transmission. Communication underwater will be performed through a bi-directional acoustic high-speed telemetry. Above water, a low-earth-orbit satellite network based on ORBComm and SAFIR satellites will establish the data transport between the moored system and a land based ground station. The system will be deployed at 3600 m water depth over a maximum duration of one year. With DOMEST, remotely controlled measurements of element and particle transport in the deep sea will be possible. On the transect from VIGO to Las Palmas, a surface buoy mooring was deployed near the ESTOC station that constitutes a central aspect of the work carried out in DOMEST.

3) Narrative

Poseidon cruise 237 was subdivided into two parts, POS 237/a from Vigo to Las Palmas, 18 to 22 March (Fig. 1), and POS 237/b from Las Palmas to Las Palmas, 23 to 30 March (Fig. 2).

POSEIDON cruise POS 237 started in VIGO (northern Spain) on 18 March, 08:00 with course to the ESTOC (European Station for Time-series in the Ocean, Canary Islands, located 60 nm north of Gran Canaria). Along the way, 3 stations were sampled with a hand net. ESTOC was reached on the morning of March 22 and a moored surface buoy was deployed. Work at the station ended in the afternoon and port of Las Palmas was called shortly before midnight.

The ship left again for POS 248/2b on 23 March, 18:00 with course to the ESTOC station. While steaming to ESTOC, six XBT's were thrown every 10 nm. A first CTD station underway had to be discarded due to technical problems. Station work at ESTOC began on the morning of the following day, continued by the recovery of the sediment trap mooring CI8. In the afternoon, a NOAA drifter was deployed that carried temperature sensors for the calibration of satellite data. Two drifting sediment traps were deployed and during the morning of March 25, the sediment trap CI 9 was deployed. The mooring that had been deployed on POS 248/2a was recovered during the afternoon. We then took course towards the coast of Morocco where we covered six stations east and south of Fuerteventura with CTD/rosette casts. We returned to the position of the drifting particle traps on March 28, recovered the drifters and re-deployed them at ESTOC where we also continued with station work. During the afternoon, acoustic modems were tested on the wire. During the following day, a mooring carrying acoustic modems was deployed and communication to and from ship was tested. On 30 March, the mooring and the drifting traps were recovered. One drifting trap was deployed again to be recovered during POS 237/3. Station work during POS 237/2 was concluded in the afternoon of March 30 and the ship called port March 31, 08:00. Weather was excellent during the journey allowing all station work to be completed as planned.

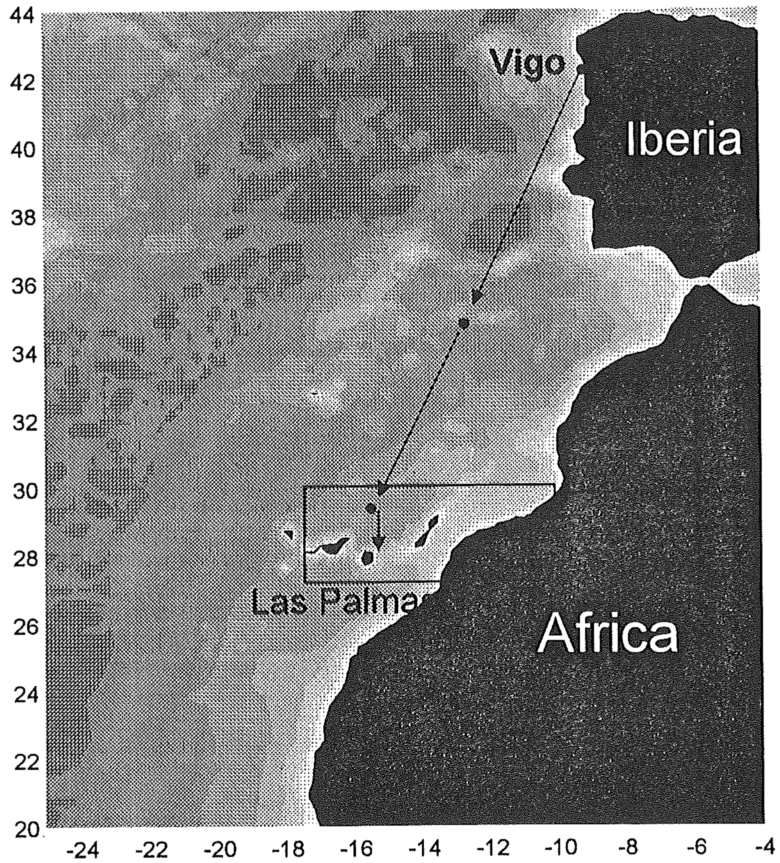


Figure 1. Cruise track of POS 237/2a from Vigo to Las Palmas and research area of POS 237/2b. For details see Fig. 2.

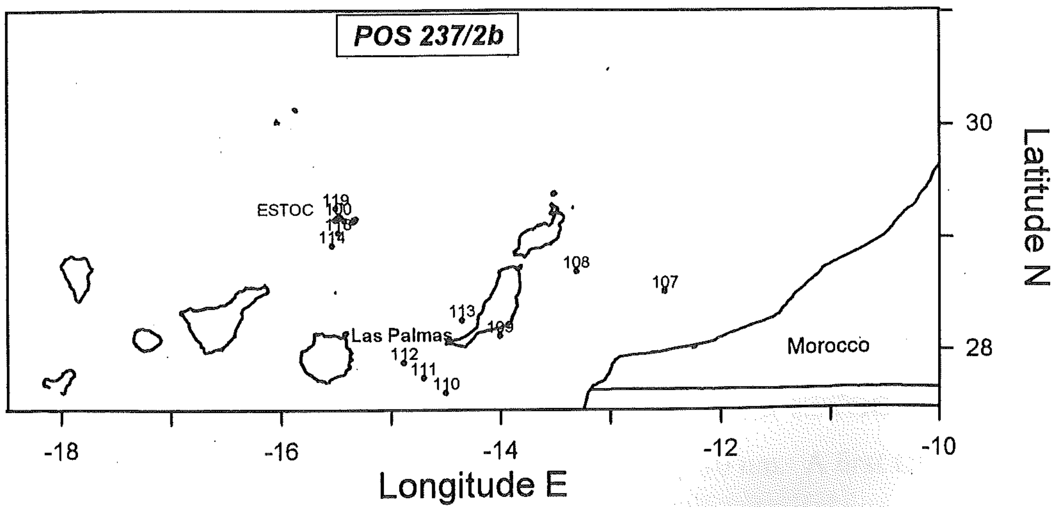


Figure 2. Stations covered on POS 237/2b.

4) Scientific report and first results

4.1. Coccolithophore sampling

Christine Klaas

During Poseidon cruise P237/2a, net samples (5 and 10 µm mesh size) were taken on three stations for coccolithophore isolation.

- 42°02' N and 09°02' W near the Spanish coast
- 34°52' N and 12°30' W in the Azores Front area
- 29°12' N and 15°19' W at the ESTOC position

(see Appendix A1).

Onboard ship, single coccolithophorid cells were pipetted out from the net samples and transferred into sterile media for growth. About 500 coccolithophores isolations were carried out.

4.2. Deployment of DOMEST moorings

Gerrit Meinecke, Volker Ratmeyer, Uwe Rosiak

The aim of the mooring was to act as relais-station in the communication line from the deep sea near the Canaries to a land station in Bremen (northern Germany). This mooring with a permanent surface buoy of 2.5 m (Fig. 3) diameter was to be placed in 3.600 m water depth (Fig. 4). The surface buoy was equipped with solar panels, flasher and radar reflector. In addition, a satellite transceiver (ORB Comm) for satellite transmission and an acoustic modem (ORCA Instrumentation) for underwater communication were installed in this buoy. Within the first three days of the cruise, all mooring components like anchor, releasers, glass spheres and the surface buoy itself were prepared for deployment.

On 22 March, the mooring was ready for deployment at 29°10.0 N and 15°20.0 W. During this deployment, problems arose with the new mooring lines which had to be fixed. Consequently, the anchor weight was slipped with nearly 2.5 hours delay. The subsurface parts of the mooring disappeared 30 minutes later. Shortly after, the subsurface parts of the mooring appeared again at the sea surface. Obviously, a connection in the ropes had ruptured under water and the complete mooring had to be recovered. The mooring could not be re-deployed during the cruise due to lack of additional equipment and we had to leave the mooring position heading to Las Palmas.

