REPORT AND PRELIMINARY RESULTS OF
POSEIDON CRUISE 237/2, VIGO - LAS PALMAS,
18.3. - 31.3. 1998
The "Berichte aus dem Fachbereich Geowissenschaften" are produced at irregular intervals by the Department of Geosciences, Bremen University.

They serve for the publication of experimental works, Ph.D.-theses and scientific contributions made by members of the department.

Reports can be ordered from:

Gisela Boelen
Sonderforschungsbereich 261
Universität Bremen
Postfach 330 440
D 28334 BREMEN

Phone: (49) 421 218-4124
Fax: (49) 421 218-3116

Citation:

Neuer, S. and cruise participants
## CONTENTS

1) Participants .................................................. 2

2) Research programme ......................................... 3

3) Narrative ....................................................... 4

4) Scientific report and first results ......................... 7
   4.1 Coccolithophore sampling ............................... 7
   4.2 Deployment of DOMEST moorings ....................... 7
   4.3 Field tests of the acoustic moorings ................. 10
   4.4 Hydrography and collection of water samples .... 14
   4.5 Nutrients, oxygen and dissolved aluminium ....... 15
   4.6 Plankton biomass ...................................... 16
   4.7 Phytoplankton production rate ....................... 18
   4.8 Carbon dioxide in sea-water and atmosphere ....... 19
   4.9 Tracers .................................................. 23
   4.10 Particle flux measurements with drifting particle traps 23
   4.11 Particle flux measurements with moored particle traps 28

5) Concluding remarks .......................................... 30

6) Station lists ................................................ 31
   6.1 Listing of parameters sampled ....................... 32
   6.2 GeoB station list ..................................... 37
## 1) Participants

<table>
<thead>
<tr>
<th>Name</th>
<th>Institute</th>
<th>Role</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuer, Susanne</td>
<td>GeoB</td>
<td></td>
<td>Particle flux, POC, Incubations Chief scientist on P237/2b</td>
</tr>
<tr>
<td>Meinecke, Gerrit</td>
<td>GeoB</td>
<td></td>
<td>Instrument testing, moorings Chief scientist on P237/2a</td>
</tr>
<tr>
<td>Cianca, Andrés</td>
<td>ICCM</td>
<td></td>
<td>Nutrients, O$_2$, Chl, Incubations</td>
</tr>
<tr>
<td>Deeken, Aloys</td>
<td>UBMCH</td>
<td></td>
<td>Particle pumps, moorings</td>
</tr>
<tr>
<td>Godoy, Juana</td>
<td>ICCM</td>
<td></td>
<td>Nutrients, O$_2$, Chl, Incubations</td>
</tr>
<tr>
<td>Klaas, Christine</td>
<td>ETHZ</td>
<td></td>
<td>Coccolithophorids</td>
</tr>
<tr>
<td>Koy, Uwe</td>
<td>IFMK</td>
<td></td>
<td>CTD</td>
</tr>
<tr>
<td>Laglera, Lluis</td>
<td>ULPGC</td>
<td></td>
<td>CO$_2$-System</td>
</tr>
<tr>
<td>Meggers, Helge</td>
<td>GeoB</td>
<td></td>
<td>Particle flux, POC</td>
</tr>
<tr>
<td>Putzka, Alfred</td>
<td>UBT</td>
<td></td>
<td>Tracergases, CTD</td>
</tr>
<tr>
<td>Ratmeyer, Volker</td>
<td>GeoB</td>
<td></td>
<td>Instrument testing, moorings</td>
</tr>
<tr>
<td>Rosiak, Uwe</td>
<td>GeoB</td>
<td></td>
<td>Instrument testing, moorings</td>
</tr>
</tbody>
</table>

## Institutions

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

IFMK: Institut für Meereskunde, Düsternbrookerweg 20, 24105 Kiel, Germany

ICCM: Instituto Canario de Ciencias Marinas, Apto. Correos 55, 35200 Telde de Gran Canaria, Spain

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

UBT: Physics FB1, Tracer-Oceanography, University of Bremen, Kufsteiner Straße, 28359 Bremen, Germany

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

ETHZ: Geological Institute, Eidgenössische 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.
<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Flasher, Yellow Group 5, alle 20 sec., Firdell Radar Reflektor (210/7) Data Buoy</td>
</tr>
<tr>
<td>20</td>
<td>20m chain</td>
</tr>
<tr>
<td>520</td>
<td>1m chain, 500m steel rope</td>
</tr>
<tr>
<td>1060</td>
<td>1500m Meteor rope 3 x 500 m, 10 Spheres</td>
</tr>
<tr>
<td>2570</td>
<td>2 Spheres, 500m Meteor rope</td>
</tr>
<tr>
<td>3070</td>
<td>2 Spheres, 500m Meteor rope</td>
</tr>
<tr>
<td>3570</td>
<td>6 Spheres, 20m Meteor rope, 1m chain</td>
</tr>
<tr>
<td>3590</td>
<td>Release AR 661 #475, 478, 8m chain, 2x1m chain</td>
</tr>
<tr>
<td>3600</td>
<td>anchor weight</td>
</tr>
</tbody>
</table>

**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

![Figure 4. Schematic drawing of the SBU (Surface Buoy Unit) Mooring.](https://example.com/schematicrawing.png)
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, an 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.
Table 1. Test results of acoustic modem tests.

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

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.
<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Data Buoy</td>
</tr>
<tr>
<td>20</td>
<td>beacon</td>
</tr>
<tr>
<td>520</td>
<td>500m steel rope</td>
</tr>
<tr>
<td>1060</td>
<td>10 Spheres</td>
</tr>
<tr>
<td>1500</td>
<td>1500m Meteor rope</td>
</tr>
<tr>
<td>2570</td>
<td>2 Spheres</td>
</tr>
<tr>
<td>3070</td>
<td>2 Spheres</td>
</tr>
<tr>
<td>3570</td>
<td>6 Spheres</td>
</tr>
<tr>
<td>3590</td>
<td>Releaser AR 661</td>
</tr>
<tr>
<td>3600</td>
<td>anchor weight</td>
</tr>
</tbody>
</table>

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  
UNIVERSITY of BREMEN  
Dept. of Geosciences

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 Oceanics rosette with 21x10 l Niskin bottles.

