Institut für Meereskunde
an der Universität Kiel

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Institute of Marine Research
Kiel University
Germany

Cruise Report

F.S.Poseidon **Cruise No.: 233**

Dates of Cruise: 03.09.1997 - 11.10.1997

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

Port Calls:	Lisbon/Portugal	01.09.1997 - 05.09.1997
	Las Palmas de Gran Canaria/Spain	15.09.1997 - 16.09.1997
	Las Palmas de Gran Canaria/Spain	21.09.1997 - 23.09.1997
	Las Palmas de Gran Canaria/Spain	26.09.1997 - 28.09.1997
	Las Palmas de Gran Canaria/Spain	05.10.1997 - 06.10.1997
	Portimao/Portugal	10.10.1997 - 13.10.1997

IFMK Department: Marine Physics

Chief Scientists: Dr. Michaela Knoll (P233 a), Dr. Thomas J. Müller (P233 b-d)

Number of Scientists: 10 (P233 a), 10 (P233 b), 10 (P233 c), 7 (P233 d)

Projects: EU MAST III Regional Seas Project CANIGO
JGOFS time series station ESTOC

Cruise Report

This cruise report consists of 41 pages including cover:

1. Scientific Crew

P233 a (03.09.1997 - 21.09.1997)

Name	Function	Discipline	Institution
1. Knoll, Michaela, Dr.	chief scientist	physical oceanogr.	IFMK
2. Bollmann, Jörg, Dr.	scientist	geology	ETHZ
3. Cianca, Andres	scientist	chemical oceanogr.	ICCM
4. Godoy, Juana	scientist	chemical oceanogr.	ICCM
5. Hilmi, Karim	observer	physical oceanogr.	INRH
6. Koy, Uwe	technician	physical oceanogr.	IFMK
7. Lenz, Bernd	scientist	physical oceanogr.	IFMK
8. Reppin, Jörg	scientist	physical oceanogr.	IFMK
9. Rocha, Francisco J.	technician	chemical oceanogr.	ICCM
10. Villagarcia, Maria, Dr.	scientist	chemical oceanogr.	ICCM

P233 b (21.09.1997 - 27.09.1997)

Name	Function	Discipline	Institution
1. Müller, Thomas J., Dr.	chief scientist	physical oceanogr.	IFMK
2. Deeken, Aloys	technician	chemical oceanogr.	UBMCh
3. Freudenthal, Tim	scientist	biological oceanogr.	GeoB
4. Koy, Uwe	technician	physical oceanogr.	IFMK
5. Lenz, Bernd	scientist	physical oceanogr.	IFMK
6. Neuer, Susanne, Dr.	scientist	biological oceanogr.	GeoB
7. Reppin, Jörg	scientist	physical oceanogr.	IFMK
8. Segl, Monika, Dr.	scientist	biological oceanogr.	GeoB
9. Sprengel, Claudia	scientist	biological oceanogr.	GeoB
10. Torres, Silvia	scientist	physical oceanogr.	IEO

P233 c (28.09.1997 - 05.10.1997)

Name	Function	Discipline	Institution
1. Müller, Thomas J., Dr.	chief scientist	physical oceanogr.	IFMK
2. Carlsen, Dieter	technician	physical oceanogr.	IFMK
3. Cisneros, Jesus	scientist	physical oceanogr.	ULPGC
4. Freudenthal, Tim	scientist	biological oceanogr.	GeoB
5. Garcia-Ramos, Carlos	scientist	physical oceanogr.	IEO
6. Lenz, Bernd	scientist	physical oceanogr.	IFMK
7. Lopez-L., Federico	scientist	physical oceanogr.	IEO
8. Meyer, Peter	engineer	physical oceanogr.	IFMK
9. Neuer, Susanne, Dr.	scientist	biological oceanogr.	GeoB
10. Sangra, Pablo, Dr.	scientist	physical oceanogr.	ULPGC

P233 d (06.10.1997 - 11.10.1997)

Name	Function	Discipline	Institution
1. Müller, Thomas J., Dr.	chief scientist	physical oceanogr.	IFMK
2. Carlsen, Dieter	technician	physical oceanogr.	IFMK
3. Deeken, Aloys	technician	chemical oceanogr.	UBMCh
4. Klass, Christine, Dr.	scientist	geology	ETHZ
5. Meyer, Peter	engineer	physical oceanogr.	IFMK
6. Rose, Henning	scientist	physics	UBT
7. Jäppinen, Tom	engineer	chemical oceanogr.	IBGMH

Participating institutions

IEO : Instituto Español de Oceanografia, COC, Sta. Cruz, TF, Spain
IFMK : Institut für Meereskunde an der Universität Kiel, Germany
GeoB : FB5, Geowissenschaften, Universität Bremen, Germany
ICCM : Instituto Canario de Ciencias Marinas, Telde de Gran Canaria Spain
INRH : Institut National de Recherche Halieutique, Casablanca, Morocco
ULPGC : Universidad de Las Palmas, Gran Canaria, Spain
ETHZ : Eidgenössisch Technische Hochschule, Zürich, Switzerland
IBGMH : Institut für Biogeochemie u. Meereschemie, Universität Hambug, Germany
UBT : FB 1, Physik, Tracerozeanographie, Universität Bremen, Germany
UBMCh : FB 2, Biologie/Chemie, Meereschemie, Universität Bremen, Germany

2. Research Programme

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

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

The POSEIDON cruise 233a was the second of a total of four cruises during different seasons to determine the variability of the physical environment in the eastern Canary Basin (Task 1.2.4: Eastern Canary Basin hydrography, Task 1.3.2: Mesoscale variability and seasonal variations in the Canary Islands region). CTD/LADCP sections including biological and chemical sampling were carried out between the African Shelf, Madeira, La Palma and back to the African shelf to obtain a closed hydrographic box for budget calculations. Sampling for coccolithophorids, diatoms and planktic foraminifera was part of the CANIGO subproject 3: Particle flux and paleoceanography in the Eastern Boundary Current, task 3.1.2: Flux of organisms. The scientific goals are (a) to obtain a better understanding of the seasonal and

interannual interaction between planktonic organisms and the physical environment along a WE-transect north of the Canary Islands and (b) to compare this interaction with the long-term variability of species composition and flux into the sedimentary archives.

During P233b and P233c, the main work was aimed at exchanging moorings for ESTOC and CANIGO (Task 1.3.3: The Eastern Boundary Current System from Eulerian Measurements), and to obtain the CTD and sample profile for the October 1997 ESTOC station. The moorings were designed to study the mean flow and particle flux, and their variability on long time scales including interannual variations (i) close to the ESTOC station (GeoB and IFMK mooring sites ESTOC/CI and ESTOC/367, respectively) that also serve as a background stations for CANIGO, (ii) in the coastal and upwelling influenced area of the Eastern Boundary Current System east of Lanzarote/Fuerteventura (EBC), and (iii) at a site well off the coastal and upwelling influence in an oligothrophic area at the CANIGO site LP north of La Palma in the open eastern Atlantic.

The transit P233d from Las Palmas to Portimao was used for obtaining anthropogenic tracer (F11, F12, He, H3), dissolved organic Carbon (DOC), and trace metal (mainly Al) samples at the ESTOC position; also three plankton net hauls for coccolithophorids to 30 m at ESTOC and two along the shelf break of Morocco were taken.

3. Narrative of cruise with technical details

3.1 P233a, 05.09. - 21.09.1997, Lisbon - Las Palmas

POSEIDON left Lisbon on 05.09.1997 at 09:00 heading southwestward. Due to a request from the Instituto de Oceanografia, Univ. de Lisboa, (responsible for CANIGO Task 4.3.3: Dynamics of Mediterranean Outflow and meddies - Lagrangian measurements) 2 sound source moorings (IO1, IO2) were deployed during the approach to the hydrographic CANIGO box. The position of mooring IO2 was reached on 06.09.1997 in the early morning and the mooring which was equipped with the sound source at about 1000 m and a release deployed immediately. About 6 hours later POSEIDON reached the position, where the mooring IO1 was deployed at a water depth of about 4000 m. This mooring was also equipped with a sound source at about 1000 m depth and a release. Just south of the mooring position IO1 a CTD test station was carried out down to a water depth of 3000 m. Afterwards, POSEIDON headed to the position close to the African shelf to start the work on the hydrographic CANIGO box.

In the beginning of the cruise the new POSEIDON GG24 receiver from Ashtec was installed. This unit is used for an exact determination of the position from GPS and russian GLONASS satellites. Also four antennas of the ADU2 from Ashtech, which allow the determination of pitch, roll and heading from the GPS signals, were mounted on the very top of the vessel's mast where a good calibration could be made. After the installation, both units improved significantly the vesselmounted ADCP data. The GG24 signal now is also supplied to the vessel's integrated 'underway' data system by which data streams from the navigation, the automized weather station, the thermosalinograph and the digital echo sounding (12 kHz) are merged.

On the hydrographic box, which extends from the African shelf towards Madeira then southward to La Palma and back to the African shelf, CTD/LADCP stations were made. Most

of the stations were already sampled during the METEOR cruise 37 in January 1997. The CTD was equipped with an oxygen sensor and at stations with a water depth of less than 3000 m an in-situ fluorometer was also attached. On each station water samples were obtained with a GO-rosette equipped with 21 x 10 l Niskin bottles. The water samples were or will be analyzed for salinity, oxygen, nutrients, chlorophyll a and coccolithophorids. At 5 stations the water samples will be also analyzed for diatoms and stable isotopes. Samples for oxygen and nutrients were taken from every bottle , while chlorophyll a and coccolithophorids will only be analyzed from the upper 200 m and 300 m, respectively. The exact sampling levels for each station and parameter are shown in Table C3. The salinity samples, which were mainly taken from the uppermost and lowest bottle were analyzed on board using an Guildline Autosal salinometer.