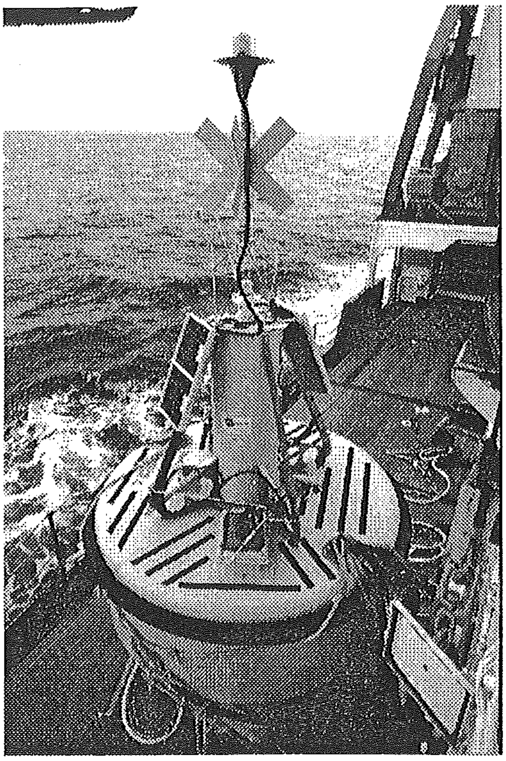
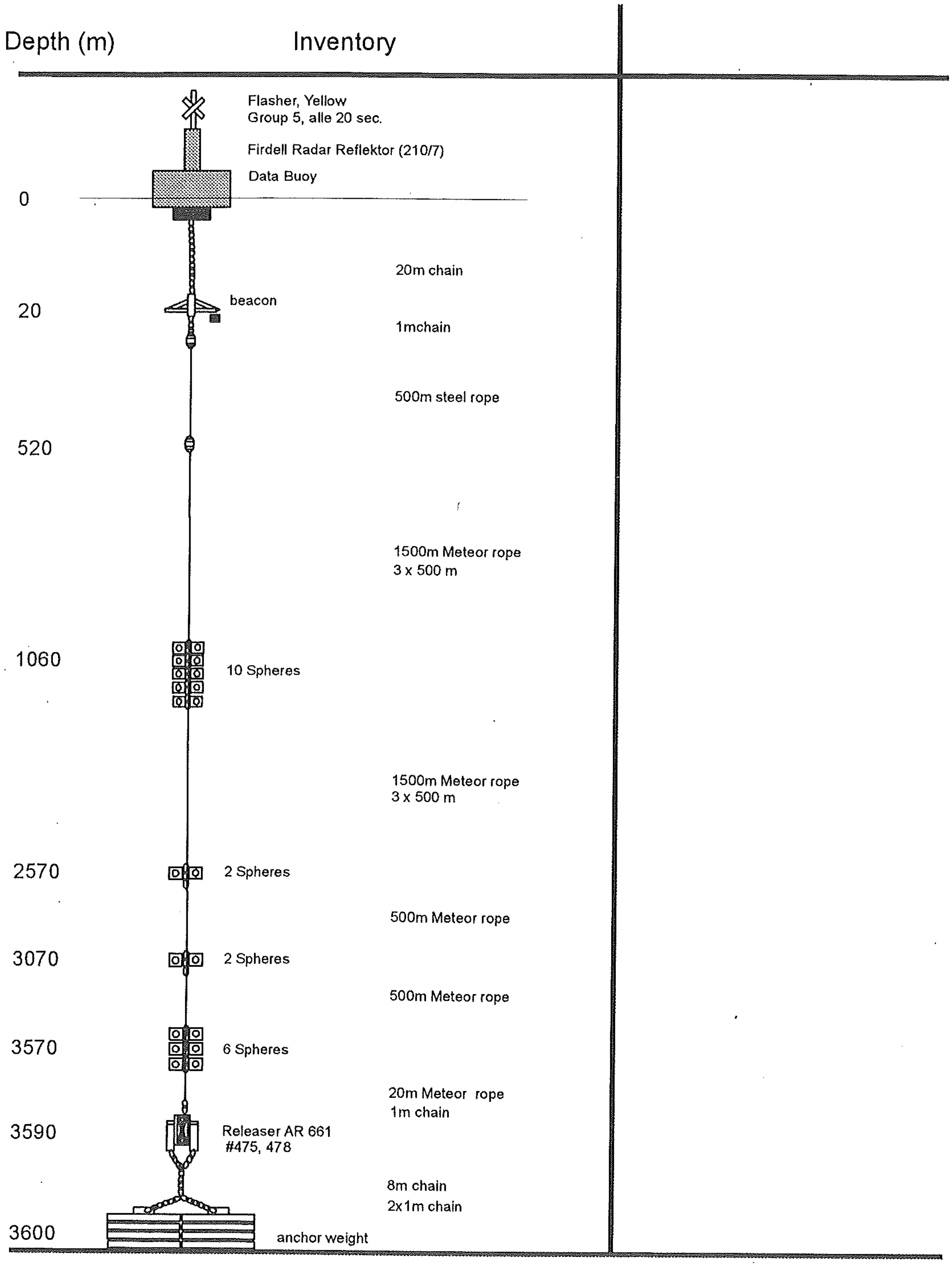


Figure 3. DOMEST Surface buoy.



Mooring: DOMEST SBU
Expedition: POS237/2a
Position 29°10.0N; 15°20.0W
Location: Canaries, 10nm east of ESTOC Station
Waterdepth: 3600m
Deployment: 22.03.1998

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Figure 4. Schematic drawing of the SBU (Surface Buoy Unit) Mooring.

4.3. Field tests of the acoustic modems

Gerrit Meinecke, Volker Ratmeyer

The aim of the tests during this cruise were to resolve the performance of the underwater acoustic telemetry system. Transmission range in distance, angle and transmission speed, all in relation to ship noise had to be checked. For this reason, the acoustic modems were tested in several ways.

Acoustic Modems used for these tests are:

- **DU** Deck Unit
- **SSP** Subsurface Platform
- **MSD** Multi-Sensor Device MODEM
- **DOBS** Deep Ocean Bottom Station MODEM.

a. Test of the deep MSD and DOBS modems at the ship wire

The modems were attached in a mooring frame with power supply by a deep sea battery (Fig.5). Both modems were lowered to 900 m water depth. All transmission speeds and modulation types up to 2400 bit/sec were tested successfully. Transmission data and the "ship noise" itself were recorded to a DAT Tape.

b. Preparation for the Multi-Sensor Unit MSU mooring.

After deployment of the MSU mooring (Fig. 6), we needed to know the exact position from the mooring itself and also from the Subsurface Platform SSP inside this mooring to be able to perform the acoustic tests. For this reason, a acoustic releaser was attached to the SSP in order to calculate the distance to ship and the depth of the SSP. For the mooring position, we simply used the attached acoustic releasers from the anchor weight.

After knowing the position of the mooring, we started the acoustic tests at the mooring site. While the ship was drifting away from the mooring site, we tested every acoustic modem (SSP, MSD, DOBS) regarding transmission speed.

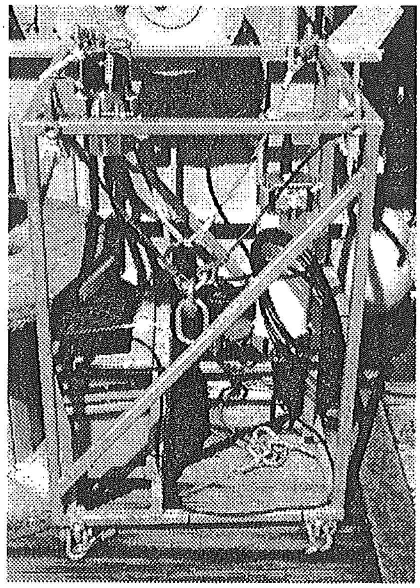
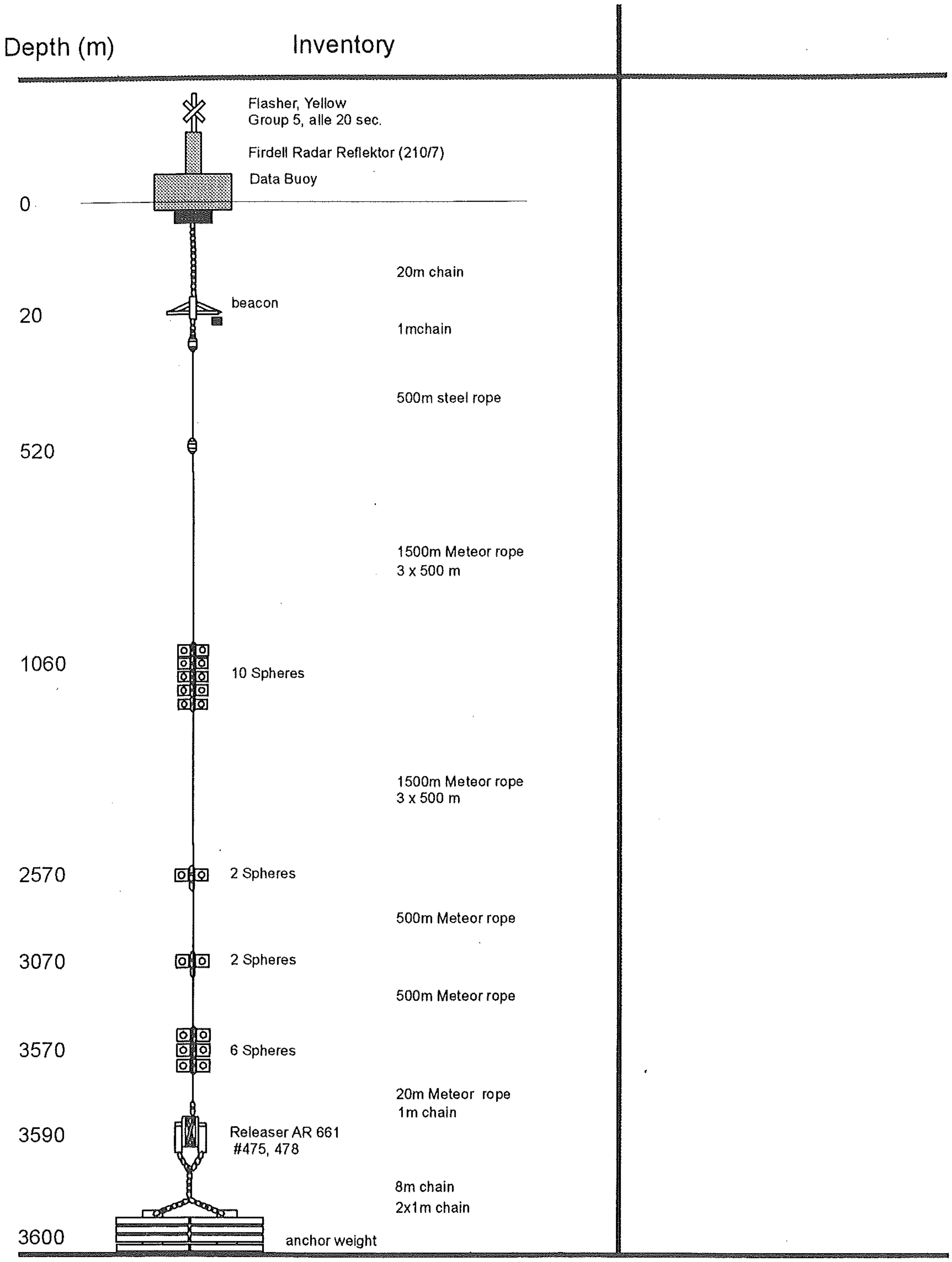


Figure 5. Moored sensor unit (MSU).

Table 1. Test results of acoustic modem tests.

Modem (nm)	Depth	Modulation	Type	Secure distance	Distance
DOBS	3500 m	PSK 2400	-	1,3 nm	1,9nm
		PSK 2400	1/3 Viterby	1,7 nm	1,9nm
MSD	3000 m	PSK 2400	-	0,9 nm	1,9nm
		PSK 2400	1/3 Viterby	1,3 nm	1,9nm
		FSK 100	-	1,7 nm	1,9 nm
SSP	500 m	CHIRP 20	-	1,9 nm	1,9 nm

For the deep modems (DOBS, MSD) the results were excellent (Table 1) as we got highest transmission speeds of up to 2400 bit/sec in all cases. However, for the uppermost modem (SSP) we were only able to communicate in the worst case mode (20 bit/sec) due to the very small transmission angle from the ship to the SSP.