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 seawater (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 CO₂ surface water pump in a high spatial resolution. High chlorophyll concentrations were determined around 15°W and close to the Moroccan shelf (Fig. 10). The higher chlorophyll concentration in the western part of the transect resulted from a filament originating from the Ferryventura 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).

<table>
<thead>
<tr>
<th>Latitude W dez.</th>
<th>Longitude N dez</th>
<th>Chlorophyll (μg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-14,85</td>
<td>29,05</td>
<td>0,17</td>
</tr>
<tr>
<td>-14,77</td>
<td>29,02</td>
<td>0,13</td>
</tr>
<tr>
<td>-14,67</td>
<td>29,00</td>
<td>0,12</td>
</tr>
<tr>
<td>-14,57</td>
<td>28,97</td>
<td>0,12</td>
</tr>
<tr>
<td>-14,47</td>
<td>28,95</td>
<td>0,12</td>
</tr>
<tr>
<td>-14,35</td>
<td>28,92</td>
<td>0,12</td>
</tr>
<tr>
<td>-14,23</td>
<td>28,88</td>
<td>0,11</td>
</tr>
<tr>
<td>-14,15</td>
<td>28,87</td>
<td>0,12</td>
</tr>
<tr>
<td>-14,03</td>
<td>28,85</td>
<td>0,11</td>
</tr>
<tr>
<td>-13,93</td>
<td>28,83</td>
<td>0,12</td>
</tr>
<tr>
<td>-13,83</td>
<td>28,80</td>
<td>0,12</td>
</tr>
<tr>
<td>-13,73</td>
<td>28,78</td>
<td>0,13</td>
</tr>
<tr>
<td>-13,63</td>
<td>28,77</td>
<td>0,12</td>
</tr>
<tr>
<td>-13,53</td>
<td>28,75</td>
<td>0,13</td>
</tr>
<tr>
<td>-13,43</td>
<td>28,72</td>
<td>0,11</td>
</tr>
<tr>
<td>-13,35</td>
<td>28,70</td>
<td>0,13</td>
</tr>
<tr>
<td>-13,25</td>
<td>28,68</td>
<td>0,13</td>
</tr>
<tr>
<td>-13,15</td>
<td>28,65</td>
<td>0,13</td>
</tr>
<tr>
<td>-13,05</td>
<td>28,63</td>
<td>0,12</td>
</tr>
<tr>
<td>-12,97</td>
<td>28,62</td>
<td>0,12</td>
</tr>
<tr>
<td>-12,90</td>
<td>28,60</td>
<td>0,13</td>
</tr>
<tr>
<td>-12,83</td>
<td>28,58</td>
<td>0,14</td>
</tr>
<tr>
<td>-12,77</td>
<td>28,58</td>
<td>0,22</td>
</tr>
<tr>
<td>-12,70</td>
<td>28,57</td>
<td>0,17</td>
</tr>
<tr>
<td>-12,62</td>
<td>28,57</td>
<td>0,17</td>
</tr>
<tr>
<td>-12,55</td>
<td>28,55</td>
<td>0,14</td>
</tr>
<tr>
<td>-12,50</td>
<td>28,53</td>
<td>0,16</td>
</tr>
</tbody>
</table>
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 50 m 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\textsubscript{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\textsubscript{2}, TCO\textsubscript{2}, titration total alkalinity TA, pH and pCO\textsubscript{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\textsubscript{2} was determined from 28 to 31 March 1998, in the ESTOC location and vicinity, together with air pCO\textsubscript{2} value (each hour). The possibility to use this system in
the RV Poseidon will allow us to compare the theoretical pCO₂ 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 hours 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 CO₂ 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 μmol 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 CO₂ 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 = 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 pCO₂ values in surface waters, we observed (Fig. 12) that the pCO₂ (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 CO₂ with an average ΔpCO₂ value of – 20 μatm. It must be pointed out that sinking of CO₂ 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.
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

Julian Day
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 $^3$He 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 1 carrying one trap at 200m depth.
Surface buoy with radar reflector (a), flash (b) and ARGOS transmitter (c)

Flotation buoys

35 m

Particle trap I

200 m

Particle trap II

300 m

Particle trap III

500 m

Current meter RCM 8

Ground weight

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.

<table>
<thead>
<tr>
<th>Drifter</th>
<th>Distance km</th>
<th>Hours Deployed</th>
<th>Speed cm/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-1</td>
<td>25.46</td>
<td>89</td>
<td>7.95</td>
</tr>
<tr>
<td>III-1</td>
<td>25.21</td>
<td>89</td>
<td>8.18</td>
</tr>
<tr>
<td>I-2</td>
<td>15.02</td>
<td>49</td>
<td>8.51</td>
</tr>
<tr>
<td>Aquatec</td>
<td>15.03</td>
<td>48</td>
<td>8.70</td>
</tr>
<tr>
<td>I-3</td>
<td>37.58</td>
<td>55</td>
<td>18.98</td>
</tr>
</tbody>
</table>
4.11. Particle flux measurements with moored particle traps
Susanne Neuer, Volker Ratmeyer, Alois Deeken

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 CI 8 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 not 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 658 m, 936 m 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.
<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>576</td>
<td>Top Buoy</td>
</tr>
<tr>
<td></td>
<td>12 Spheres</td>
</tr>
<tr>
<td>658</td>
<td>Trap Aquatec SMT 234</td>
</tr>
<tr>
<td>678</td>
<td>INFLUX-Current meter</td>
</tr>
<tr>
<td></td>
<td>8 Spheres</td>
</tr>
<tr>
<td>936</td>
<td>Trap Aquatec SMT 230</td>
</tr>
<tr>
<td>956</td>
<td>RCM8 current meter</td>
</tr>
<tr>
<td>1046</td>
<td>Camera System</td>
</tr>
<tr>
<td></td>
<td>10 Spheres</td>
</tr>
<tr>
<td>3002</td>
<td>Trap Aquatec SMT 230</td>
</tr>
<tr>
<td>3328</td>
<td>Particle Pump</td>
</tr>
<tr>
<td>3554</td>
<td>Particle Pump</td>
</tr>
<tr>
<td>3600</td>
<td>Release</td>
</tr>
</tbody>
</table>

Mooring CI-9

Deployment

Expedition: POS 237/2b
Position: 29°10,7' N; 15°26,8' W
Water depth: 3602 m
Deployment date: 25.03.1998