Glass bottles (ranging in volume from 120 to 135 ml) were used to collect water samples for oxygen which were immediately fixed using two reactives (manganese chloride and alkalin solution of iodure, respectively). Then, the bottles were left for at least six hours for precipitation; finally, they were titrated using a Metrohm 682 Titroprocessor.

Nutrient samples (50 ml plastic bottles) were immediately frozen after taking while standing vertically since their analysis was not made on board the vessel. The bottles will be used to determine nitrites and nitrates, phosphates and silicates at the ICCM laboratory using an Skalar continuous-flow autoanalyser.

Chlorophyll was sampled from 200 m to the surface using one liter plastic bottles and 500 ml were subsequentely filtered with Whatman GF/F 47 mm glass microfibre filters, saving each filter in 10 ml glass tubes that were finally frozen. The samples were defrozed and acetone was added to dilute the pigments; they were left for 24 hours in order to release the pigments and then chlorophyll a was measured using fluorometric analysis.

On 14.09.1997 the ship´s gyro started to fail, but since it is necessary for the vesselmounted ADCP measurements, we decided to have it repaired in port. POSEIDON left the hydrographic box after station 592 and headed for Las Palmas, where it arrived on 15.09.1997 at 09:30. After the installation of a new ball within the gyro POSEIDON left Las Palmas again on 16.09.1997 at 19:30 and headed back to station 593 to complete the hydrographic station work. After the CANIGO box was finished, two further sections were made between Fuerteventura and the African shelf. A total of 73 CTD profiles were carried out on 70 stations.

After the last CTD station was completed POSEIDON continued the vesselmounted ADCP-section northward along the African shelf to the position of station 608. The section between the stations 608 and 595 was repeated with the vesselmounted ADCP. Afterwards, POSEIDON returned to Las Palmas, where it arrived on 21.09.1997 at 09:00.

3.2 P233b, 23.09. - 26.09.1997, Las Palmas - Las Palmas

In port, the scientific crew partially changed: chief scientist M. Knoll, the group of chemists from the ICCM and the observer from Morocco disembarked; the new chief scientist T.J. Müller took over, and four bio-geochemists from GeoB and a physical oceanographer from the IEO embarked. POSEIDON sailed in the morning of 26.09.1997 heading for the mooring position LP north of La Palma.

Close to LP, station 632 with CTD/rosette was obtained on 24.09.1997 early in the morning, sampling water to be sent to J. Scholten (Univ. Kiel). Later the same day, GeoB mooring LP-1 was recovered, and GeoB mooring LP-2 was set at almost the same position without any problems. After the mooring work, water samples were taken down to 200 m with the CTD/rosette. In the evening, POSEIDON headed for GeoB mooring CI-7 at ESTOC. On the way, water samples were taken from the upper 500 m of the water column to start the incubation experiment onboard.

In the morning of 25.09.1997, GeoB mooring CI-7 was recovered. In the afternoon at a position about 10 nm northeast of the CI, two systems with drifting sediment traps were launched for 4 days to measure the particle flux in the upper water column which cannot be achieved with moored instruments. Close to the drifting traps, water samples were taken from the upper 200 m. On the return to the mooring position, a deep CTD/rosette profile was obtained sampling water for salinity (IFMK) and nutrient analysis (IEO).

In the morning of 26.09.1997, GeoB mooring CI-8 was set. The same day late in the afternoon, POSEIDON called port of Las Palmas to exchange personnel and equipment.

3.3 P233c, 28.09. - 05.10.1997, Las Palmas - Las Palmas

In port, 2 scientists from IFMK, 2 from GeoB and the physical oceanographer from IEO disembarked, and 2 scientists from each, IFMK, IEO and ULPGC embarked to perform the planned mooring work. The vessel sailed 28.09.1997 in the morning heading for the position of ESTOC/367-3. This IFMK mooring was recovered in the afternoon without any problems. Again, water samples were taken from the upper 200 m for the incubation experiment, and a CTD/rosette profile was obtained close to the bottom. Next morning, 29.09.1997, IFMK mooring ESTOC/367-4 was launched. However, the upper buoyancy did not dive after the anchor was slipped since one of the Kevlar ropes broke next to a fitting due to wiggling of the rope around that fitting. Thus, the mooring needed to be recovered and reset. Later in the evening of the same day, the two drifting sediment trap systems were recovered and reset close to the position of the first launch next morning, 30.09.1997.

POSEIDON then headed towards the EBC array of 5 moorings east of Lanzarote. The vessel reached the array in the evening. Here, the first two stations of a CTD section were obtained close to the mooring section. On 01.10.1997 in the morning we recovered IFMK mooring EBC2/378-1 without any problems. However, the next mooring EBC1-1 of ULPGC which had been set on the continental shelf break off Africa in January 1997 with METEOR did not surface although the release confirmed release several times with different deck units. A survey with GPS/GLONASS positioning (better 50 m) and hydrophone ranging from 4 positions between the vessel and the release resulted in a position of the release at 28°39.925' N, 012°56.808', very close to its nominal position estimated during the launching procedure from METEOR (28°39.9' N, 012°56.8' W). Another ranging above the releaser's position gave a distance of 486 m, which is the same value as the depth measured with POSEIDON's echo sounding system. It therefore was concluded that mooring EBC1-1 had been cut below the deepest buoyancy causing the releaser to stay at the bottom. The upper part of the mooring obviously was no longer in site and had to be given up.

With 5 CTD stations, the section was continued. Next day, moorings EBC3/377-1, EBC4-1, and EBC5-1 were recovered. Mooring EBC3/377-2 was set with an optical sensing nutrient recorder. With 3 CTD stations the section was completed. Next day, the setting of moorings

EBC4-2 and EBC5-2 completed the work east of the islands in the afternoon of 03.10.1997. We then sailed towards the drifting traps and took the occasion for a grill party on deck celebrating unification day.

Near ESTOC we successfully recovered the drifting traps, and then finished the work of this leg with the ESTOC October station. POSEIDON called port of Las Palmas on the 06.10.1997 in the morning.

3.4 P233d, 07.10. - 10.10.1997, Las Palmas - Portimao

After unloading, exchange of personnel and loading we sailed again in the evening of 07.10.1997 for the short leg to Portimao. On the ESTOC position, a CTD/rosette station was taken for anthropogenic tracers (CFCs) followed by trace metal sampling with in-situ pumps and a special rosette, and by plankton net haul to 30 m. Steaming east to the EBC array on the African shelf and the towards Portimao to close the CANIGO box with ADCP measurements, we took further 2 plankton hauls. We called port of Portimao on 10.10.1997 in the morning.

4. Scientific report and first results

4.1 Physical, chemical and tracer oceanography

CTD/LADCP-sections including biological and chemical sampling were carried out between the African shelf, Madeira, La Palma and back to the African shelf. Two further sections were made between Fuerteventura and the African shelf. The potential temperature and salinity sections are shown in the following figures.

The CTD-sections are showing upwelling processes near the African shelf within the upper 500 m indicated by an uprising of the isotherms and isohalines. A sharp thermocline is observed in the upper 80 m above which sometimes an intermediate salinity maximum occurs. The sections show the influence of warm and saline Mediterranean Water, which is strongest in the northern section at 32°15' N. The Mediterranean Water spreads within a depth level of about 1000 m. Within the sections between the Canary Islands and the African shelf Antarctic Intermediate Water is observed with salinities of less than 35.25 psu. This water mass moves northward along the African shelf in a depth level of about 700 m to 1200 m.

Results from the analysis of the oxygen, nutrient and chlorophyll samples (ICCM) as well as from the current meter moorings (IFMK, GeoB, IEO, ULPGC, AWI) will be available later.