Mooring: DOMEST SBU

Expedition: POS237/2a **Position** 29°10.0N; 15°20.0W

Location: Canaries, 10nm east of ESTOC Station

Waterdepth: 3600m

Deployment: 22.03.1998

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Figure 6. Mooring drawing of the Moored Sensor Unit .

On the next morning, we recovered all equipment (Fig. 7). All acoustic test data were recorded successfully to a DAT tape.

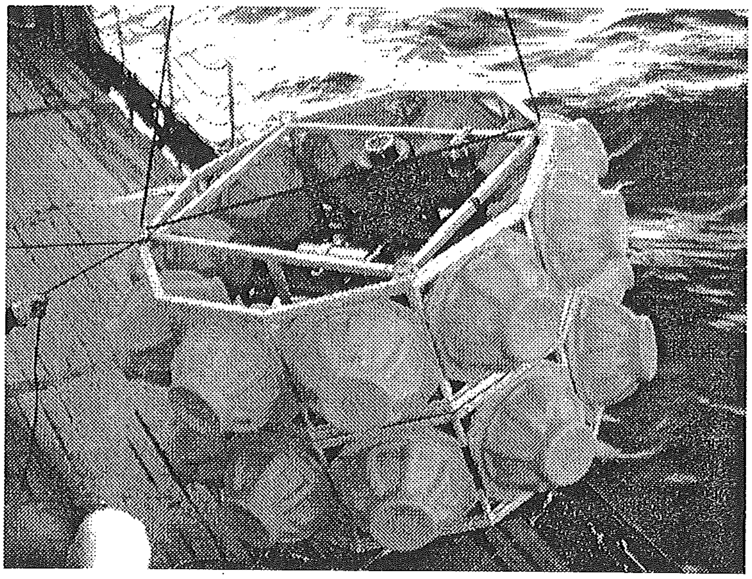


Figure 7. Recovery of the subsurface platform (SSP).

4.4 Hydrography and collection of water samples

Susanne Neuer, Andres Cianca , Uwe Koy, Alfred Putzka

6 XBT (Expandable Bathythermograph) were thrown on the way from Las Palmas to ESTOC to monitor temperature profiles along the way (see list of stations for details). Temperature (T) and salinity (S) were determined using a Neil Brown CTD (Mk 3b) which operated together with a General Ocenics rosette with 21x10 l Niskin bottles.

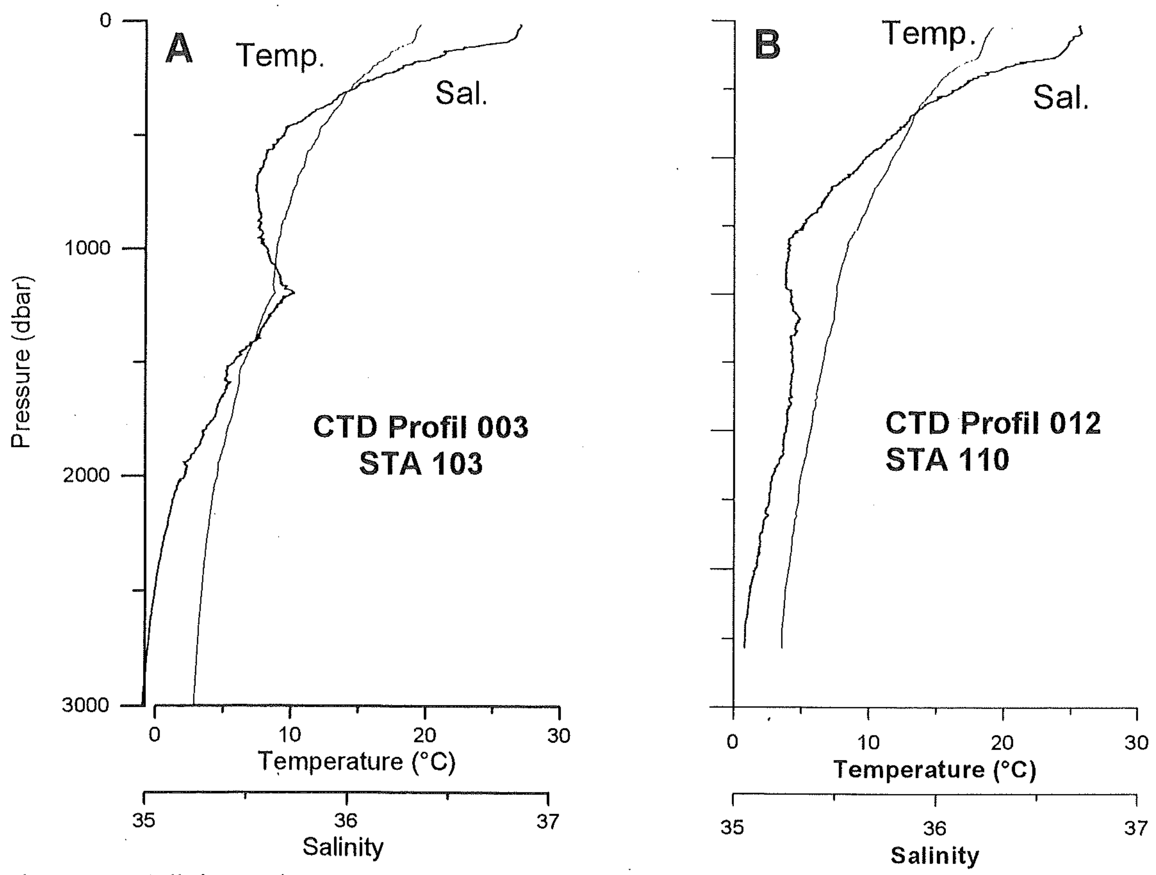


Figure 8. Salinity and Temperature profiles at Stations 103 (a, ESTOC) and 110 (b, south of Fuerteventura).

The salinity and temperature profiles at ESTOC (Fig. 8a) show a maximum of salinity indicative of the Mediterranean outflow water (MW) at 1200 m depth. This water mass was absent at Station 110 south of Fuerteventura (Fig. 8b). This is also shown in the TS diagram (Fig. 9) . Antarctic intermediate water (AIW) could be observed at the stations in the channel between the islands Gran Canaria and Fuerteventura and west of

Fuerteventura (Fig. 9). North Atlantic Central water (NACW) between ca 100 and 700 m depth is characterized by an almost linear TS relationship.

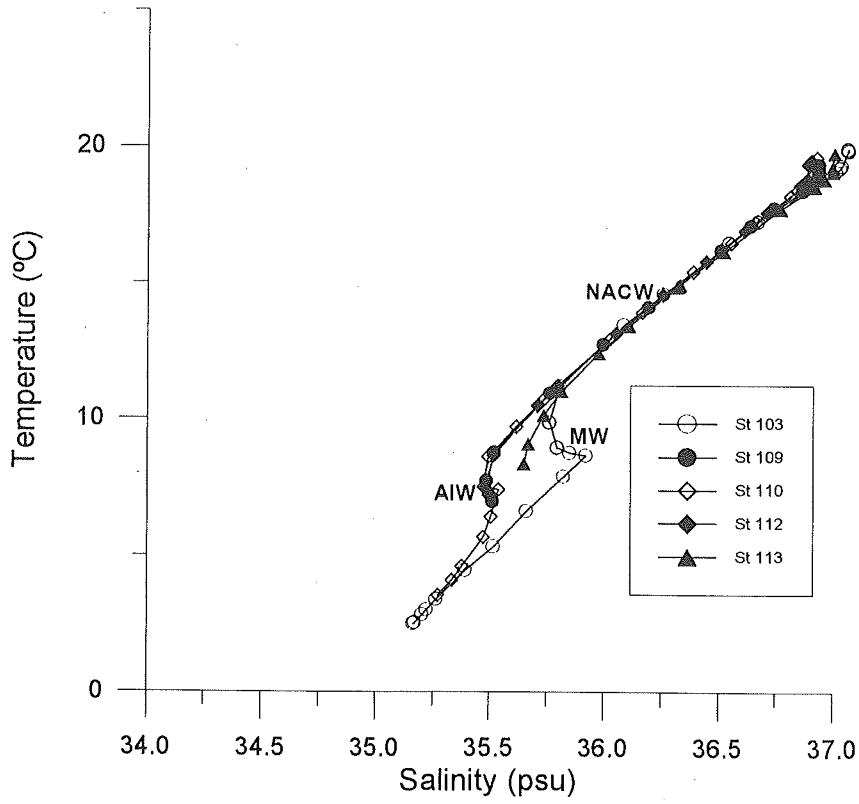


Figure 9. TS diagramm for different stations on POS 237/2b.

4.5. Nutrients, oxygen and dissolved aluminum

Juana Godoy, Andres Cianca

Samples for nutrients were collected in plastic bottles and frozen immediately until analysis onshore with a Skalar San Plus continuous flow autoanalyser. Samples for oxygen were taken in 125 ml glas bottles and titrated using a Metrohm 665 Dosimat Oxygen Auto-Titrator. All analyses followed the WOCE operations manual, WHP Office Report No. 68/91.

Samples for aluminum were taken and manipulated while wearing plastic gloves to avoid metal contamination. Water was stored at 250 ml polyethylene bottles and immediately frozen until analysis at the land-based laboratory. Every container had been cleaned previously using conventional procedures in trace metal assays. The HPACSV (High Performance Adsorptive Cathodic Stripping Voltammetry) method will be used to measure dissolved aluminum in sea-water (J. Hernández-Brito, ULPGC).

4.6. Plankton biomass

Susanne Neuer, Helge Meggers, Juana Godoy

The phytoplankton community was quantified in the upper 200 m at the monthly ESTOC sampling at ESTOC and at the beginning and end of the trap deployments. Samples were taken for chlorophyll, taxonomically characteristic pigments (analysed with High Pressure Liquid Chromatography, HPLC) and POC (Particulate Organic Carbon). All of the water samples were filtered on GF/F filters. While chlorophyll a was analysed onboard ship as an acetone extract using a Turner AU 10 fluorometer, POC and HPLC samples were kept frozen until analysis onshore.