UNIVERSITÄT BREMEN
FACHBEREICH GEOWISSENSCHAFTEN

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:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3H</td>
<td>Tritium</td>
</tr>
<tr>
<td>CFC</td>
<td>Chlorofluorocarbons</td>
</tr>
<tr>
<td>Chl</td>
<td>Chlorophyll a</td>
</tr>
<tr>
<td>CI</td>
<td>Canary Islands</td>
</tr>
<tr>
<td>CTD</td>
<td>Conductivity, Temperature, Depth sensor</td>
</tr>
<tr>
<td>Dil. Exp.</td>
<td>Dilution Experiment</td>
</tr>
<tr>
<td>Dün.</td>
<td>Dünung, long period surface waves</td>
</tr>
<tr>
<td>He</td>
<td>Helium</td>
</tr>
<tr>
<td>HPLC</td>
<td>Pigment samples to be analysed with High Pressure Liquid Chromatography</td>
</tr>
<tr>
<td>Lat N</td>
<td>Latitude North</td>
</tr>
<tr>
<td>Lon W</td>
<td>Longitude West</td>
</tr>
<tr>
<td>KWS</td>
<td>Kranzwasserschöpfer</td>
</tr>
<tr>
<td>MN</td>
<td>Multinet</td>
</tr>
<tr>
<td>MSU</td>
<td>Moored Sensor Unit</td>
</tr>
<tr>
<td>NB</td>
<td>Neil Brown CTD</td>
</tr>
<tr>
<td>NOAA</td>
<td>National Oceanographic and Atmospheric Administration</td>
</tr>
<tr>
<td>Nut</td>
<td>Nutrients</td>
</tr>
<tr>
<td>O₂</td>
<td>Oxygen</td>
</tr>
<tr>
<td>O₂ Incub.</td>
<td>Incubation to determine oxygen change during incubation</td>
</tr>
<tr>
<td>POC</td>
<td>Particulate Organic Carbon</td>
</tr>
<tr>
<td>Prof.</td>
<td>Profile</td>
</tr>
<tr>
<td>SBU</td>
<td>Surface Buoy Unit</td>
</tr>
<tr>
<td>Sta.</td>
<td>Station</td>
</tr>
<tr>
<td>u.way</td>
<td>Under way</td>
</tr>
<tr>
<td>XBT</td>
<td>Expendable Bathythermograph</td>
</tr>
</tbody>
</table>
6.1 Listing of parameters sampled