Fig. 4.1. potential temperature (°C) along 32.25°N

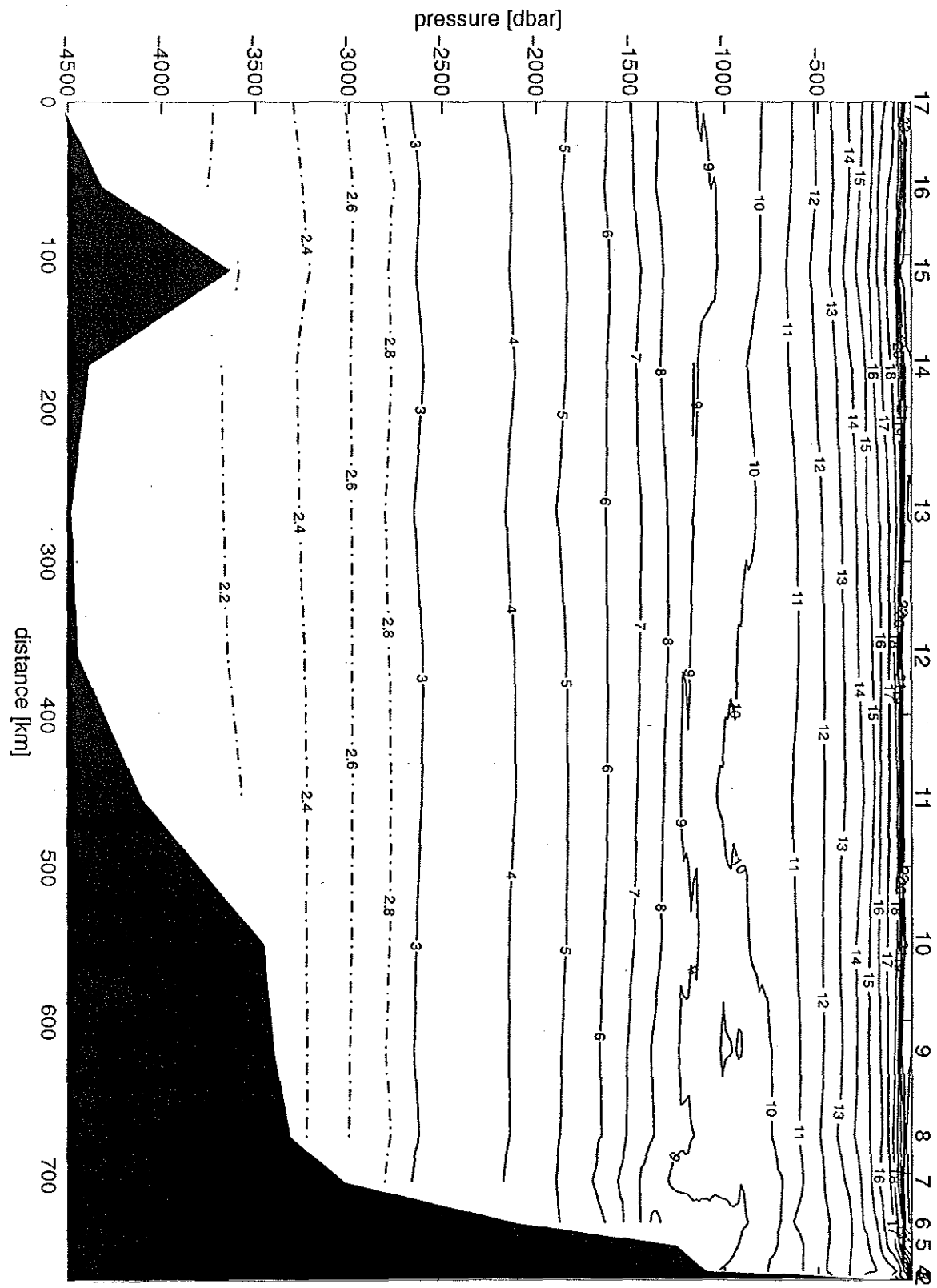


Fig. 4.2. potential temperature (°C) along 18° W

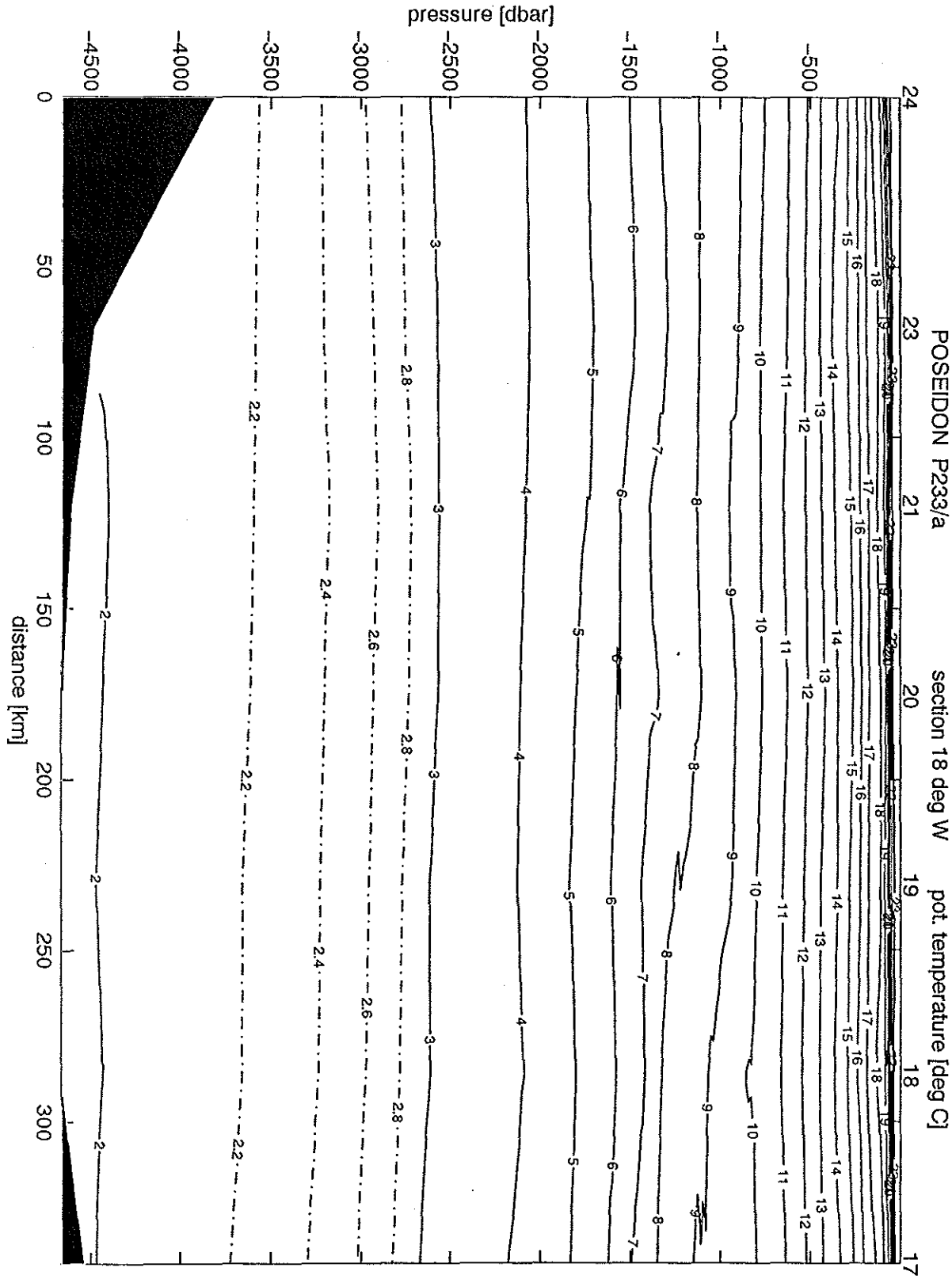


Fig. 4.3. potential temperature (°C) along 29° N

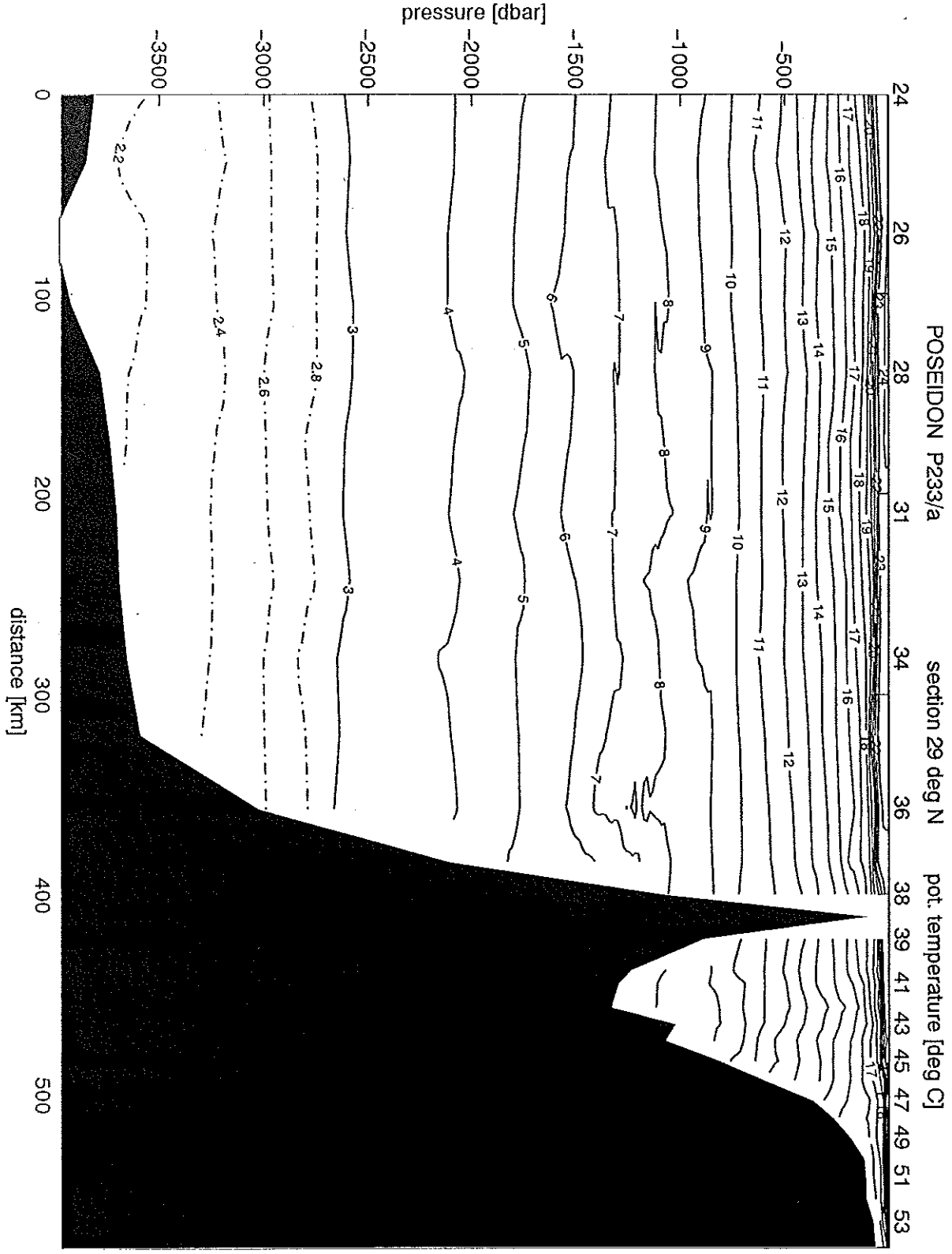


Fig. 4.4. potential temperature (°C) along 28.4° N

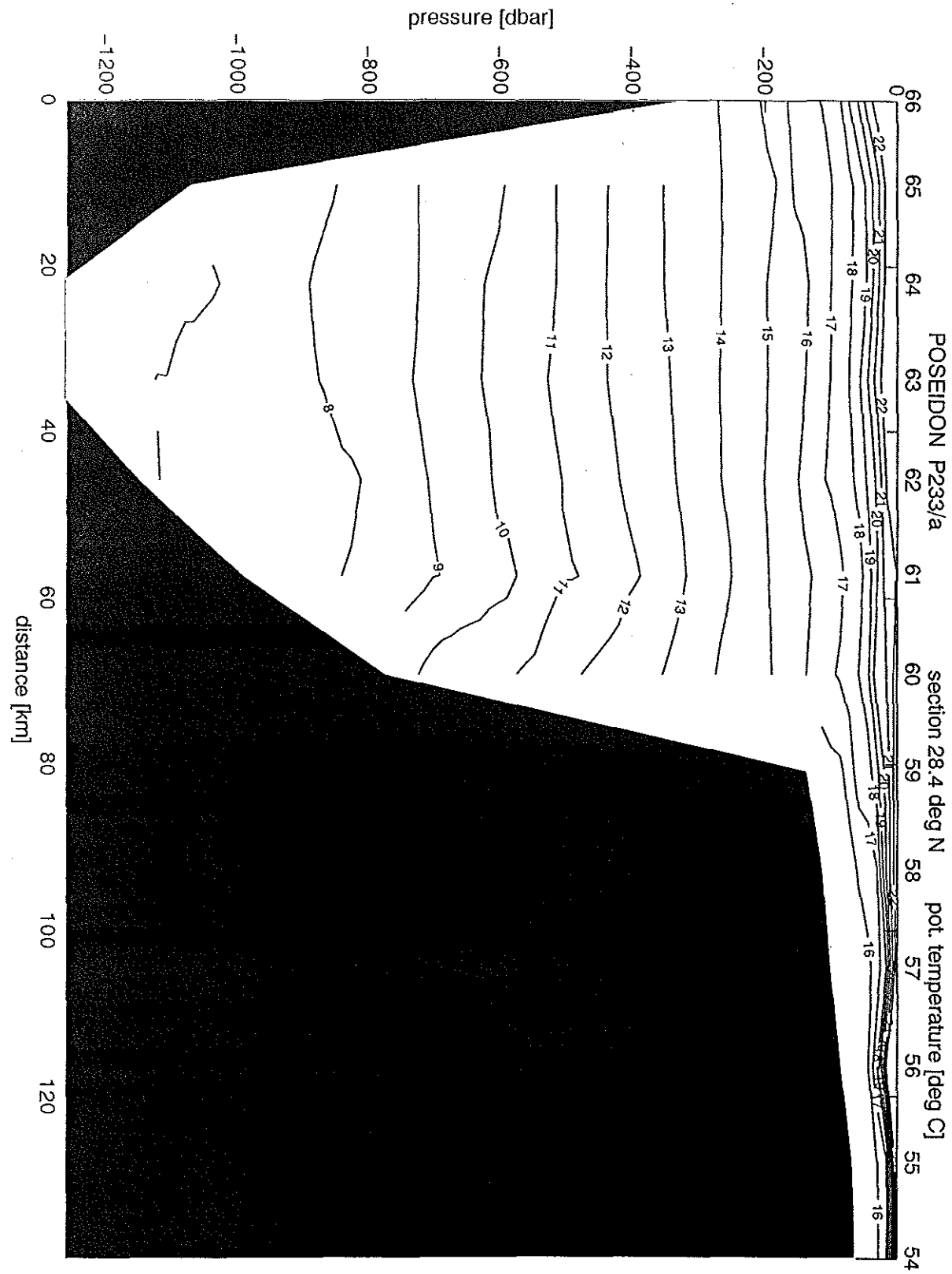


Fig. 4.5. potential temperature (°C) along 28° N

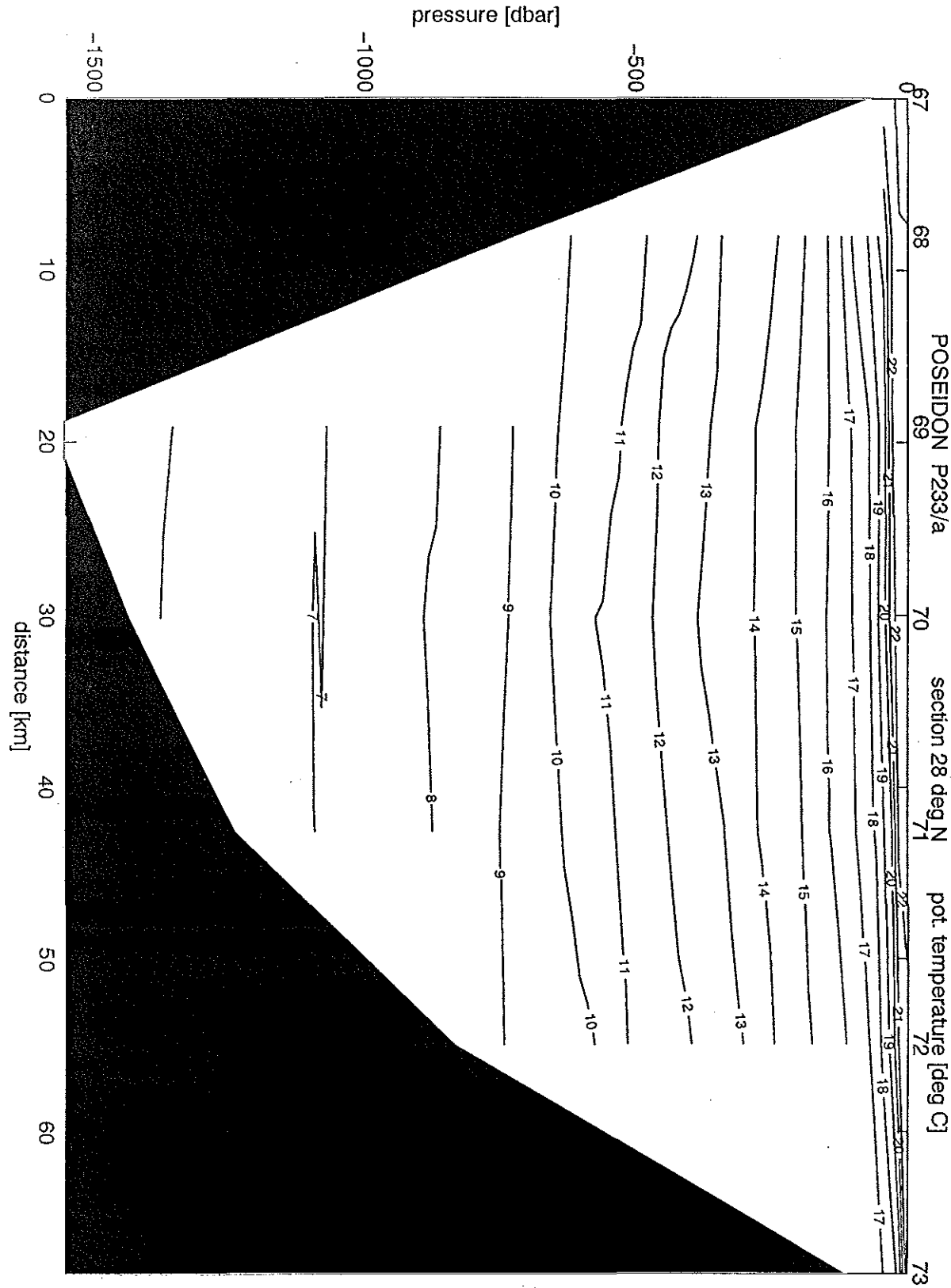


Fig. 4.6. salinity (psu) along 32.25°N

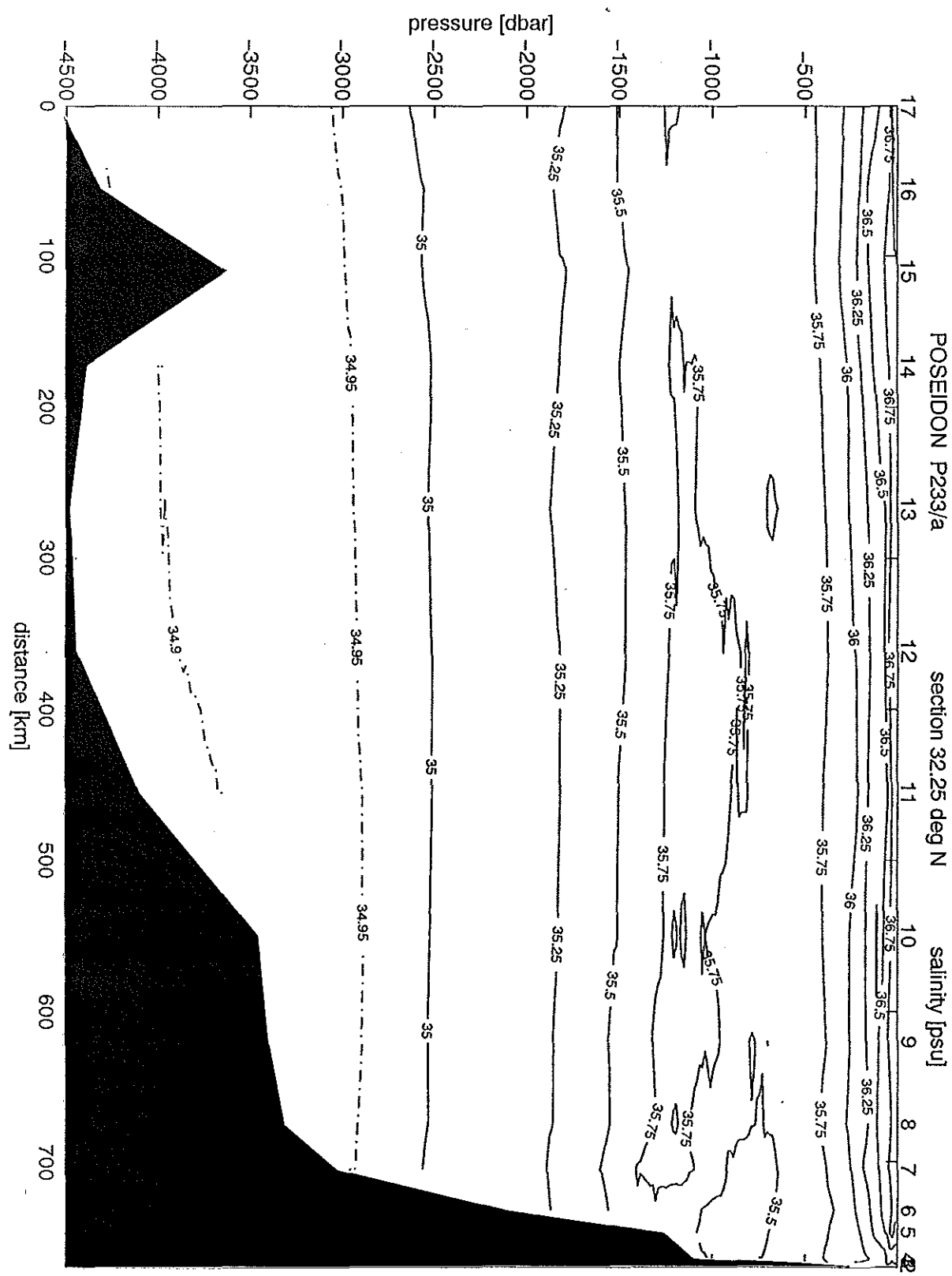


Fig. 4.7. salinity (psu) along 18° W

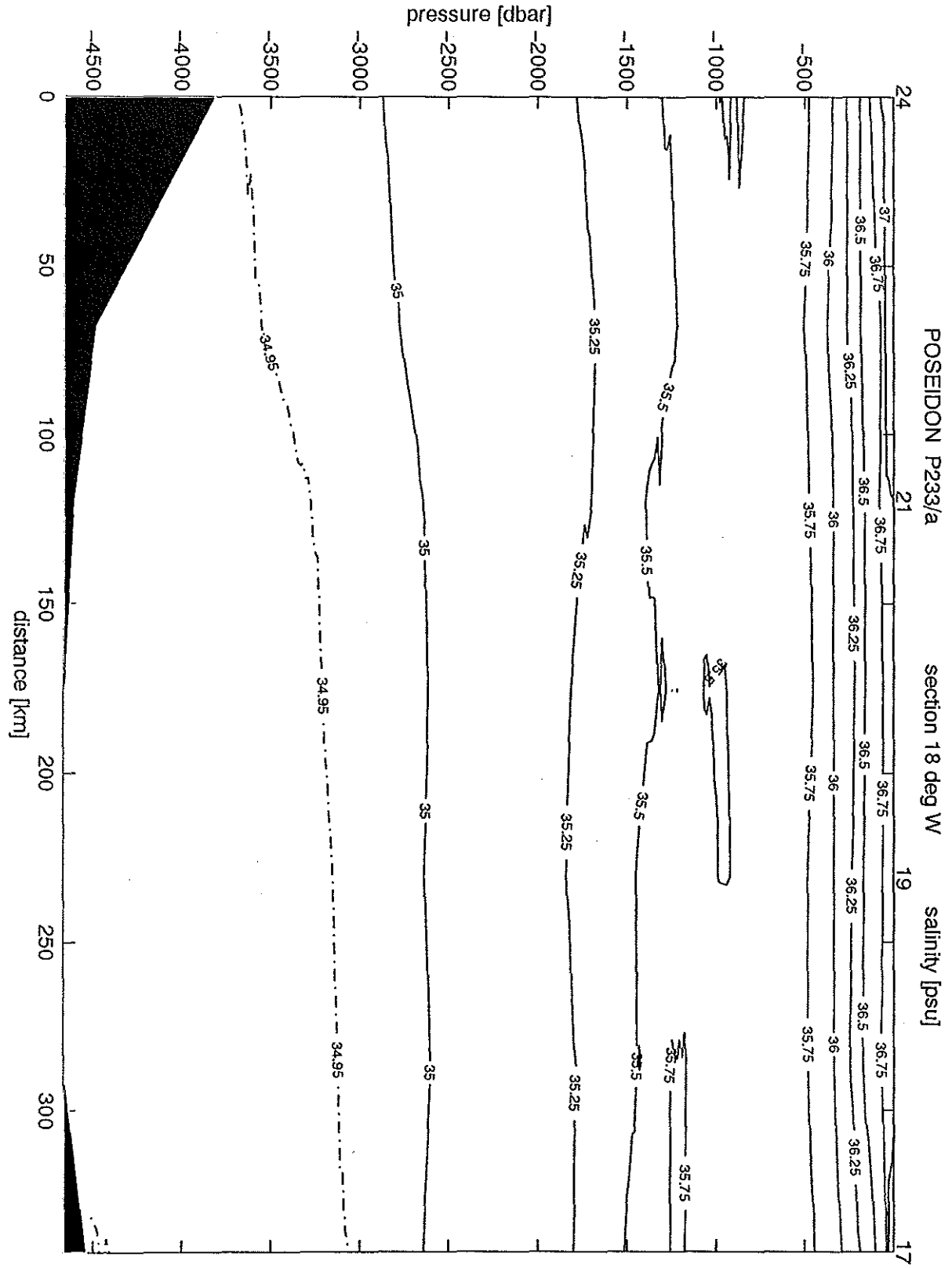


Fig. 4.8. salinity (psu)along 29° N

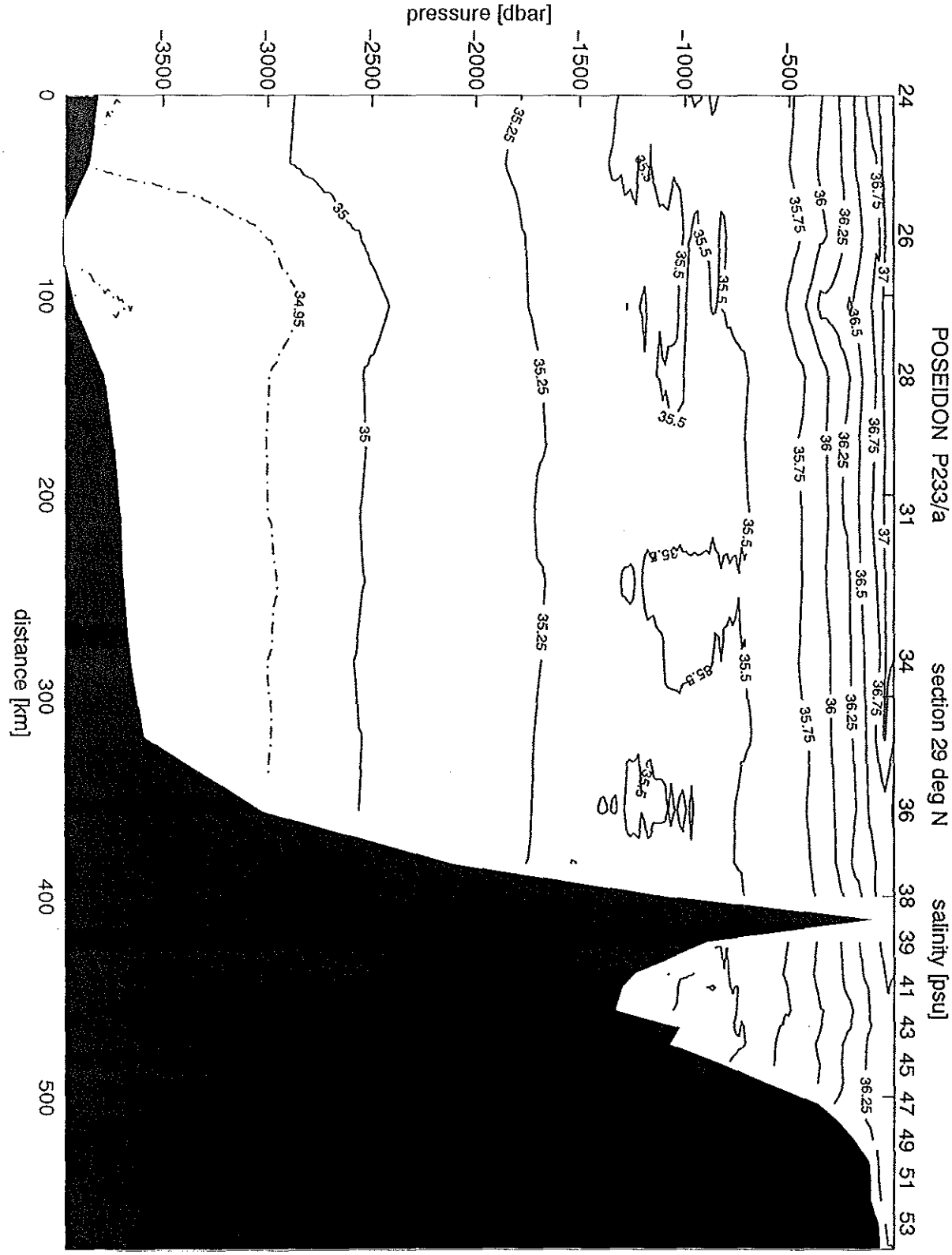