In addition, on the transect from the ESTOC station towards the Moroccan shelf, chlorophyll samples were taken from the CO_2 surface water pump in a high spatial resolution. High chlorophyll concentrations were determined around 15°W and close to the Morocccan shelf (Fig. 10). The higher chlorophyll concentration in the western part of the transect resulted from a filament originating from the Ferteventura upwelling zone as shown on a SeaWIFS satellite image of the same time-period (R. Davenport, pers. comm.).

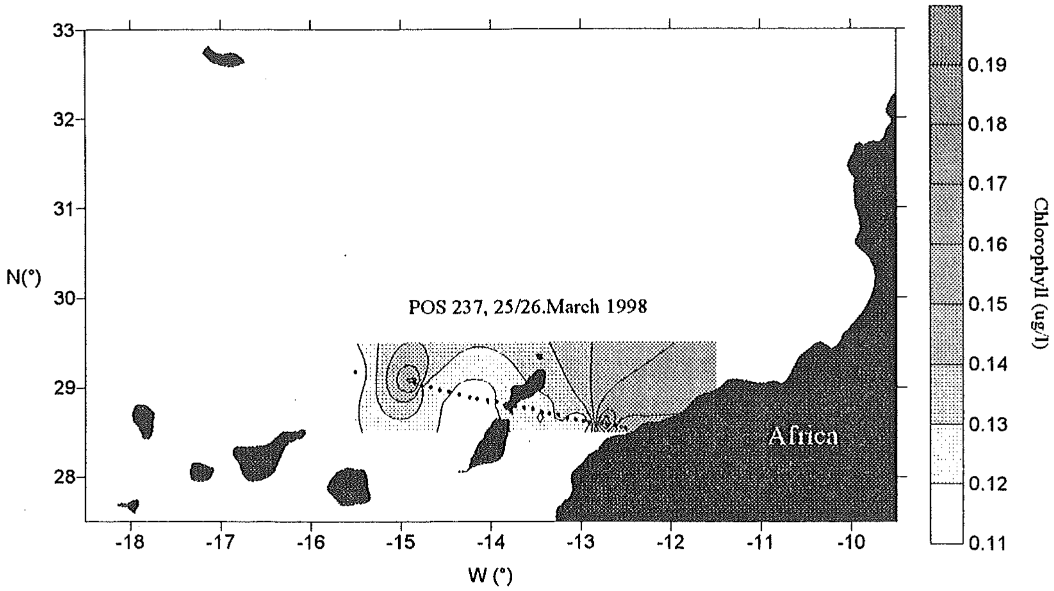


Figure 10. Surface water chlorophyll a on the 29°N transect determined on 25/26 March 1998.

Table. 2. Chlorophyll a values measured along the east-west transect (see Fig.8).

Latitude W dez.	Longitude N dez	Chlorophyll (µg)
-14,85	29,05	0,17
-14,77	29,02	0,13
-14,67	29,00	0,12
-14,57	28,97	0,12
-14,47	28,95	0,12
-14,35	28,92	0,12
-14,23	28,88	0,11
-14,15	28,87	0,12
-14,03	28,85	0,11
-13,93	28,83	0,12
-13,83	28,80	0,12
-13,73	28,78	0,13
-13,63	28,77	0,12
-13,53	28,75	0,13
-13,43	28,72	0,11
-13,35	28,70	0,13
-13,25	28,68	0,13
-13,15	28,65	0,13
-13,05	28,63	0,12
-12,97	28,62	0,12
-12,90	28,60	0,13
-12,83	28,58	0,14
-12,77	28,58	0,22
-12,70	28,57	0,17
-12,62	28,57	0,17
-12,55	28,55	0,14
-12,50	28,53	0,16

Chlorophyll profiles taken during the cruise at ESTOC show the development of a deep chlorophyll maximum in 100 m depth. In comparison, the chlorophyll concentration at EBC (Station 107) was slightly higher and the chlorophyll maximum was located in 50m depth (Fig. 11).

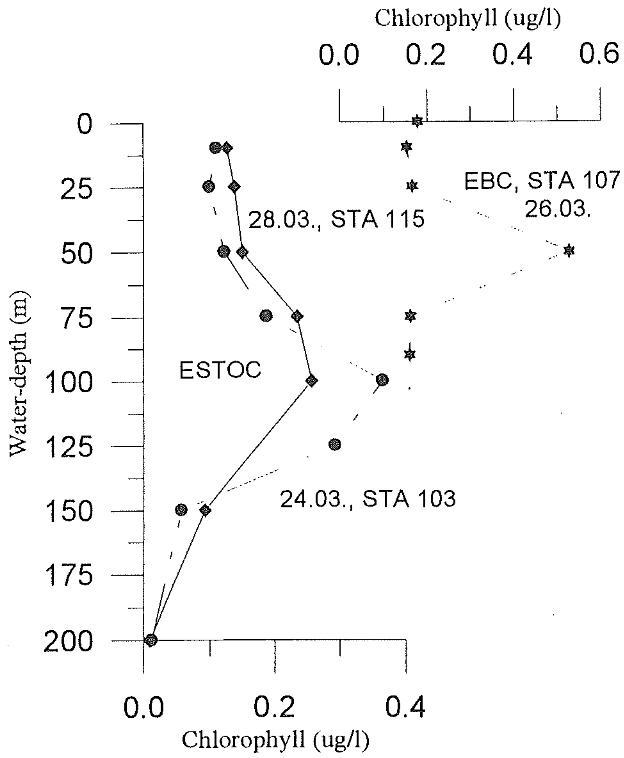


Figure 11. Comparison of chlorophyll profiles from ESTOC and EBC stations.

4.7. Phytoplankton production rate

Susanne Neuer, Juana Godoy, Helge Meggers

Phytoplankton primary production was determined by dilution experiments and by the change of oxygen during incubation. Experiments were carried out east of Fuerteventura (Sta. 109) and in the vicinity of ESTOC (Sta 114).

Dilution experiments were incubated for 24 h with water from 25 and 50 m in an on-deck incubator during 24 h, always starting at dawn or at night. Light-levels at depths were simulated with neutral density screens. Different dilutions of natural sea-water were incubated in 1 l poly-carbonate bottles. Phytoplankton growth and microzooplankton grazing rates can be determined from the change of chlorophyll in the different dilutions by linear regression of the apparent growth rate in each dilution versus dilution factor.

O_2 - incubations were carried out under the same conditions, with the change of oxygen (for methods see 4. 5) determined in light and dark (wrapped in black plastic sheets) bottles. The change of oxygen in the dark bottles is due to respiration by the whole plankton community, and the change in the light bottles is due to the production of oxygen by photosynthesis minus the loss due to respiration and represents the net photosynthetic rate of the phytoplankton community. Gross photosynthesis can be determined by adding the loss of oxygen (calculated as hourly rate) due to respiration as determined from the dark bottles.

4.8. Carbon dioxide in sea-water and atmosphere

Melchor González-Dávila, J. Magdalena Santana-Casiano, Luis M. Laglera-Baquer

In response to increased interest in global climate change and greenhouse warming, measurements of the marine carbon system (i.e. total CO_2, TCO_2, titration total alkalinity TA, pH and pCO_2) have been included in several global research programs such as the World Ocean Circulation Experiments (WOCE) and the Joint Global Ocean Flux Study (JGOFS). These programs include time series stations primarily designed to examine temporal variability and the mechanism controlling this variability. The Canary Islands Time series (ESTOC) is visited each month and the surrounding area approximately twice a year. Time series station data provide excellent opportunities to study the temporal variability of the carbon system at a single location over several years, while cruises around the ESTOC station will provide information about spatial variability of the carbon species in the area.

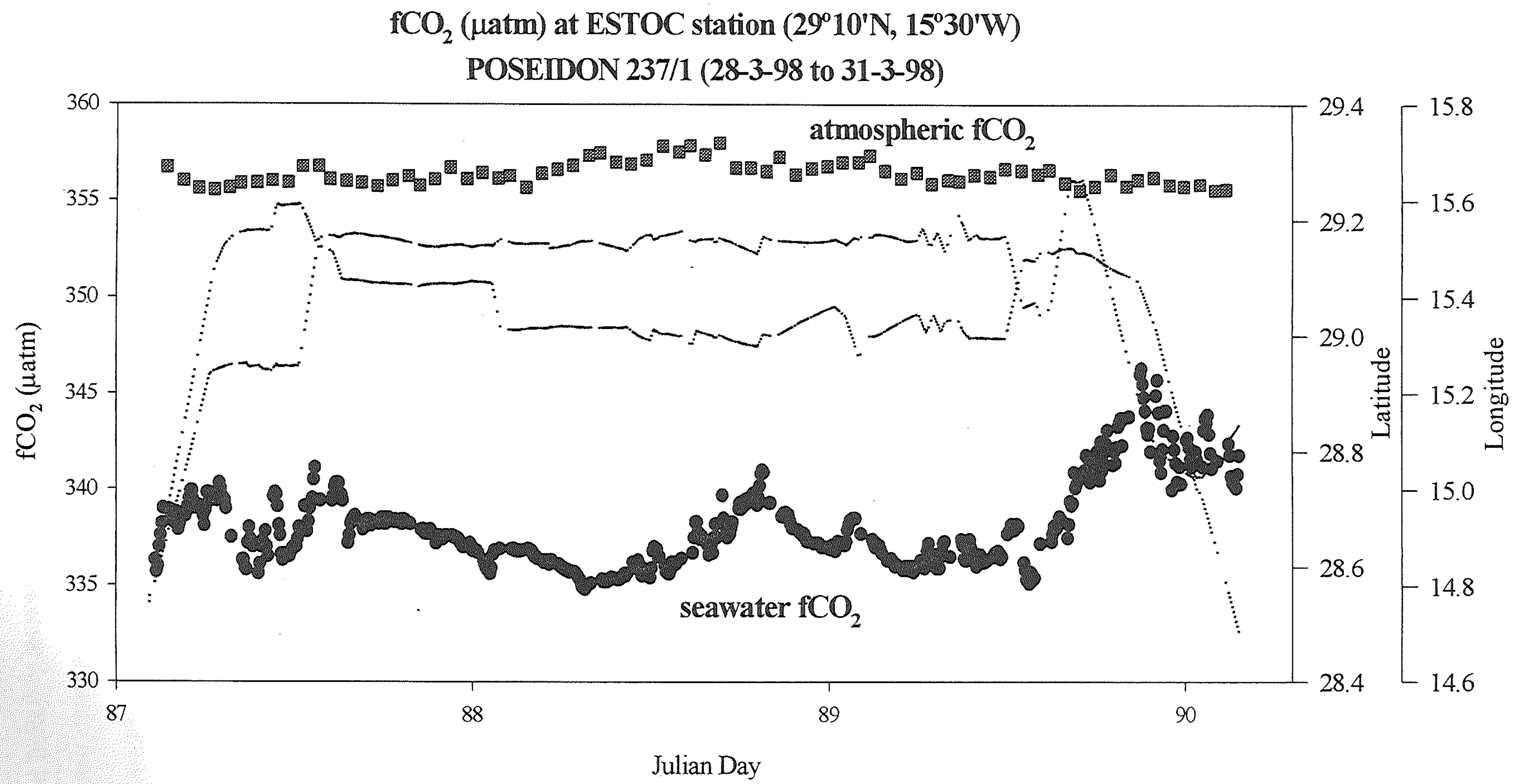
The main objective of the work of the carbon dioxide group at the ULPGC was to study the spatio-temporal variability of the parameters which define the carbonate system in the water column. The parameters to be determined are pH and total alkalinity. Underway continuous pCO_2 was determined from 28 to 31 March 1998, in the ESTOC location and vicinity, together with air pCO_2 value (each hour). The possibility to use this system in the RV Poseidon will allow us to compare the theoretical pCO_2 values determined by using TA and pH on surface sea-waters and experimental ones.