<table>
<thead>
<tr>
<th>Date</th>
<th>Sta.</th>
<th>Prof.</th>
<th>Lat N Lon W</th>
<th>Weather</th>
<th>Depth /m</th>
<th>Time start (UTC)</th>
<th>Ctd</th>
<th>sampling depth /m</th>
<th>He²/H CFC</th>
<th>O₂</th>
<th>Alk/ pH</th>
<th>Chl std</th>
<th>Chl Geo B</th>
<th>Sal.</th>
<th>Nut</th>
<th>Trace metal</th>
<th>Gelbstoff</th>
<th>POC</th>
<th>HPLC</th>
<th>Dil- Exp.</th>
<th>Free-floating traps</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.03.</td>
<td>uw</td>
<td>28°20.0 15°23.0</td>
<td>19:49</td>
<td>XBT u.way</td>
<td>underwater-sampling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.03.</td>
<td>uw</td>
<td>28°30.0 15°25.0</td>
<td>20:43</td>
<td>XBT u.way</td>
<td>underwater-sampling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.03.</td>
<td>uw</td>
<td>28°40.0 15°25.5</td>
<td>21:43</td>
<td>XBT u.way</td>
<td>underwater-sampling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.03.</td>
<td>uw</td>
<td>28°50.0 15°26.0</td>
<td>23:11</td>
<td>XBT u.way</td>
<td>underwater-sampling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.03.</td>
<td>uw</td>
<td>29°00.0 15°26.7</td>
<td>00:09</td>
<td>XBT u.way</td>
<td>underwater-sampling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.03.</td>
<td>uw</td>
<td>29°10.0 15°27.0</td>
<td>01:17</td>
<td>XBT u.way</td>
<td>underwater-sampling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.03.</td>
<td>100</td>
<td>29°11.3 15°28.6</td>
<td>W'13, 2 Dün.</td>
<td>3606</td>
<td>06:54</td>
<td>NB4</td>
<td>200</td>
<td>water for traps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.03.</td>
<td>101</td>
<td>29°11.2 15°27.3</td>
<td>W-SW 3 1-2 Dün.</td>
<td>3602</td>
<td>08:30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.03.</td>
<td>101</td>
<td>29°11.8 15°26.8</td>
<td>13:58</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.03.</td>
<td>102</td>
<td>29°09.9 15°30.4</td>
<td>var.1 bis S'1 bis S'1 bis 1-2 Dün.</td>
<td>3602</td>
<td>15:34</td>
<td>I-I</td>
<td>200</td>
<td>NOAA-Drifter deployment drifter I-I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.03.</td>
<td>102</td>
<td>29°10.2 15°30.4</td>
<td>16:28</td>
<td>III-I</td>
<td>200,300,500</td>
<td></td>
<td></td>
<td>deployment drifter III-I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.03.</td>
<td>103</td>
<td>29°10.0 15°29.8</td>
<td>S-SW 4-6 2-1 Dün.</td>
<td>3607</td>
<td>16:55</td>
<td>NB4</td>
<td>1000, 800, 600, 400, 300, 200, 141, 116, 91, 66, 41, 16, 1</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>&lt;200 m</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>(excl. &lt;100)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.03.</td>
<td>103</td>
<td>29°09.3 15°30.0</td>
<td>20:02</td>
<td>NB4</td>
<td>3670,3500,3000,2800,2500,2000,</td>
<td>#</td>
<td>#</td>
<td>(excl. &lt;100)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Sta</td>
<td>Prof</td>
<td>Lat N</td>
<td>Lon W</td>
<td>Weather</td>
<td>Depth /m</td>
<td>Time start (UTC)</td>
<td>Ctd</td>
<td>sampling depth /m</td>
<td>He/H CFC</td>
<td>O₂</td>
<td>Alk</td>
<td>pH</td>
<td>Chl</td>
<td>Chl Geo</td>
<td>B</td>
<td>Sal.</td>
<td>Nut</td>
<td>Trace metal</td>
<td>Gelb-</td>
<td>POC</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td>------</td>
<td>--------</td>
<td>-------</td>
<td>---------</td>
<td>----------</td>
<td>------------------</td>
<td>-----</td>
<td>------------------</td>
<td>---------</td>
<td>-----</td>
<td>-----</td>
<td>----</td>
<td>-----</td>
<td>---------</td>
<td>---</td>
<td>------</td>
<td>-----</td>
<td>--------------</td>
<td>-------</td>
<td>-----</td>
</tr>
<tr>
<td>24.03</td>
<td>103</td>
<td>004</td>
<td>29°07.7</td>
<td>15°29.2</td>
<td></td>
<td>3632</td>
<td>00:19</td>
<td>NB4</td>
<td></td>
<td>1800, 1500, 1300, 1200, 1100, 800, 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.03</td>
<td>104</td>
<td></td>
<td>29°09.6</td>
<td>15°25.5</td>
<td>S'/2-3</td>
<td>3605</td>
<td>08:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>bis var. 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.03</td>
<td>105</td>
<td></td>
<td>29°10.0</td>
<td>15°20.0</td>
<td>E'/2-3</td>
<td>?</td>
<td>12:58</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.03</td>
<td>uw</td>
<td></td>
<td></td>
<td></td>
<td>transect</td>
<td>var.</td>
<td>18:28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.03</td>
<td>106</td>
<td>005</td>
<td>28°32.0</td>
<td>12°29.9</td>
<td>E'/2</td>
<td>9B</td>
<td>7:25</td>
<td>NB4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.03</td>
<td>107</td>
<td>006</td>
<td>28°31.8</td>
<td>12°29.9</td>
<td>Stille</td>
<td>102</td>
<td>8:00</td>
<td>NB4</td>
<td>102, 83, 58, 33, 18, 10</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.03</td>
<td>108</td>
<td>008</td>
<td>28°42.3</td>
<td>13°18.1</td>
<td>Stille</td>
<td>1034</td>
<td>12:34</td>
<td>NB4</td>
<td>1045, 1000, 900, 875, 850, 825, 800, 775, 750, 700, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25, 10</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.03</td>
<td>108</td>
<td>009</td>
<td>28°42.5</td>
<td>13°19.0</td>
<td></td>
<td>1092</td>
<td>14:53</td>
<td>NB4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Sta.</td>
<td>Prof</td>
<td>Lat N Lon W</td>
<td>Weather</td>
<td>Depth /m</td>
<td>Time start (UTC)</td>
<td>Ctd</td>
<td>sampling depth /m</td>
<td>He/H CFC</td>
<td>O₂</td>
<td>Alk/ pH</td>
<td>Chl std</td>
<td>Chl Geo</td>
<td>Sal.</td>
<td>Nut</td>
<td>Trace metal</td>
<td>Geißlof</td>
<td>POC</td>
<td>HPLC</td>
<td>Dil-Exp. 0₂- In cub.</td>
<td>Moorings</td>
</tr>
<tr>
<td>--------</td>
<td>------</td>
<td>------</td>
<td>-------------</td>
<td>---------</td>
<td>----------</td>
<td>------------------</td>
<td>-----</td>
<td>-------------------</td>
<td>----------</td>
<td>----</td>
<td>--------</td>
<td>---------</td>
<td>---------</td>
<td>------</td>
<td>-----</td>
<td>--------------</td>
<td>---------</td>
<td>-----</td>
<td>-------</td>
<td>----------------------</td>
<td>----------</td>
</tr>
<tr>
<td>26.03.</td>
<td>108</td>
<td>010</td>
<td>28°42.4 13°19.0</td>
<td></td>
<td>1096</td>
<td>15:20</td>
<td>NB4</td>
<td>1185, 1000, 800, 600, 400, 300, 200, 100, 75, 50, 25, 10</td>
<td>#</td>
<td>&lt;200 m</td>
<td>#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>tubidity-traps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.03.</td>
<td>109</td>
<td>011</td>
<td>28°08.0 14°00.0</td>
<td>Stille See 0</td>
<td>1180</td>
<td>20:19</td>
<td>NB4</td>
<td>1185, 1000, 800, 600, 400, 300, 200, 100, 75, 50, 25, 10</td>
<td>#</td>
<td>&lt;200 m</td>
<td>#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50/25 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.03.</td>
<td>110</td>
<td>012</td>
<td>27°38.0 14°29.9</td>
<td>W5 - SW3 See 3-2</td>
<td>2277</td>
<td>07:40</td>
<td>NB4</td>
<td>1185, 1000, 800, 600, 400, 300, 200, 100, 75, 50, 25, 10</td>
<td>#</td>
<td>&lt;200 m</td>
<td>#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;1000 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.03.</td>
<td>111</td>
<td>013</td>
<td>27°45.9 14°42.0</td>
<td>SSE 3 See: 2</td>
<td>2201</td>
<td>11:27</td>
<td>NB4</td>
<td>1185, 1000, 800, 600, 400, 300, 200, 100, 75, 50, 25, 10</td>
<td>#</td>
<td>&lt;200 m</td>
<td>#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;1000 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.03.</td>
<td>112</td>
<td>014</td>
<td>27°53.9 14°52.9</td>
<td></td>
<td>973</td>
<td>14:50</td>
<td>NB4</td>
<td>1185, 1000, 800, 600, 400, 300, 200, 100, 75, 50, 25, 10</td>
<td>#</td>
<td>&lt;200 m</td>
<td>#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>tubidity-traps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.03.</td>
<td>112</td>
<td>015</td>
<td>27°53.7 14°52.8</td>
<td>S 4 See: 3</td>
<td>1031</td>
<td>15:50</td>
<td>NB4</td>
<td>1185, 1000, 800, 600, 400, 300, 200, 100, 75, 50, 25, 10</td>
<td>#</td>
<td>&lt;200 m</td>
<td>#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;1000 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Sta.</td>
<td>Prof.</td>
<td>Lat N Lon W</td>
<td>Weather</td>
<td>Depth /m</td>
<td>Time start (UTC)</td>
<td>Ctd</td>
<td>sampling depth /m</td>
<td>He/H</td>
<td>O₂</td>
<td>Alk/ pH</td>
<td>Chl std ICM</td>
<td>Chl Geo B</td>
<td>Sal.</td>
<td>Nut</td>
<td>Trace metal</td>
<td>Gelbstoff</td>
<td>POC</td>
<td>HPLC</td>
<td>Dil-Exp.</td>
<td>Free-floating</td>
</tr>
<tr>
<td>--------</td>
<td>------</td>
<td>-------</td>
<td>-------------</td>
<td>--------------------------</td>
<td>----------</td>
<td>------------------</td>
<td>-----</td>
<td>------------------</td>
<td>------</td>
<td>----</td>
<td>--------</td>
<td>-------------</td>
<td>------------</td>
<td>------</td>
<td>-----</td>
<td>-------------</td>
<td>-----------</td>
<td>-----</td>
<td>-------</td>
<td>-----------</td>
<td>----------------</td>
</tr>
<tr>
<td>28.03.</td>
<td>114</td>
<td>28°56.3</td>
<td>15°32.1</td>
<td>var. 2-3 See: 2</td>
<td>3600</td>
<td>08:03</td>
<td></td>
<td>780, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25, 10</td>
<td>&lt;200 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28.03.</td>
<td>114</td>
<td>28°56.7</td>
<td>15°35.2</td>
<td></td>
<td>3600</td>
<td>09:29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>recovery drifter I/1</td>
<td></td>
</tr>
<tr>
<td>28.03.</td>
<td>114</td>
<td>28°56.7</td>
<td>15°35.2</td>
<td></td>
<td>3607</td>
<td>09:37</td>
<td>NB4</td>
<td>200, 150, 100, 75, 50, 25, 10</td>
<td>#</td>
<td>#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>recovery drifter III/1</td>
</tr>
<tr>
<td>28.03.</td>
<td>115</td>
<td>29°10.3</td>
<td>15°29.9</td>
<td>var. 2-3 See: 2</td>
<td>3600</td>
<td>12:09</td>
<td>I-2</td>
<td></td>
<td>200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>deployment drifter I/2</td>
</tr>
<tr>
<td>28.03.</td>
<td>115</td>
<td>29°10.3</td>
<td>15°29.4</td>
<td>var. 2-3 See: 2</td>
<td>3600</td>
<td>12:29</td>
<td></td>
<td></td>
<td>200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>deployment Aquatec drifter</td>
</tr>
<tr>
<td>28.03.</td>
<td>115</td>
<td>29°10.1</td>
<td>15°26.6</td>
<td></td>
<td>3604</td>
<td>13:19</td>
<td>NB4</td>
<td>3600, 3400, 3200, 3000, 2600, 1700, 1400, 1200, 1000, 800, 600, 400, 300, 200, 130, 100, 75, 50, 25, 10</td>
<td>#</td>
<td>#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;200 m</td>
</tr>
<tr>
<td>28.03.</td>
<td>115</td>
<td>29°10.1</td>
<td>15°25.6</td>
<td></td>
<td>3603</td>
<td>16:15</td>
<td></td>
<td></td>
<td>900</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>acoustic modem test I</td>
</tr>
<tr>
<td>28.03.</td>
<td>115</td>
<td>29°09.6</td>
<td>15°25.5</td>
<td></td>
<td>3602</td>
<td>17:26</td>
<td></td>
<td></td>
<td>900</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>acoustic modem test II</td>
</tr>
<tr>
<td>28.03.</td>
<td>115</td>
<td>29°09.6</td>
<td>15°25.5</td>
<td></td>
<td>3601</td>
<td>18:41</td>
<td>NB4</td>
<td>3000, 2500, 2000, 1700, 1500, 1400, 1250, 1000, 750, 500, 250, 100, 75, 50, 25, 10</td>
<td>#</td>
<td>#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;200 m</td>
</tr>
<tr>
<td>Date</td>
<td>Sta.</td>
<td>Prof.</td>
<td>Lat N Lon W</td>
<td>Weather</td>
<td>Depth /m</td>
<td>Time start (UTC)</td>
<td>Ctd</td>
<td>sampling depth /m</td>
<td>HePH</td>
<td>CFC</td>
<td>O2</td>
<td>Alk/ pH</td>
<td>Chl std</td>
<td>ICCM</td>
<td>Chl</td>
<td>Geo</td>
<td>B</td>
<td>Sal.</td>
<td>Nut</td>
<td>Trace</td>
<td>metal</td>
</tr>
<tr>
<td>--------</td>
<td>------</td>
<td>-------</td>
<td>-------------</td>
<td>---------</td>
<td>----------</td>
<td>------------------</td>
<td>------</td>
<td>------------------</td>
<td>---------------</td>
<td>-----</td>
<td>------</td>
<td>---------</td>
<td>---------</td>
<td>------</td>
<td>-----</td>
<td>-----</td>
<td>---</td>
<td>------</td>
<td>-----</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>28.03.</td>
<td>115</td>
<td>020</td>
<td>29°10.0, 15°26.0</td>
<td>3602</td>
<td>22:30</td>
<td>NB4 300, 200, 150, 125, 100, 75, 25, 10</td>
<td>#</td>
<td>#</td>
<td>1200, 1100, 1000, 900, 300, 200, 150, 100, 75, 25, 10</td>
<td>1400, 400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29.03.</td>
<td>116</td>
<td></td>
<td>29°08.9, 15°20.1</td>
<td>3600</td>
<td>08:00</td>
<td>W'1 5-3 3-2 Dtn. 15°20.1</td>
<td>15°26.0</td>
<td>#</td>
<td>deployment MSU and acoustic modem test</td>
<td>recovery of MSU mooring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.03.</td>
<td>117</td>
<td></td>
<td>29°10.3, 15°18.9</td>
<td>3600</td>
<td>07:45</td>
<td>W'1 2-3 See: 2 15°26.0</td>
<td>15°18.9</td>
<td>#</td>
<td>recovery of MSU mooring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.03.</td>
<td>118</td>
<td>21</td>
<td>29°03.0, 15°28.7</td>
<td>3605</td>
<td>11:12</td>
<td>NB4 200, 150, 125, 100, 75, 25, 10</td>
<td>#</td>
<td>#</td>
<td>recovery drifter L/2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.03.</td>
<td>118</td>
<td></td>
<td>29°02.2, 15°29.5</td>
<td>3600</td>
<td>12:21</td>
<td>1-3 200</td>
<td>1-3 200</td>
<td>#</td>
<td>recovery Aquatec drifter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.03.</td>
<td>119</td>
<td></td>
<td>29°16.1, 15°30.1</td>
<td>3604</td>
<td>14:11</td>
<td>200, 150, 125, 100, 75, 25, 10</td>
<td>NB4 200, 150, 125, 100, 75, 25, 10</td>
<td>#</td>
<td>#</td>
<td>deployment drifter L/3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.03.</td>
<td>119</td>
<td>22</td>
<td>29°15.5, 15°29.5</td>
<td>3604</td>
<td>14:37</td>
<td>NB4 200, 150, 125, 100, 75, 25, 10</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 6.2. GeoB station list
(including multinet sampling conducted on leg POS 237/3)