Fig. 4.9. salinity (psu) along 28.4° N

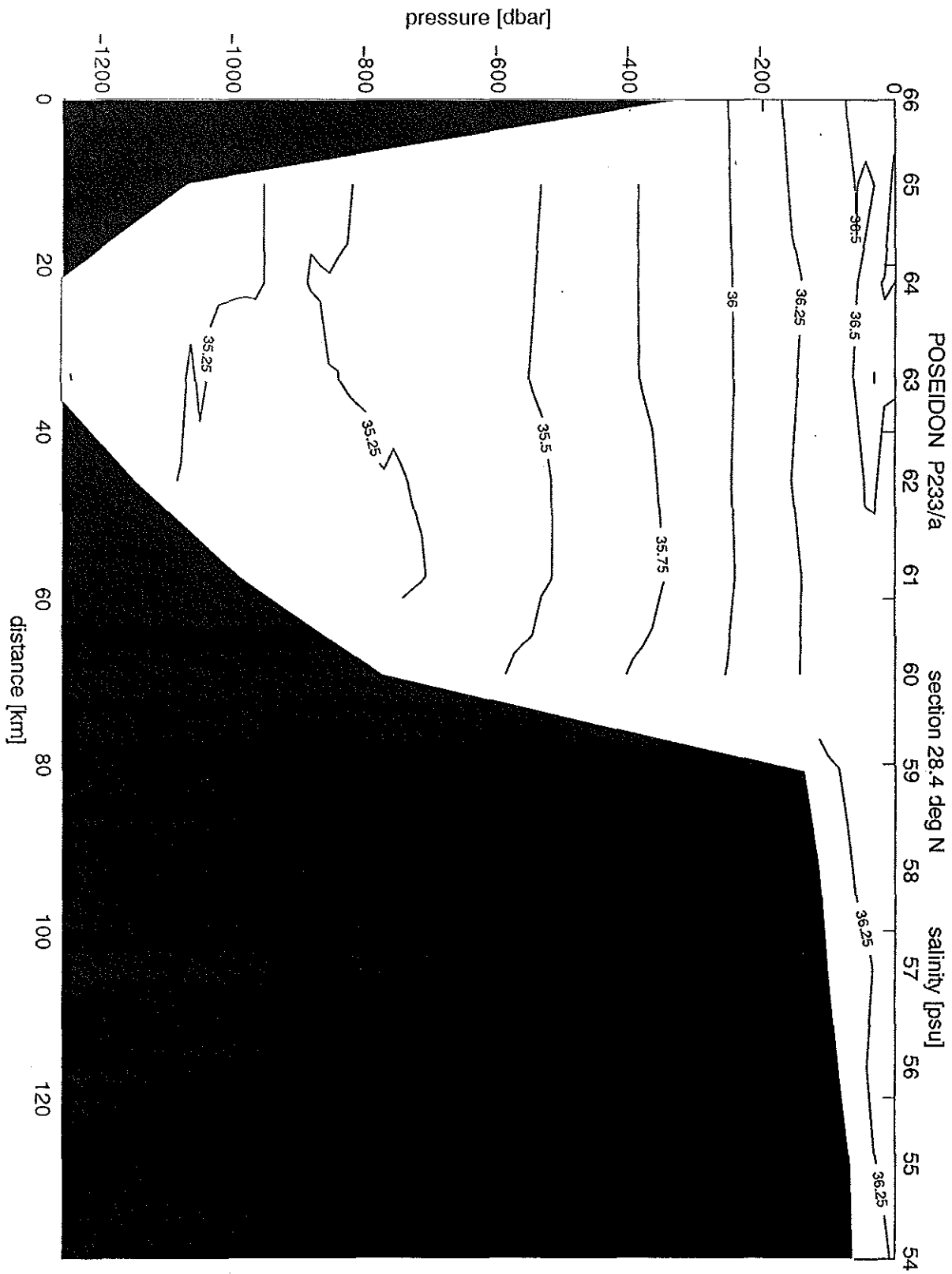
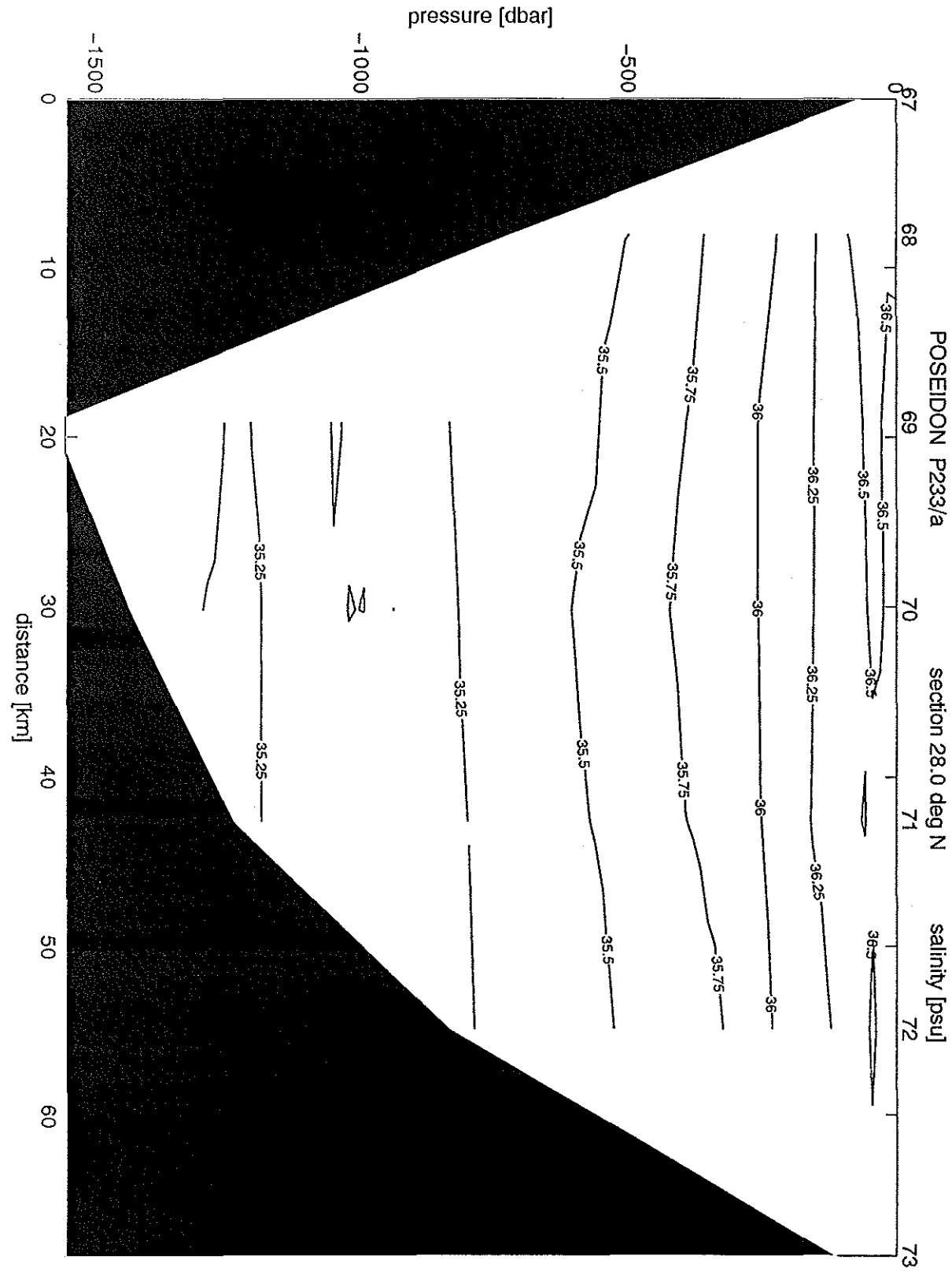


Fig. 4.10. salinity (psu) along 28° N



4.2 Particle flux measurements with moored particle traps

Particle flux measurements at the ESTOC (European Station for Time Series in the Ocean, Canary Islands) station are carried out since fall 1991. They show seasonal and short-term variability due to varying productivity and hydrographic conditions. In addition, this long-term particle flux record indicates that a large portion of deep particle flux originates laterally. In CANIGO, additional sediment traps were placed along the 29°N transect, north of La Palma (mooring LP) and between the eastern islands and the Moroccan