Water samples for pH and titration alkalinity collected from surface to bottom were analysed on board within four hour of collection with a two-thermostatized (25°C ± 0.1) 200 ml titration cells with ROSS glass pH electrode and Orion double junction Ag, AgCl reference electrodes. The reliability of the titration systems was tested by determining the TA of Certified Reference Material for Oceanic CO_2 measurements (batch 35) provided by Dr. Dickson, Scripps Institution of Oceanography, San Diego. The results of these measurements indicate that high-precision measurements of TA (±1.2 μmol kg^{-1}) can be obtained. Photometric pH was determined by a stopped-flow system designed by this group by using a m-cresol purple sea-water solution as dye for the pH determination following the DOE (1994) SOP 6 for the analysis of the carbonate system variables of oceanic sea-water samples. Reproducibility better than 0.003 pH units has been obtained.

On the 1998 Poseidon cruise, we had the opportunity to analyse during 7 days both the ESTOC station and the eastern Lanzarote-Fuerteventura sea water. Two ESTOC sampling profiles were carried out (March 24th and 28th) in a total of 24 and 19 depths, respectively. The total alkalinity (NTA, normalised to salinity 35) values in surface waters were 2290 μmol kg^{-1} increasing continuously with depth until a value of 2360 μ mol kg^{-1} at bottom (3650 m). The total alkalinity in the surface water at ESTOC was 2411 μmol kg^{-1}, which is similar to other values found at the ESTOC location on previous cruises. The alkalinity plot is related to the salinity distribution in the water column. Thus, two features can be observed in the TA profile: a minimum value around 700 m and a maximum at around 1200 m related to minimum salinity and to the presence of Mediterranean outflow water, respectively. High pH values in surface are related to CO_2 assimilation by phytoplankton. The pH values exhibit a sharp decrease with depth to approximately 800-1000 meters, coincidentally with the minimum of oxygen, while the C_T increases with depth, resulting from remineralisation of organic matter. Again, the presence of Mediterranean outflow water (MOW) is characterised by a maximum of pH and total inorganic carbon at intermediate depth (around 1200 m). On the other hand, other features are visible in the eastern Lanzarote-Fuerteventura sea-water total alkalinity, total dissolved inorganic carbon and pH values. Minimum of pH and TA about 600-900 m are related to salinity minimum between the Canary Islands and the continental slope, tracing the influence of Antarctic Intermediate Water (pH_t-25 = 7.66; TA = 2330 µmol kg^{-1}). Titration alkalinity does not exhibit a nutrient type distribution prior to normalisation to a fixed salinity (S = 35) suggesting that physical processes of water mass formation and mixing occur on a faster scale that particle dissolution.

Regarding pCO_2 values in surface waters, we observed (Fig. 12) that the pCO_2 (average value of 338 µatm) was always below atmospheric value (358-360 µatm) showing that during the end of March the area around ESTOC was acting as a sink of CO_2 with an average ΔpCO_2 value of – 20 µatm. It must be pointed out that sinking of CO_2 similar to that found in March in ESTOC area has been observed from January to May 1996, where the surface sea-water temperature was generally bellow 20°C.

Figure 12 (next page). Sea-water and atmospheric pCO_2.


fCO2 (µatm) at ESTOC station (29°10'N, 15°30'W)
POSEIDON 237/1 (28-3-98 to 31-3-98)
atmospheric fCO2
seawater fCO2
fCO2 (µatm)
360
355
350
345
340
335
330
87
88
89
90
Julian Day
Latitude
29.4
29.2
29.0
28.8
28.6
28.4
Longitude
15.8
15.6
15.4
15.2
15.0
14.8
14.6

4. 9. Tracers
Alfred Putzka

Measurements of transient tracers were conducted only at ESTOC station proper. The station was sampled twice. Each tracer profile consisted of up to 9 depth levels covering the upper 1000m. The CFC samples were sealed off in glass ampoules and will be measured by means of ECD capillary gas chromatography in the laboratory in Bremen. Helium samples were placed into clamped-off copper tubes, and tritium samples into 1-liter glass bottles, to be analysed in the laboratory at Bremen after the cruise. Helium and tritium samples will be extracted immediately after the cruise. The next step in the procedure is helium isotope mass spectrometry (precision 0.2 % in ^{3}He, 0.4 % in He isotope and Ne concentrations). Tritium is measured by determining 3He grown in from tritium decay (typical ingrowth period 6 months).

4. 10. Particle flux measurements with drifting particle traps
Susanne Neuer, Uwe Koy, Helge Meggers

In addition to moored sediment traps, drifting trap experiments were carried out to determine particulate carbon flux that originates directly from the euphotic zone. These rates are then interpreted in the context of measurements of the standing stock and production rates of the plankton community in the euphotic zone.

To study particle flux below the euphotic zone, three surface-tethered particle interceptor arrays were deployed north-east of the ESTOC station, one carrying one trap at 200 m (Trap I, Fig.13), the other one three traps at 200, 300 and 500m depth (Trap III, Fig. 14). The third drifting trap array had an Aquatec trap attached instead of the cylinder traps (Aquatec, Fig. 15). The traps were attached to a surface buoy carrying an ARGOS transmitter and a Radar reflector. The main buoyancy was located at about 30 m depth to avoid the wind-induced EKMAN layer.

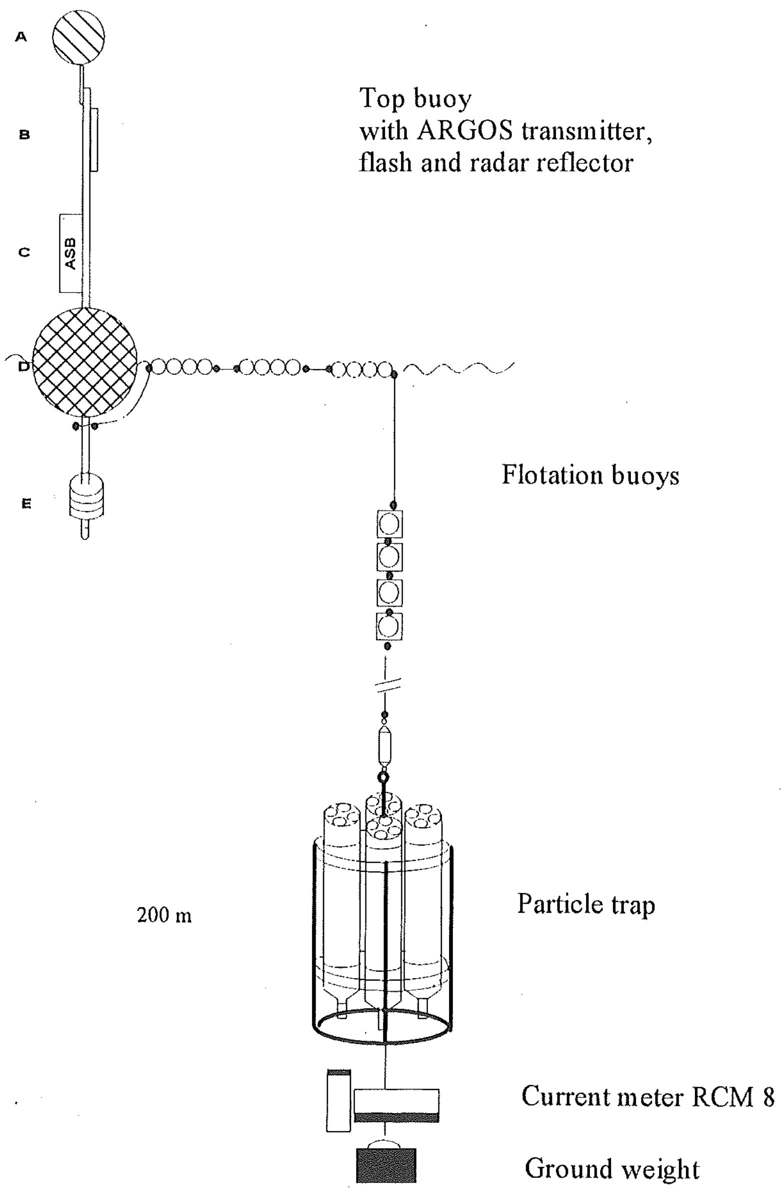


Figure 13. Drifter I carrying one trap at 200m depth.