<table>
<thead>
<tr>
<th>GeoB #</th>
<th>Poseidon #</th>
<th>Date</th>
<th>Coring</th>
<th>Time</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Water</th>
<th>Core-</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>KWS/CTD</td>
<td>24.03</td>
<td>06:54</td>
<td>29°11,3</td>
<td>15°28,6</td>
<td>3606</td>
<td>- water for traps</td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>CI-8</td>
<td>24.03</td>
<td>08:00</td>
<td>29°11,2</td>
<td>15°27,3</td>
<td>3602</td>
<td>- recovery CI-8</td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>NOAA</td>
<td>24.03</td>
<td>13:58</td>
<td>29°11,8</td>
<td>13°26,8</td>
<td>3602</td>
<td>- Drifter out</td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>Trap I-1</td>
<td>24.03</td>
<td>15:15</td>
<td>29°09,9</td>
<td>15°30,4</td>
<td>3602</td>
<td>- Trap I-1 out</td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>Trap II-1</td>
<td>24.03</td>
<td>25:10</td>
<td>15°30,4</td>
<td>3602</td>
<td>- Trap II-1 (200, 300, 500 m) out</td>
<td></td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>KWS/CTD</td>
<td>24.03</td>
<td>16:56</td>
<td>29°10,0</td>
<td>15°29,8</td>
<td>3607</td>
<td>- 1000, 800, 600, 400, 300, 290, 141, 116, 91, 66, 41, 16, 1 m O₂, Alk/pH, Sal, Nut, Tre mt, Gelbstoff, Chl &lt; 200 m (GeoB + ICCM)</td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>KWS/CTD</td>
<td>24.03</td>
<td>20:02</td>
<td>29°09,3</td>
<td>15°30,0</td>
<td>3608</td>
<td>- 3670, 3500, 3000, 2800, 2500, 2000, 1800, 1500, 1300, 1200, 1100, 800, 8 m O₂, Alk/pH, Sal, Nut, Tre mt + Gelbstoff (exl. &lt;100 - 0 m)</td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>KWS/CTD</td>
<td>25:03</td>
<td>00:19</td>
<td>29°07,8</td>
<td>15°29,1</td>
<td>3632</td>
<td>- 3600, 3400, 3200, 3000, 2000, 1700, 1400, 1200, 1000, 800, 600, 400, 300, 200, 141, 91, 66, 41, 9, 1 m He/P</td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>CI-9</td>
<td>25.03</td>
<td>08:00</td>
<td>29°09,6</td>
<td>15°25,5</td>
<td>3605</td>
<td>- Deployment of CI-9</td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>SBU-</td>
<td>25.03</td>
<td>12:58</td>
<td>29°09,0</td>
<td>15°20,2</td>
<td>99</td>
<td>- Recovery SBU-DOMEST</td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>KWS/CTD</td>
<td>26.03</td>
<td>07:25</td>
<td>28°32,0</td>
<td>12°29,9</td>
<td>99</td>
<td>- pressure sensor failed</td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>KWS/CTD</td>
<td>26.03</td>
<td>08:00</td>
<td>28°31,9</td>
<td>12°29,9</td>
<td>102</td>
<td>-</td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>KWS/CTD</td>
<td>26.03</td>
<td>12:30</td>
<td>28°42,3</td>
<td>13°18,1</td>
<td>1007</td>
<td>-</td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>KWS/CTD</td>
<td>26.03</td>
<td>14:53</td>
<td>28°42,5</td>
<td>13°19,0</td>
<td>1092</td>
<td>- fluorometer-test</td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>KWS/CTD</td>
<td>26.03</td>
<td>15:20</td>
<td>28°42,4</td>
<td>13°19,0</td>
<td>1096</td>
<td>- turbidity-device test</td>
</tr>
<tr>
<td>237/2b</td>
<td>237/2b</td>
<td>1998</td>
<td>KWS/CTD</td>
<td>26.03</td>
<td>20:18</td>
<td>28°08,0</td>
<td>14°00,0</td>
<td>1178</td>
<td>- 1185, 1000, 800, 600, 400, 875, 850, 825, 800, 775, 750, 700, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25, 10 m O₂, Alk/pH, Nut, POC, Chl (ICCM)</td>
</tr>
</tbody>
</table>
5311-1  110  27.03  KWS/CTD  07:30  27°38.0  14°29.9  2277  -  300, 200, 100, 75, 50, 25, 10, m O², Alk/pH 25/50 m, Chl<200 m (ICCM)