shelf (mooring sites EBC2 and EBC3). Including the ESTOC position, these three main locations cover the productivity gradient from shelf region to the oligotrophic gyre. It is intended to thus distinguish the influence of autochtonous and allochtonous sources of particle flux along the transect with moored traps for at least 1 1/2 seasons.

The LP 1 sediment trap mooring, carrying also an INFLUX current meter (current meter with fluorometer and transmissometer) and two current meters from IFMK, was recovered and re-deployed (LP 2, see Fig. 4.11.) on 24.09.1997. During the first mooring period, the INFLUX current meter had failed due to leakage. LP 2 will again be exchanged in October 1998 during METEOR cruise 42/4.

On 25.09.1997, the ESTOC particle trap mooring (CI 7) was recovered. In addition to sediment traps and current meters, this mooring also carried 2 particle pumps. The mooring was re-deployed on 26.09.1997 (CI 8, see Fig. 4.12.). CI 8 will be exchanged in March 1998 during POSEIDON cruise 237/2.

The sediment traps in EBC2 and EBC3 are jointly moored with current meters of the IFMK. Each mooring carries a particle trap in 700 m depth. On 01.10.1997, EBC 2-1 was recovered and re-deployed. The sediment trap worked properly. EBC3, which also carries an INFLUX current meter from the AWI 20 m below the trap, was exchanged and re-deployed on 02.10.1997. The sediment trap in this mooring failed and did not rotate the sampling cups.