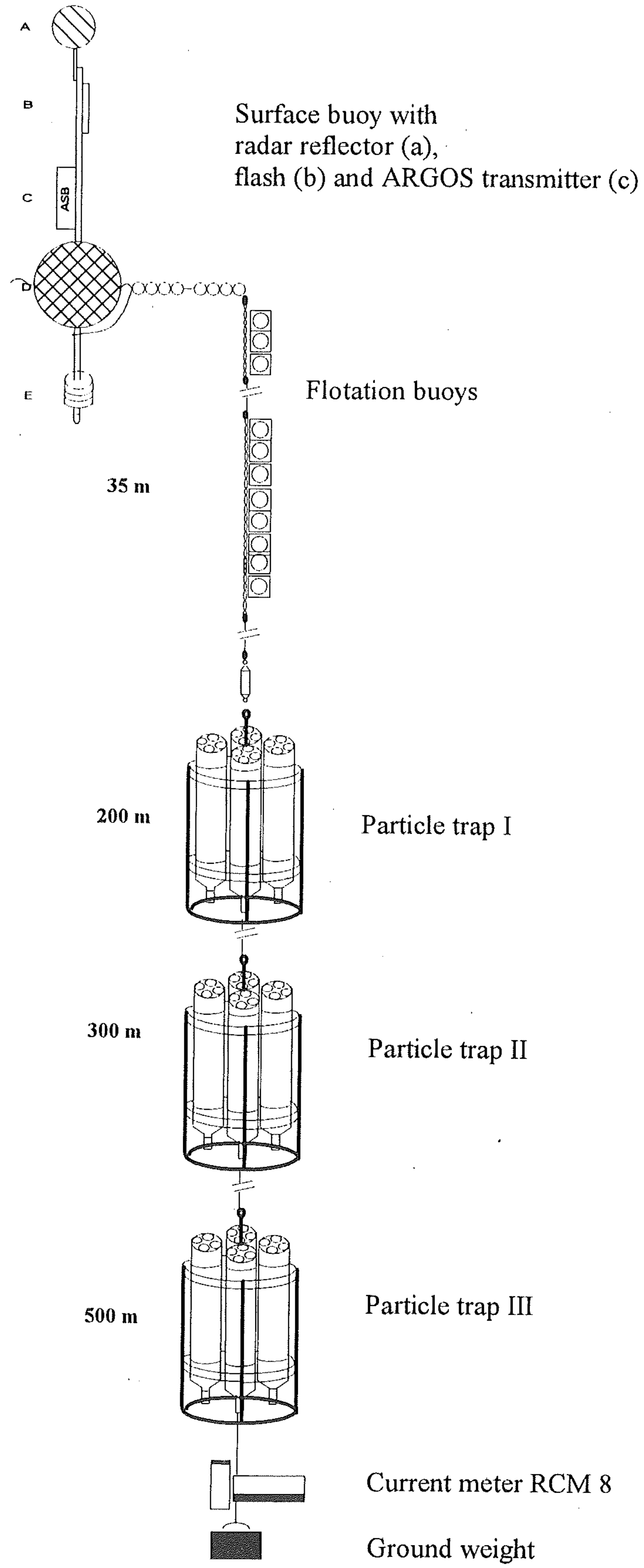


Figure 14. Drifter III carrying traps 200, 300 and 500 m depth.

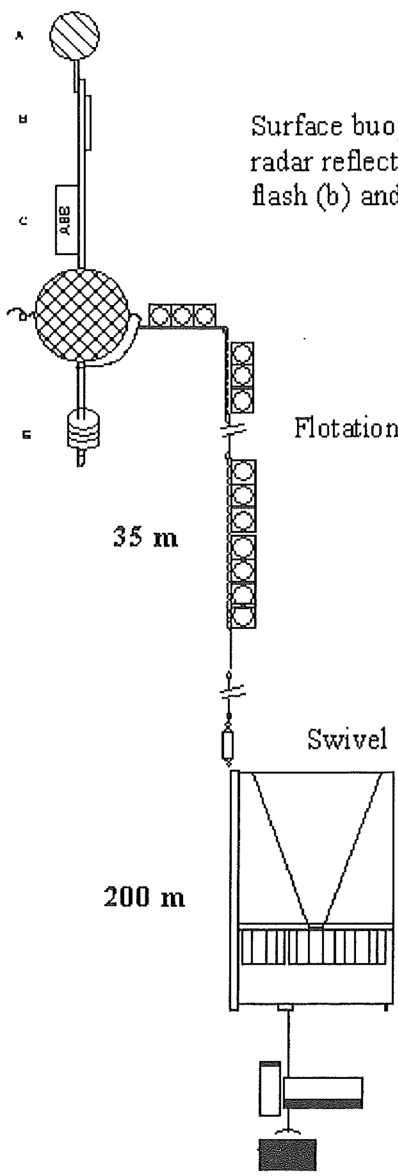


Figure 15. Drifter Aquatec, with an Aquatec 234 trap at 200m depth.

Drifter I was deployed three times (I-1, I-2, I-3), drifter III was deployed once (III-1). The first deployment period lasted from 24-28 March (I-1, III-1) and the second deployment period lasted from 28 -30 March (I-2, Aquatec). During both deployment periods, the traps drifted south (Fig. 16a). Trap I was deployed again from 30 March through 2 April and went almost due west (I-3, Fig. 16b). While the drifting speeds during the first two deployments were in the range expected from the mean water mass movement (see Table 3), drifter I-3 drifted with twice that speed which might indicate manipulation from another vessel. This manipulation and even loss of buoys and transmitters had been experienced on former cruises.

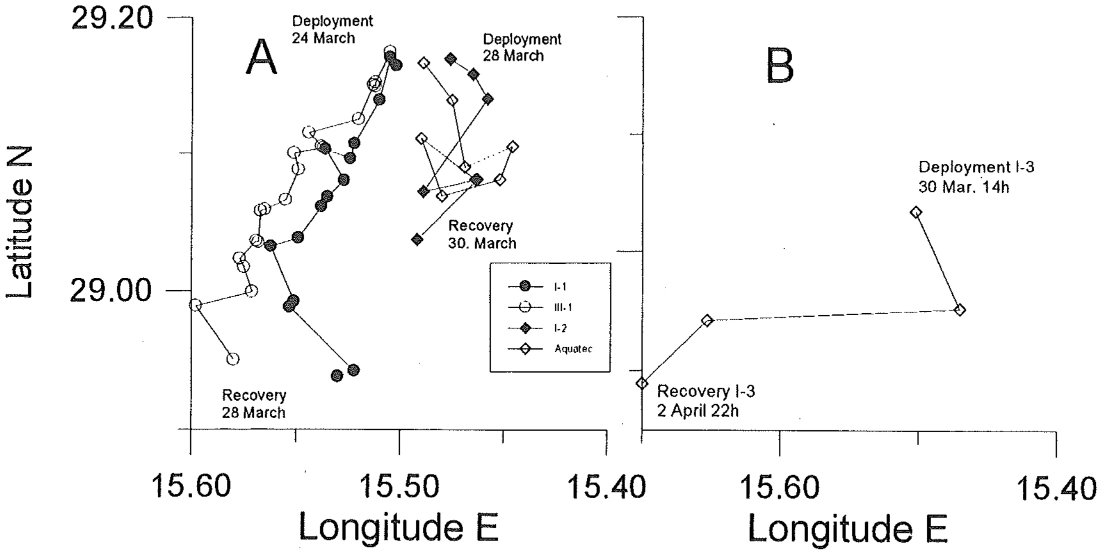


Figure 16. Drift course of drifters deployed during P237/2b. A. Drifters I-1, III-1, I-2 and Aquatec. B. Drifter I-3 which was recovered during P237/3.

Table 3. Distance and drifting speed of the different drifters deployed during P237/2b. For drift course see Figure 14.

Drifter	Distance km	Hours Deployed	Speed cm/s
I-1	25.46	89	7.95
III-1	25.21	89	8.18
I-2	15.02	49	8.51
Aquatec	15.03	48	8.70
I-3	37.58	55	18.98

4.11. Particle flux measurements with moored particle traps

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Particle flux measurements at ESTOC have been carried out since fall of 1991 and show seasonal and short-term variability due to varying productivity and hydrographic conditions. This long-.term particle flux record also indicates that a large portion of deep particle flux originates laterally. In CANIGO, additional sediment traps have been placed north of La Palma (mooring LP) and between the eastern Canary Islands and the Moroccan shelf (moorings EBC 2 and 3). Including the ESTOC position, these three main trap locations cover the productivity gradient from the shelf region to the oligotrophic gyre.

On 24 March, the ESTOC sediment trap mooring CI8 was recovered. It carried three traps, an INFLUX current meter (G. Krause, Bremerhaven), an Aanderaa current meter, 2 particle pumps (Marine Chemistry department, Univ. of Bremen). The surface buoy was sighted before the mooring was released, indicating that the mooring line had been longer than calculated. This may have been due to either to unusual stretching of the rope under pull or wrongly labelled lengths. The latter possibility could no be confirmed upon checking the rope lengths in the laboratory in Bremen. The mooring was re-deployed on 25 March with shorter rope lengths (CI 9, see Fig. 17). It carried three sediment traps in 658m, 936m and 3002 m, one INFLUX current meter below the upper trap, one RCM 8 current meter and one particle camera system (GeoB) below the middle trap, and two particle pumps above the sea floor.