5312-1  111  27.03  KWS/CTD  11:18  27°45.9  14°42.0  2201  -  2290, 2200, 1800, 1500, 1300, 1100, 1000, 800, 700, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25, 10 m O², Nut, <1000 POC, Chl<200 m (ICCM)

5313-1  112  27.03  KWS/CTD  14:50  27°54.0  14°53.0  963  -  2200, 2000, 1800, 1500, 1300, 1100, 1000, 800, 700, 600, 400, 300, 200, 150, 75, 50, 25, 10 m O², Nut, <1000 POC, Chl<200 m (ICCM) 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 O², 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 O², Nut, Chl=200 m (ICCM), Water for Traps

5315-1  114  28.03  Trap I-I  07:53  28°56.3  15°32.1  3607  -  Trap I-I recovered

5315-2  114  28.03  Trap III-I  28°56.7  15°35.2  3607  -  Trap III-I recovered

5315-3  114  28.03  KWS/CTD  28°56.7  15°33.2  3607  -  200, 150, 100, 75, 50, 25, 10 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/H₂, 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,
| 5316-7 | 115 | 28.03 | KWS/CTD | 29°10.0 | 13°26.0 | 3602 |
| 5317-1 | 116 | 29.03 | MSU mooring | 08:00 | 29°08.9 | 15°20.1 | 3600 |
| 5317-2 | 117 | 30.03 | MSU mooring | 07:45 | 29°10.3 | 15°18.9 | 3600 |
| 5318-1 | 118 | 30.03 | KWS/CTD | 11:12 | 29°03.0 | 15°28.7 | 3605 |
| 5318-2 | 118 | 30.03 | Trap I-2 | 29°02.2 | 15°29.5 | 3600 |
| 5318-3 | 118 | 30.03 | Aquatec Drifter | 29°02.2 | 15°29.6 | 3600 |