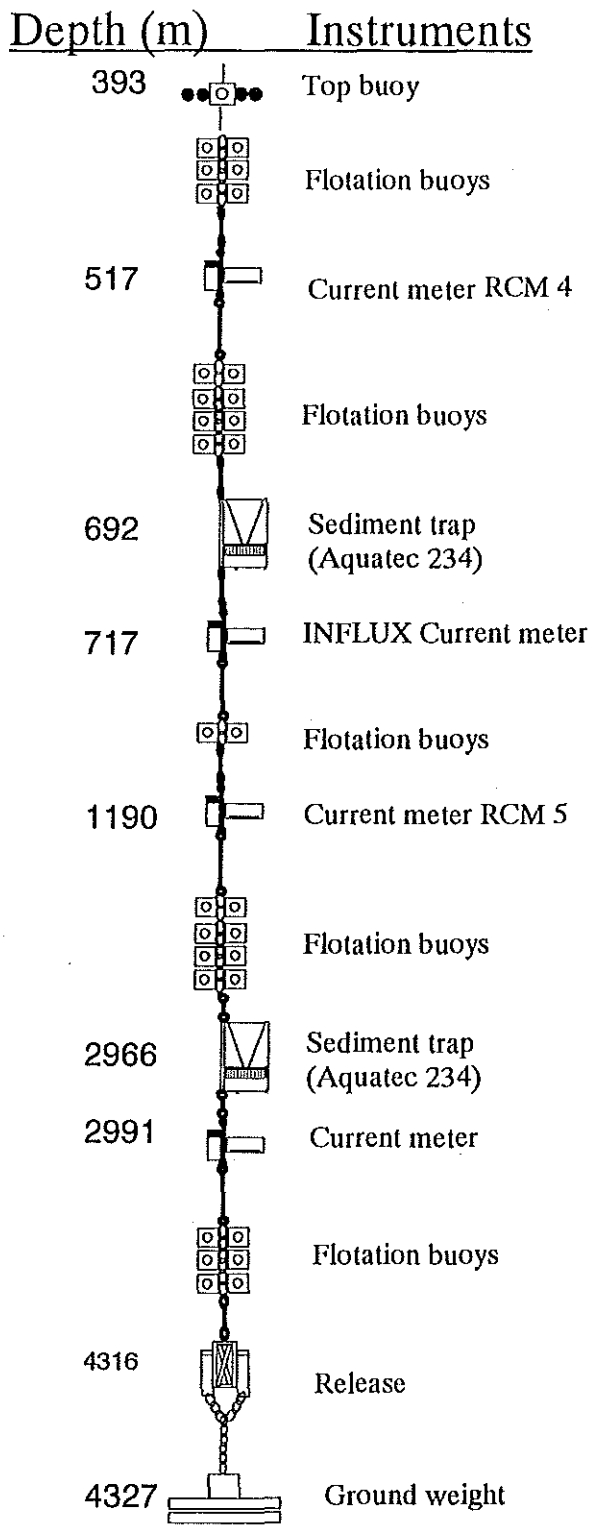


Fig. 4.11. Sediment trap mooring LP 2 deployed north of La Palma.

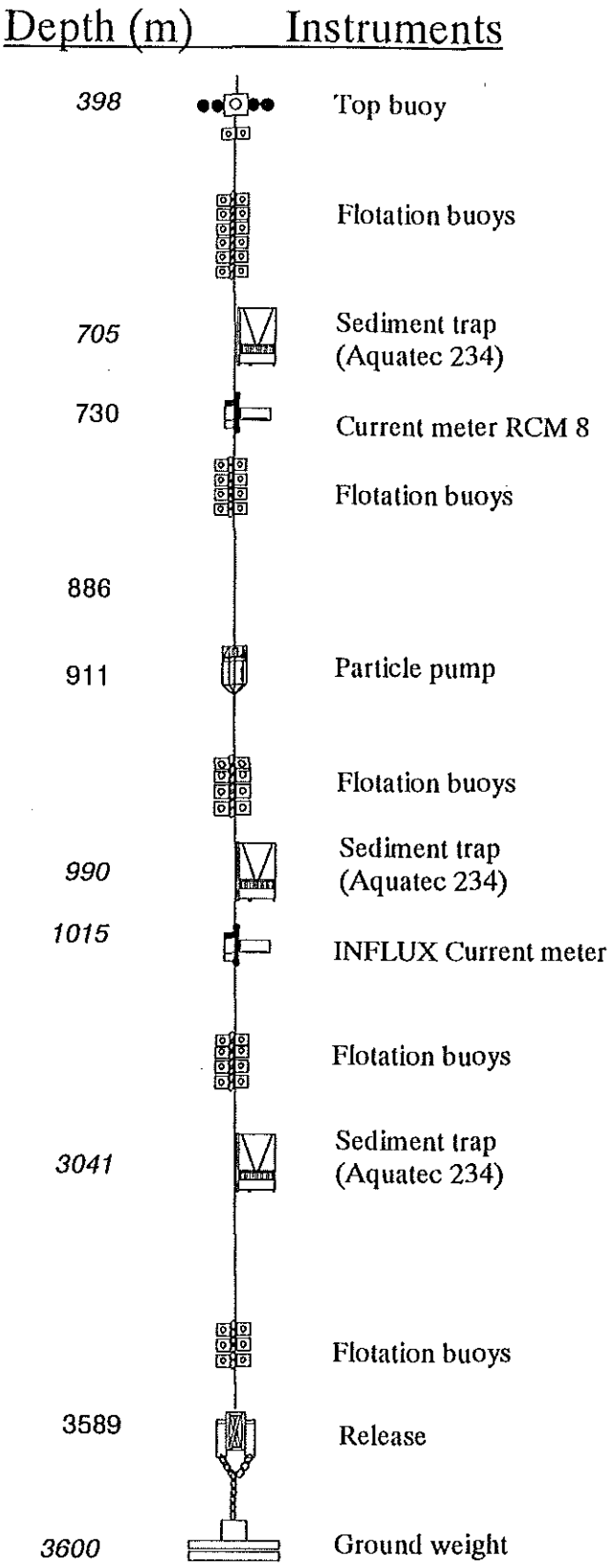


Fig. 4.12. Sediment trap mooring CI 8 deployed at ESTOC.

4.3 Experiments with drifting particle traps

In addition to moored sediment traps, drifting trap experiments were carried out to determine particulate carbon flux that originates directly from the euphotic zone. Ideally, these sinking flux determinations need to be coupled with measurements of the standing stock and production rates of the plankton community in the euphotic zone.

To study particle flux below the euphotic zone, two surface-tethered particle interceptor arrays were deployed northeast of the ESTOC station, one carrying one trap at 200 m (200 m drifter, Fig. 4.13.), the other one three traps at 200 m, 300 m and 500 m depth (500 m drifter, Fig. 4.14.). The traps were attached to a surface buoy that carried an ARGOS transmitter and a Radar reflector. The main buoyancy was located at about 30 m depth to avoid the wind-induced EKMAN layer. The first deployment period lasted from 25.09. to 30.09.1997, the second one from 01.10. to 04.10.1997. During both periods, the traps drifted south-east, the 200 m drifter with a higher velocity than the 500 m drifter (see Fig. 4.15.).

Plankton biomass and production rates

To quantify the plankton community in the euphotic zone during 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.

Dilution experiments were carried out at ESTOC (station 643) and EBC 3 (station 664) to determine phytoplankton growth and microzooplankton grazing rates under close to in-situ conditions. Dilution experiments were carried out with water from 25 m and 50 m in an on-deck incubator.

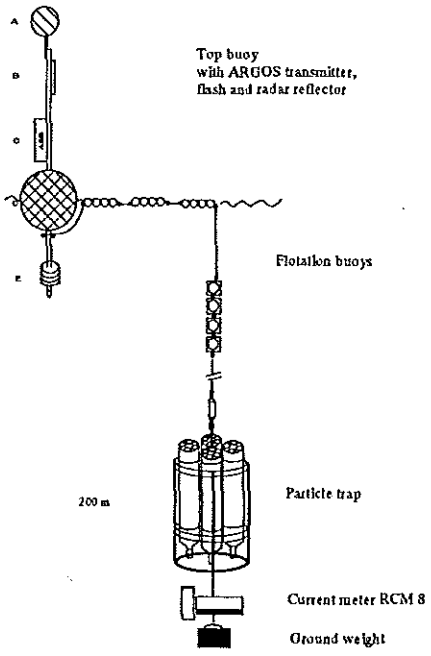


Fig. 4.13. Drifting trap at 200 m tethered to to the surface.