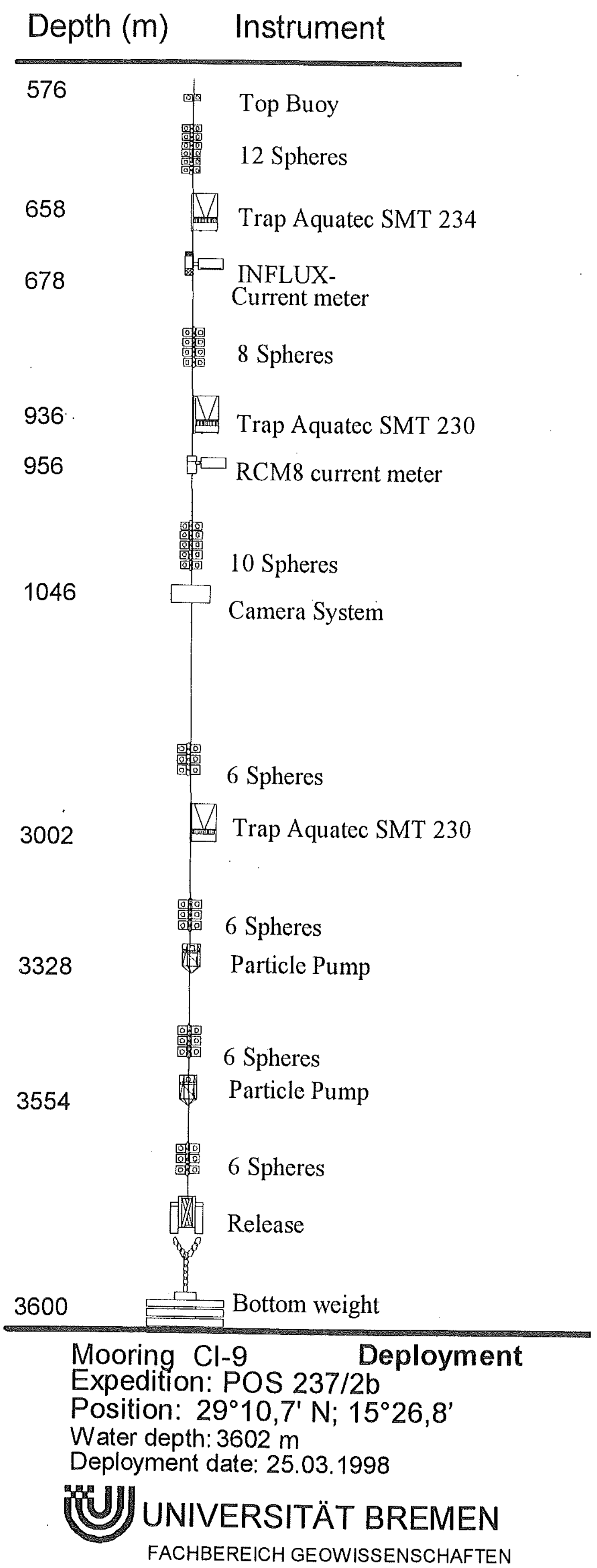

Figure 17. Sediment trap mooring CI9.

5) Concluding remarks

With the exception of the deployment of the surface buoy mooring, we could meet the goals set for cruise POS 237/2. We would like to thank Captain H. Bruns and his crew for the excellent help and collaboration during this cruise. We are grateful to the IfM Kiel for providing the ship time. This research was funded by the Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie (BMBF) and by the EU (MAS3-PL95-0443).

6) Station lists

List of abbreviations:

3H	Tritium
CFC	Chlorofluorocarbons
Chl	Chlorophyll a
CI	Canary Islands
CTD	Conductivity, Temperature, Depth sensor
Dil. Exp.	Dilution Experiment
Dün.	Dünung, long period surface waves
He	Helium
HPLC	Pigment samples to be analysed with High Pressure Liquid Chromatography
Lat N	Latitude North
Lon W	Longiude West
KWS	Kranzwasserschöpfer
MN	Multinet
MSU	Moored Sensor Unit
NB	Neil Brown CTD
NOAA	National Oceanographic and Atmospheric Administration
Nut	Nutrients
O_2	Oxygen
O_2-Incub.	Incubation to determine oxygen change during incubation
POC	Particulate Organic Carbon
Prof.	Profile
SBU	Surface Buoy Unit
See	Sea state
Sta.	Station
u.way	Under way
XBT	Expendable Bathythermograph

6.1 Listing of parameters sampled

Date	Sta.	Prof.	Lat N Lon W	Weather	Depth /m	Time start (UTC)	Ctd	sampling depth /m	He/³H CFC	O_2	Alk/ pH	Chl std ICCM	Chl Geo B	Sal.	Nut	Trace metal	Gelb-stoff	POC	HPLC	Dil-Exp. 0_2-Incub.	Moorings Free-floating traps
23.03.	uw		28°20.0 15°23.0			19:49	XBT u.way	underway-sampling													
23.03.	uw		28°30.0 15°25.0			20:43	XBT u.way	underway-sampling													
23.03.	uw		28°40.0 15°25.5			21:43	XBT u.way	underway-sampling													
23.03.	uw		28°50.0 15°26.0			23:11	XBT u.way	underway-sampling													
24.03.	uw		29°00.0 15°26.7			00:09	XBT u.way	underway-sampling													
24.03.	uw		29°10.0 15°27.0			01:17	XBT u.way	underway-sampling													
24.03.	**100**	001	29°11.3 15°28.6	W`1 3, 2 Dün.	3606	06:54	NB4	200													water for traps
24.03.	**101**		29°11.2 15°27.3	W-SW 3 1-2 Dün.	3602	08:50															recovery CI8
24.03.	101		29°11.8 15°26.8		3602	13:58															NOAA-Drifter
24.03.	**102**		29°09.9 15°30.4	var.1 bis S`1 3-4 1-2 Dün.	3602	15:34		I-1 200													deployment drifter I-1
24.03.	102		29°10.2 15°30.4		3602	16:28		III-1 200,300, 500													deployment drifter III-1
24.03.	**103**	002	29°10.0 15°29.8	S-SW 4-6 2-1 Dün.	3607	16:55	NB4	1000, 800, 600, 400, 300, 200, 141, 116, 91, 66, 41, 16, 1		#	#	# <200 m	# <200 m	#	#	#	#				
24.03.	103	003	29°09.3 15°30.0		3608	20:02	NB4	3670,3500, 3000, 2800, 2500, 2000,		#	#			#	#	# (exl. <100	# (exl. <100				

Date	Sta.	Prof.	Lat N Lon W	Weather	Depth /m	Time start (UTC)	Ctd	sampling depth /m	He/³H CFC	O_2	Alk/ pH	Chl std ICCM	Chl Geo B	Sal.	Nut	Trace metal	Gelb-stoff	POC	HPLC	Dil-Exp. O_2-Incub.	Moorings Free-floating traps
								1800, 1500, 1300, 1200, 1100, 800, 8								0m)	0m)				
24.03.	103	004	29°07.7 15°29.2		3632	00:19	NB4	3600,3400, 3200, 3000, 2000, 1700, 1400, 1200, 1000, 800, 600, 400, 300, 200, 141, 91, 66, 41, 9, 1	#												
25.03.	**104**		29°09.6 15°25.5	S'1 2-3 bis var.1 2-1 Dün.	3605	08:00															deployment CI9
25.03.	**105**		29°10.0 15°20.0	E'1 2-3 See 1	?	12:58															recovery SBU-mooring DOMEST
25.03.	uw		transect	var.		18:28		underway-sampling (surface)			#	#									
26.03.	**106**	005	28°32.0 12°29.9	E 2 See 1	9ß	7:25	NB4														pressure sensor failed
26.03.	**107**	006	28°31.8 12°29.9	Stille See 0	102	8:00	NB4	102 , 83, 58, 33, 18, 10		#	#	#			#			#			
26.03.	**108**	008	28°42.3 13°18.1	Stille See 0	1034	12:34	NB4	1045, 1000, 900, 875, 850. 825, 800, 775, 750, 700, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25, 10		#	#	#			#			# 600, 300, 200, 100, 75, 50. 25, 10			
26.03.	108	009	28°42.5 13°19.0		1092	14:53	NB4														fluorometer-test

Date	Sta.	Prof.	Lat N Lon W	Weather	Depth /m	Time start (UTC)	Ctd	sampling depth /m	He/³H CFC	O_2	Alk/ pH	Chl std ICCM	Chl Geo B	Sal.	Nut	Trace metal	Gelb-stoff	POC	HPLC	Dil-Exp. 0_2-Incub.	Moorings Free-floating traps
26.03.	108	010	28°42.4 13°19.0		1096	15:20	NB4														tubidity-device test
26.03.	**109**	011	28°08.0 14°00.0	Stille See 0	1180	20:19	NB4	1185, 1000, 800, 600, 400, 300, 200, 100, 75, 50, 25, 10		#		# <200 m			#					# 50/25 m	
27.03.	**110**	012	27°38.0 14°29.9	W5 - SW3 See 3-2	2277	07:40	NB4	2290 ,2000 1800, 1500, 1300, 1100, 1000, 800, 700, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25, 10		#		# <200 m			#			# < 1000 m			
27.03.	**111**	013	27°45.9 14°42.0	SSE 3 See: 2	2201	11:27	NB4	2200, 2000, 1800, 1500, 1300, 1100, 1000, 800, 700, 600, 400, 300, 200, 150, 75, 50, 25, 10		#		# <200 m			#			# < 1000 m			
27.03.	**112**	014	27°53.9 14°52.9		973	14:50	NB4														tubidity-device test
27.03.	112	015	27°53.7 14°52.8	S 4 See: 3	1031	15:50	NB4	1046, 1000, 800, 700, 600, 400, 300, 200, 150, 125, 108, 75, 50, 25, 10		#		# <200 m			#			# < 1000 m			
27.03.	**113**	016	28°16.4	SW 3-4	951	20:26	NB4	977, 800,		#		#			#						water for

Date	Sta.	Prof.	Lat N Lon W	Weather	Depth /m	Time start (UTC)	Ctd	sampling depth /m	He/^{3}H CFC	O_2	Alk/ pH	Chl std ICCM	Chl Geo B	Sal.	Nut	Trace metal	Gelb-stoff	POC	HPLC	Dil-Exp. 0_2-Incub.	Moorings Free-floating traps
			14°20.9	bis NW 3 See: 3-2				7ß0, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25, 10				<200 m									traps
28.03.	**114**		28°56.3 15°32.1	var. 2-3 See: 2	3600	08:03															recovery drifter I/1
28.03.	114		28°56.7 15°35.2		3600	09:29															recovery drifter III/1
28.03.	114	017	28°56.7 15°35.2		3607	09:37	NB4	200, 150, 100. 75, 50, 25, 10, 0					#						#		
28.03.	**115**		29°10.3 15°29.9	var. 2-3 bis W5 See 2-4	3600	12:09		I-2 200													deployment drifter I/2
28.03.	115		29°10.3 15°29.4		3600	12:29		200													deployment Aquatec drifter
28.03.	115	018	29°10.1 15°26.6		3604	13:19	NB4	3600, 3400, 3200, 3000, 2000, 1700, 1400, 1200, 1000, 800, 600, 400, 300, 200, 150, 100, 75,50, 25, 10	#				# <200 m								
28.03.	115		29°10.1 15°25.6		3603	16:15		900													acoustic modem test I
28.03.	115		29°09.6 15°25.5		3602	17:26		900													acoustic modem test II
28.03.	115	019	29°09.6 15°25.5		3601	18:41	NB4	3000, 2500, 2000, 1700, 1500, 1400,	# 3000, 1700.	#		# <200 m			#						