**237/3**

| 5319-1 | 119 | 30.03 | Trap I-3 | 14:11 | 29°16.1 | 15°30.1 | 3604 |
| 5319-2 | 119 | 30.03 | KWS/CTD | 29°15.5 | 15°29.5 | 3604 |
| 5320-1 | 129 | 04.04 | MN | 06:57 | 28°42 | 13°12 | 1050 |
| 5320-2 | 129 | 04.04 | CTD | 28°42 | 13°12 | 1050 |
| 5321-1 | 130 | 04.04 | MN | 28°43.1 | 13°17.2 | 1010 |
| 5321-2 | 130 | 04.04 | CTD | 28°43.1 | 13°17.2 | 1010 |
| 5322-1 | 135 | 04.04 | MN | 22:13 | 28°51.3 | 13°56.3 | 978 |
| 5322-2 | 135 | 04.04 | CTD | 22:13 | 28°51.3 | 13°56.3 | 978 |
| 5323-1 | 140 | 05.04 | MN | 00:15 | 29°10 | 15°30 | 3608 |
| 5323-2 | 140 | 05.04 | CTD | 00:15 | 29°10 | 15°30 | 3608 |
| 5324-1 | 143 | 06.04 | MN | 20:18 | 29°09.8 | 16°33.9 | 3702 |
| 5324-2 | 143 | 06.04 | CTD | 20:18 | 29°09.8 | 16°33.9 | 3702 |
| 5325-1 | 148 | 08.04 | MN | 29°47 | 18°00 | 4367 |
| 5325-2 | 148 | 08.04 | CTD | 29°47 | 18°00 | 4367 |
| 5326-1 | 165 | 14.04 | MN | 32°03 | 09°55.5 | 886 |
| 5326-2 | 165 | 14.04 | CTD | 32°03 | 09°55.5 | 886 |
| 5327-1 | 170 | 16.04 | MN | 05:00 | 28°53.7 | 14°08.4 | 2161 |

---

**Notes:**
- 600, 400, 300, 200, 150, 100, 75, 50, 25, 10 m He/II, Chl <200 m (ICCM)
- 300, 200, 150, 125, 100, 75, 50, 25, 10 m O², Chl, Nut, D1-Exp
- MSU-mooring out, acoustic modem test
- MSU-mooring recovered
- 200, 150, 125, 100, 75, 50, 25, 10 m Chl, POC, HPLC
- Trap I-2 recovered
- Drifter recovered
- Trap I-3 recovered
- 200, 150, 125, 100, 75, 50, 25, 10 m Chl
- 0-25, 25-50, 50-150, 150-300, 300-500 m
- Water for isotopes
- 0-25, 25-50, 50-150, 150-300, 300-500 m
- Water for isotopes
- 0-25, 25-50, 50-150, 150-300, 300-500 m
- Water for isotopes
- 0-25, 25-50, 50-150, 150-300, 300-500 m
- Water for isotopes
- 0-25, 25-50, 50-150, 150-300, 300-500 m
- Water for isotopes
- 0-25, 25-50, 50-150, 150-300, 300-500 m
- Water for isotopes
- 0-25, 25-50, 50-150, 150-300, 300-500 m
- Water for isotopes
- 0-25, 25-50, 50-150, 150-300, 300-500 m
- Water for isotopes
- 0-25, 25-50, 50-150, 150-300, 300-500 m
Publications of this series:

No. 1  Wefer, G., E. Suess and cruise participants
       60 pages, Bremen, 1986.

No. 2  Hoffmann, G.
       Holozänstratigraphie und Küstenlinienverlagerung an der andalusischen Mittelmeerküste.
       173 pages, Bremen, 1988. (out of print)

No. 3  Wefer, G. and cruise participants

No. 4  Wefer, G., G.F. Lutze, T.J. Müller, O. Pfannkuche, W. Schenke, G. Siedler, W. Zenk
       29 pages, Bremen, 1988. (out of print)

No. 5  Fischer, G.
       Stabile Kohlenstoff-Isotope in partikulärer organischer Substanz aus dem Südpolarmeer

No. 6  Berger, W.H. and G. Wefer
       Partikelfluß und Kohlenstoffkreislauf im Ozean.

No. 7  Wefer, G. and cruise participants

No. 8  Kölling, M.
       Modellierung geochemischer Prozesse im Sickerwasser und Grundwasser.

No. 9  Heinze, P.-M.
       Das Auftriebsgeschehen vor Peru im Spätquartär. 204 pages, Bremen, 1990. (out of print)

       Beiträge zur Geologie und Paläontologie Norddeutschlands: Exkursionsführer.

No. 11 Wefer, G. and cruise participants

No. 12 Dahmke, A., H.D. Schulz, A. Kölling, F. Kracht, A. Lücke
       Schwermetallsupren und geochemische Gleichgewichte zwischen Porenlösung und Sediment

No. 13 Rostek, F.
       Physikalische Strukturen von Tiefseesedimenten des Südatlantiks und ihre Erfassung in

No. 14 Baumann, M.
       Die Ablagerung von Tschernobyl-Radiocäsium in der Norwegischen See und in der Nordsee.
       133 pages, Bremen, 1991. (out of print)

No. 15 Kölling, A.
       Frühdiagenetische Prozesse und Stoff-Flüsse in marinen und ästuarinen Sedimenten.

No. 16 SFB 261 (ed.)
       Der Südatlantik im Spätquartär: Rekonstruktion von Stoffhaushalt und Stromsystemen.

No. 17 Pätzold, J. and cruise participants
       Bericht und erste Ergebnisse über die METEOR-Fahrt M 15/2, Rio de Janeiro - Vitoria,

No. 18 Wefer, G. and cruise participants
       Bericht und erste Ergebnisse über die METEOR-Fahrt M 16/1, Pointe Noire - Recife,

No. 19 Schulz, H.D. and cruise participants
       Bericht und erste Ergebnisse über die METEOR-Fahrt M 16/2, Recife - Belem. 28.4. - 20.5.1991.
No. 20  
**Berner, H.**  

No. 21  
**Schneider, R.**  

No. 22  
**Hebbeln, D.**  

No. 23  
**Lücke, A.**  

No. 24  
**Wefer, G. and cruise participants**  

No. 25  
**Schulz, H.D. and cruise participants**  

No. 26  
**Gingeie, F.**  

No. 27  
**Bickert, T.**  
Rekonstruktion der spätquartären Bodenwasserzirkulation im östlichen Südatlantik über stabile Isotope benthalischer Foraminiferen. 205 pages, Bremen, 1992. (out of print)

No. 28  
**Schmidt, H.**  

No. 29  
**Meinecke, G.**  

No. 30  

No. 31  
**Damm, E.**  

No. 32  
**Antia, E.E.**  

No. 33  
**Duinker, J. and G. Wefer (ed.)**  

No. 34  
**Kasten, S.**  

No. 35  
**Spieß, V.**  

No. 36  
**Schinzel, U.**  

No. 37  
**Sieger, R.**  
CoTAM - ein Modell zur Modellierung des Schwermetalltransports in Grundwasserleitern. 56 pages, Bremen, 1993. (out of print)

No. 38  
**Willems, H. (ed.)**  

No. 39  
**Hamr, K.**  

No. 40  
**Sieger, R.**  
No. 41  Thießen, W.

No. 42  Spieß, V. and cruise participants

No. 43  Bleil, U. and cruise participants

No. 44  Wefer, G. and cruise participants

No. 45  Giese, M. and G. Wefer (ed.)

No. 46  Balzer, W. and cruise participants

No. 47  Stax, R.

No. 48  Skowronek, F.

No. 49  Dersch-Hansmann, M.

No. 50  Zabel, M.

No. 51  Bleil, U. and cruise participants

No. 52  Symposium: The South Atlantic: Present and Past Circulation.

No. 53  Kretzmann, U.B.

No. 54  Bachmann, M.

No. 55  Kemle-von Mücke, S.

No. 56  Petermann, H.

No. 57  Mulitza, S.

No. 58  Segl, M. and cruise participants

No. 59  Bleil, U. and cruise participants

No. 60  Henrich, R. and cruise participants
<table>
<thead>
<tr>
<th>No.</th>
<th>Author</th>
<th>Title and Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>68</td>
<td>Hebbeln, D. and cruise participants</td>
<td>Report and preliminary results of SONNE-Cruise SO 102, Valparaiso - Valparaiso, 95 134 pages, Bremen, 1995.</td>
</tr>
<tr>
<td>72</td>
<td>Teske, A.</td>
<td>Phylogenetische und ökologische Untersuchungen an Bakterien des oxidativen und reduktiven marinen Schwefelkreislaufs mittels ribosomaler RNA. 220 pages, Bremen, 1996. (out of print)</td>
</tr>
<tr>
<td>75</td>
<td>Schüring, J.</td>
<td>Die Verwendung von Steinkohlebergematerialien im Deponiebau im Hinblick auf die Pyritverwitterung und die Eignung als geochemische Barriere. 110 pages, Bremen, 1996.</td>
</tr>
<tr>
<td>78</td>
<td>Schulz, H.D. and cruise participants</td>
<td>Report and preliminary results of METEOR-Cruise M 34/2, Walvis Bay - Walvis Bay, 29.1.-18.2.96 133 pages, Bremen, 1996.</td>
</tr>
</tbody>
</table>
No. 80  Fischer, G. and cruise participants  

No. 81  Kulbrok, F.  

No. 82  Kasten, S.  

No. 83  Holmes, M.E.  
Reconstruction of Surface Ocean Nitrate Utilization in the Southeast Atlantic Ocean Based on Stable Nitrogen Isotopes. 113 pages, Bremen, 1996.

No. 84  Rühlemann, C.  

No. 85  Ratmeyer, V.  

No. 86  Cepek, M.  

No. 87  Otto, S.  

No. 88  Hensen, C.  

No. 89  Giesen, M. and G. Wefer  

No. 90  Wefer, G. and cruise participants  

No. 91  Isenbeck-Schröter, M., E. Bedbur, M. Kofod, B. König, T. Schramm & G. Mattheß  
Occurrence of Pesticide Residues in Water - Assessment of the Current Situation in Selected EU Countries. 65 pages, Bremen 1997.

No. 92  Kühn, M.  

No. 93  Determann, S. & K. Herterich  

No. 94  Fischer, G. and cruise participants  

No. 95  Bleil, U. and cruise participants  

No. 96  Neuer, S. and cruise participants  

No. 97  Villinger, H. and cruise participants  

No. 98  Lüning, S.  

No. 99  Haese, R.R.  
<table>
<thead>
<tr>
<th>No. 100</th>
<th>Lührte, R. von</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. 101</th>
<th>Ebert, M.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Der Einfluß des Redoxmilieus auf die Mobilität von Chrom im durchströmten Aquifer.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. 102</th>
<th>Krögel, F.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. 103</th>
<th>Kerntopf, B.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. 104</th>
<th>Breitzke, M.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. 105</th>
<th>Marchant, M.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. 106</th>
<th>Habicht, K.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sulfur isotope fractionation in marine sediments and bacterial cultures.</td>
</tr>
</tbody>
</table>

|--------|----------------------------------------------------------------------------------------------------------------------------------|

<table>
<thead>
<tr>
<th>No. 108</th>
<th>Greeff, O.W.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. 109</th>
<th>Pätzold, M. und G. Wefer</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. 110</th>
<th>Landenberger, H.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. 111</th>
<th>Villinger, H. und Fahrtteilnehmer</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. 112</th>
<th>Gietl, R.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. 113</th>
<th>Ziebis, W.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The Impact of the Thalassinidean Shrimp Callianassa truncata on the Geochemistry of permeable, coastal Sediments. 158 pages, Bremen 1998.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. 114</th>
<th>Schulz, H.D. and cruise participants</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. 115</th>
<th>Völker, D.J.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. 116</th>
<th>Schlünz, B.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Riverine Organic Carbon Input into the Ocean in Relation to Late Quaternary Climate Change. 136 pages, Bremen, 1998.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. 117</th>
<th>Kuhnert, H.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. 118</th>
<th>Kirst, G.</th>
</tr>
</thead>
</table>
No. 120  Lamy, F.