Date	Sta.	Prof.	Lat N Lon W	Weather	Depth /m	Time start (UTC)	Ctd	sampling depth /m	He/³H CFC	O_2	Alk/ pH	Chl std ICCM	Chl Geo B	Sal.	Nut	Trace metal	Gelb- stoff	POC	HPLC	Dil-Exp. 0_2-Incub.	Moorings Free-floating traps
								1200, 1100, 1000, 900, 300, 200, 150, 100, 75,50, 25, 10	1400, 400												
28.03.	115	020	29°10.0 15°26.0		3602	22:30	NB4	300, 200, 150, 125, 100, 75, 50, 25, 10		#		#			#					#	
29.03.	**116**		29°08.9 15°20.1	W'1 5-3 3-2 Dün.	3600	08:00															deployment MSU and acoustic modem test
30.03.	**117**		29°10.3 15°18.9	W'1 2-3 See: 2	3600	07:45															recovery of MSU mooring
30.03.	**118**	21	29°03.0 15°28.7	NW 2-3 See: 2	3605	11:12	NB4	200, 150, 125, 100, 75, 50, 25, 10					#					#	#		
30.03.	118		29°02.2 15°29.5		3600	12:21															recovery drifter I/2
30.03.	118		29°02.2 15°29.5		3600	12:31															recovery Aquatec drifter
30.03.	**119**		29°16.1 15°30.1	NW 2-3 See: 2	3604	14:11		I-3 200													deployment drifter I/3
30.03.	119	22	29°15.5 15°29.5		3604	14:37	NB4	200, 150, 125, 100, 75, 50, 25, 10					#								

6.2. GeoB station list

(including multinet sampling conducted on leg POS 237/3)

GeoB #	Poseidon #	Date 1998	Coring	Time	Latitude	Longitude	Water	Core-	Remarks
237/2b									
5301-1	100	24.03	KWS/CTD	06:54	29°11,3	15°28,6	3606	-	water for traps
5302-1	101	24.03	CI-8	08:00	29°11,2	15°27,3	3602	-	recovery CI8
5302-2	101		NOAA	13:58	29°11,8	13°26,8	3602	-	Drifter out
5303-1	102	24.03	Trap I-1	15:15	29°09,9	15°30,4	3602	-	Trap I-1 out
5303-2	102	24.03	Trap III-1		29°10,2	15°30,4	3602	-	Trap III-1 (200, 300, 500 m) out
5304-1	103	24.03	KWS/CTD	16:56	29°10,0	15°29,8	3607	-	1000, 800, 600, 400, 300, 200, 141, 116, 91, 66, 41, 16, 1 m O^2, Alk/pH, Sal, Nut, Tre mt, Gelbstoff, Chl < 200 m (GeoB + ICCM)
5304-2	103	24.03	KWS/CTD	20:02	29°09,3	15°30,0	3608	-	3670, 3500, 3000, 2800, 2500, 2000, 1800, 1500, 1300, 1200, 1100, 800, 8 m O^2, Alk/ph, Sal, Nut, Tre mt + Gelbstoff (exl. <100 - 0 m)
5304-3	103	25:03	KWS/CTD	00:19	29°07,8	15°29,1	3632		3600, 3400, 3200, 3000, 2000, 1700, 1400, 1200, 1000, 800, 600, 400, 300, 200, 141, 91, 66, 41, 9, 1 m He/^{3}H
5305-1	104	25.03	CI9	08:00	29°09,6	15°25,5	3605	-	Deployment of CI9
5306-1	105	25.03	SBU-	12:58	29°09,0	15°20,2	-	-	Recovery SBU-DOMEST
5307-1	106	26.03	KWS/CTD	07:25	28°32,0	12°29,9	99	-	pressure sensor failed
5308-1	107	26.03	KWS/CTD	08:00	28°31,9	12°29,9	102	-	102, 83, 58, 33, 18, 10 m O^2, Alk/pH, Nut, POC, Chl
5309-1	108	26:03	KWS/CTD	12:30	28°42,3	13°18,1	1007	-	1045, 1000, 900, 875, 850, 825, 800, 775, 750, 700, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25, 10 m O^2, Alk/pH, Nut, POC 600, 300, 300, 100, 75, 50, 25, 10 m, Chl < 200 m (ICCM)
5309-2	108	26.03	KWS/CTD	14:53	28°42,5	13°19,0	1092	-	fluorometer-test
5309-3	108	26.03	KWS/CTD	15:20	28°42,4	13°19,0	1096	-	turbidity-device test
5310-1	109	26.03	KWS/CTD	20:18	28°08,0	14°00,0	1178	-	1185, 1000, 800, 600, 400,

									300, 200, 100, 75, 50, 25, 10, m O^2, Alk/pH 25/50 m, Chl<200 m (ICCM)
5311-1	110	27.03	KWS/CTD	07:30	27°38,0	14°29,9	2277	-	2290, 2200, 1800, 1500, 1300, 1100, 1000, 800, 700, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25, 10 m O^2, Nut, <1000 POC, Chl <200 m (ICCM)
5312-1	111	27.03	KWS/CTD	11:18	27°45,9	14°42,0	2201		2200, 2000, 1800, 1500, 1300, 1100, 1000, 800, 700, 600, 400, 300, 200, 150, 75, 50, 25, 10 m O^2, Nut, <1000 POC, Chl <200 m (ICCM)
5313-1	112	27.03	KWS/CTD	14:50	27°54,0	14°53,0	963		Fluorometer
5313-2	112	27.03	KWS/CTD		27°53,7	14°52,8	1040		1046, 1000, 800, 700, 600, 400, 300, 200, 150, 125, 108, 75, 50, 25, 10 m O^2, Nut, <1000 POC, Chl <200 m (ICCM)
5314-1	113	27.03	KWS/CTD	20:24	28°16,4	14°20,9	950		977, 800, 700, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25, 10 m O^2, Nut, Chl<200 m (ICCM), Water for Traps
5315-1	114	28.03	Trap I-1	07:53	28°56,3	15°32,1	3607	-	Trap I-1 recovered
5315-2	114	28.03	Trap III-1		28°56,7	15°35,2	3607	-	Trap III-1 recovered
5315-3	114	28.03	KWS/CTD		28°56,7	15°33,2	3607	-	200, 150, 100, 75, 50, 25, 10, 0 m HPLC, Dil-Exp, Chl (GeoB)
5316-1	115	28.03	Trap II-2	11:40	29°10.3	15°29,9	3604	-	Trap I-2 out
5316-2	115	28.03	Aquatec Drifter	12:15	29°10,3	15°29,4	3604	-	Aquatec Drifter out
5316-3	115	28.03	KWS/CTD		29°10,1	15°25,6	3604		3600, 3400, 3200, 3000, 2000, 1700, 1400, 1200, 1000, 800, 600, 400, 300, 200, 150, 100, 75, 50, 25, 10 m He/^3H, Chl < 200 m (GeoB)
5316-4	115	28.03	acoustic modem test		29°10,1	15°25,6	3603		900 m Test
5316-5	115	28.03	modem test		29°09,6	15°25,5	3602		900 m Test
5316-6	115	28.03	KWS/CTD		29°09,6	15°25,5	3601		3000, 2500, 2000, 1700, 1500, 1400, 1200, 1000, 800,

								600, 400, 300, 200, 150, 100, 75, 50, 25, 10 m He/^{3}H, Chl <200 m (ICCM)
5316-7	115	28.03	KWS/CTD		29°10,0	13°26,0	3602	300, 200, 150, 125, 100, 75, 50, 25, 10, 0 m O^2, Chl, Nut, Dil-Exp
5317-1	116	29.03	MSU mooring	08:00	29°08,9	15°20,1	3600	MSU-mooring out, acoustic modem test
5317-2	117	30.03	MSU mooring	07:45	29°10,3	15°18,9	3600	MSU-mooring recovered
5318-1	118	30.03	KWS/CTD	11:12	29°03,0	15°28,7	3605	200, 150, 125, 100, 75, 50, 25, 10 m Chl, POC, HPLC
5318-2	118	30.03	Trap I-2		29°02,2	15°29,5	3600	Trap I-2 recovered
5318-3	118	30.03	Aquatec Drifter		29°02,2	15°29,6	3600	Drifter recovered

237/3

5319-1	119	30.03	Trap I-3	14:11	29°16,1	15°30,1	3604	Trap I-3 recoverd
5319-2	119	30.03	KWS/CTD		29°15,5	15°29,5	3604	200,150, 125, 100, 75, 50, 25, 10 m Chl
5320-1	129	04.04	MN	06:57	28°42	13°12	1050	0-25, 25-50, 50-150, 150-300, 300-500 m
5320-2	129	04.04	CTD	06:57	28°42	13°12	1050	Water for isotopes
5321-1	130	04.04	MN	09:55	28°43,1	13°17,2	1010	0-25, 25-50, 50-150, 150-300, 300-500 m
5321-2	130	04.04	CTD	09:55	28°43,1	13°17,2	1010	Water for isotopes
5322-1	135	04.04	MN	22:13	28°51,3	13°56,3	978	0-25, 25-50, 50-150, 150-300, 300-500 m
5322-2	135	04.04	CTD	22:13	28°51,3	13°56,3	978	Water for isotopes
5323-1	140	05.04	MN	00:15	29°10	15°30	3608	0-25, 25-50, 50-150, 150-300, 300-500 m
5323-2	140	05.04	CTD	00:15	29°10	15°30	3608	Water for isotopes
5324-1	143	06.04	MN	20:18	29°09,8	16°33,9	3702	0-25, 25-50, 50-150, 150-300, 300-500 m
5324-2	143	06.04	CTD	20:18	29°09,8	16°33,9	3702	Water for isotopes
5325-1	148	08.04	MN	02:13	29°47	18°00	4367	0-25, 25-50, 50-150, 150-300, 300-500 m
5325-2	148	08.04	CTD	02:13	29°47	18°00	4367	Water for isotopes
5326-1	165	14.04	MN	14:21	32°03	09°55,5	886	0-25, 25-50, 50-150, 150-300, 300-500 m
5326-2	165	14.04	CTD	14:21	32°03	09°55,5	886	Water for isotopes
5327-1	170	16.04	MN	05:00	28°53,7	14°08,4	2161	0-25, 25-50, 50-150, 150-300, 300-500 m

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