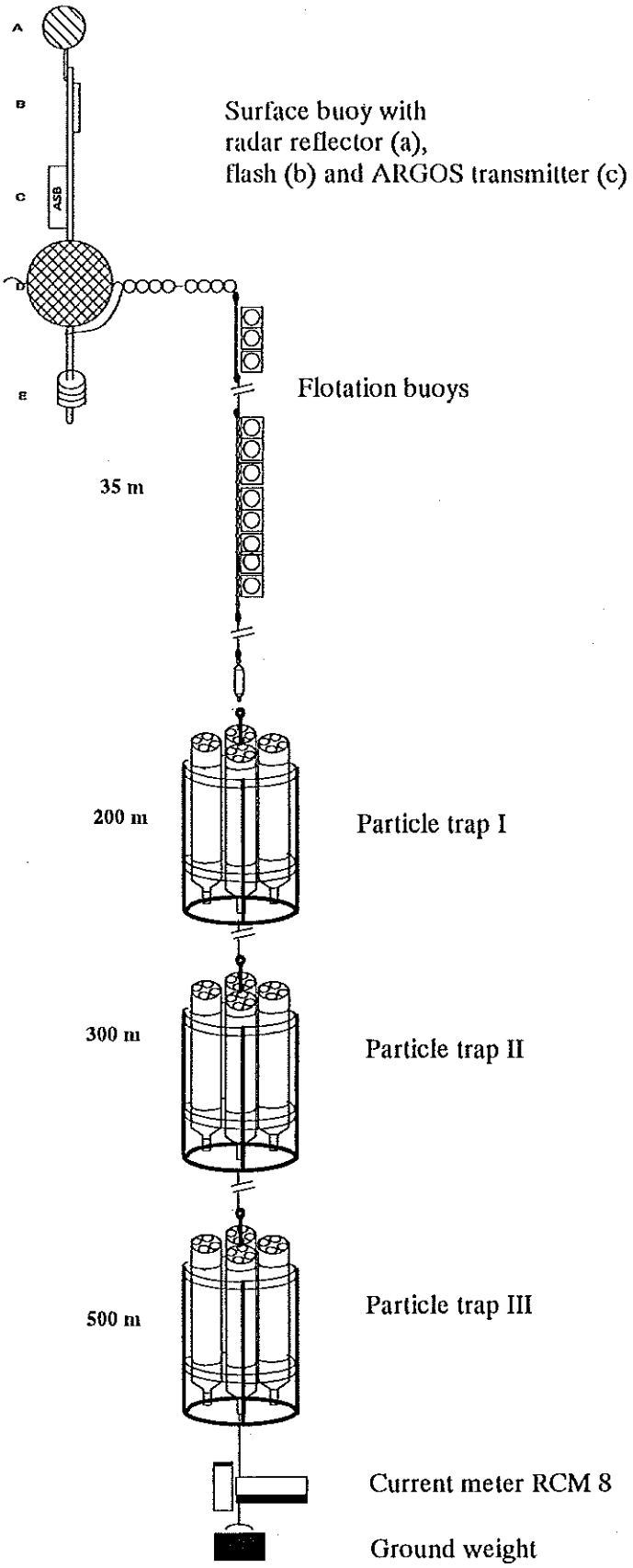


Fig. 4.14. Drifting traps at 200 m, 300 m and 500 m depth tethered to the surface.

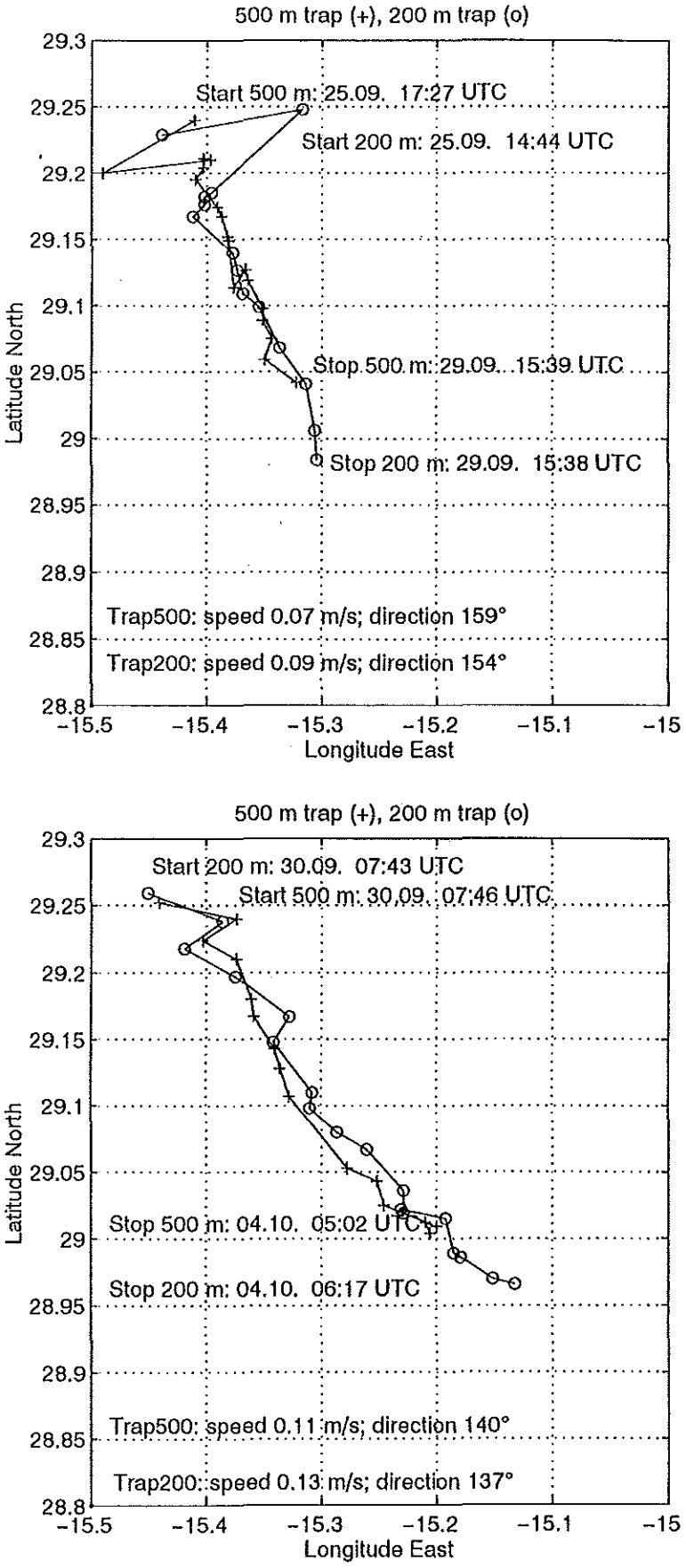


Fig. 4.15. Tracks of drifting traps deployed 01.10. to 04.10.1997 north of Gran Canaria.

4.4 Plankton Observations on the hydrographic box

Coccolithophore sampling

During POSEIDON cruise 233a water casts of 10 litres were taken at 33 stations and the following water depth levels were sampled: 0, 10, 25, 50, 75, 100, 125, 150, 200, 250, 300 meters. 13 stations were sampled along a zonal transect from the African coast to Madeira, 3 stations were sampled during the meridional transect from Madeira to La Palma, 16 stations during the zonal transect from La Palma towards the African coast and 1 station was on a transect between Fuerteventura and the African shelf at about 28°N.

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

After filtration the filters were rinsed with 50 ml buffered destilled water (NH_4OH, PH8.5) in order to eliminate all traces of sea salt. Rinsed filters were transferred to labelled petri-dishes, dried immediately in an oven at 55 °C and stored in a refrigerator.

Ongoing analyses
In subsequent analyses using a Scanning Electron Microscope cell density (#/l) and taxonomic composition of the coccolithophore populations will be determined. In addition morphological features of *Gephyrocapsa* sp. and *Calcidiscus leptoporus* will be analysed. First analysis revealed lower cell densities than in January 1997, so far in all the samples analysed.

Diatom sampling

During POSEIDON cruise 233a water casts of 10 litres were taken at 11 stations along the zonal transect from La Palma to the African coast and if possible the following water depth levels were sampled: 0, 10, 25, 50, 75, 100, 125, 150, 200, 250, 300 meters. 300 ml water were transferred from Niskin bottles into plastic bottles with 30 ml Formol and Hexamathyl-Tetramine.

Diatom plankton net sampling

At 11 stations a plankton net with 20 μm mesh size was used to sample diatoms from 100 m water depth to the surface (integrated sampling). The net was released to 100 m water depth and was pulled with 0.3 m/s back to the surface. Subsequently the net was rinsed with sea water and the catch was transferred into a plastic bottle with 20 ml Glutardialdehyde.

Ongoing analyses
In subsequent analyses using a light microscope and if necessary a Scanning Electron Microscope, diatom standing stock and assemblage composition will be determined.

Planktic foraminifera sampling

Planktic foraminifera were collected with a multi-closing-net (mesh size 64 μm) at five depth intervals (440-300 m, 300-150 m, 150-50 m, 50-25 m, 25-0 m) at 6 stations including the three mooring stations LP1, ESTOC and EBC1. The multinet-samples were preserved on board with

a saturated solution of $HgCl_2$ and stained with Bengalrosa. In addition sea water was taken at the base of each net-interval for stable isotope analyses (δ-^{18}O- and δ-^{13}C). These samples were preserved with $HgCl_2$ and the glass bottles were sealed with Paraffin to prevent the oxidation of organic matter. All samples were stored at 4°C in a refrigerator.

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

5. Scientific equipment, instruments and moorings

- CTD Neil Brown Mk.IIIB (IFMK code NB2) equipped with an oxygen sensor (ME) and an in-situ flourometer (Haardt)
- Lowered Acoustic Doppler Current Profiler (RDI 150 kHz)
- GO-rosette including 21x10 l Niskin bottles
- vesselmounted Acoustic Doppler Current Profiler (RDI 150 kHz)
- plankton single net
- multinet
- salinometer (Autosal Guildline)
- Metrohm 682 Titroprocessor
- Laboratory fluorometer
- 2 moorings for a water depth of 4000 and 4600 m each equipped with a sound source (Webb) and a release (Mors)
- 4 Eastern Boundary Current (EBC) moorings reset east of Lanzarote equipped with current meters and particle traps
- 2 moorings replaced at Las Palmas (LP) and ESTOC equipped with particle traps and current meters
- 1 mooring replaced at ESTOC equipped with current meters

6. Additional Remarks

We want to thank the crew of POSEIDON with captain Matthias Gross for their excellent help in gathering this data set. The Ashtech positioning systems installed during this cruise made it possible to obtain a much improved accuracy and to determine accurately pitch, roll and heading. These systems provide an improvement of the quality of the vesselmounted ADCP data also for future cruises.

Problems occurred with the GO-rosette, which had been on board already for several months and where no further maintenance had been carried out. Cleaning the pylon improved the closing results of the rosette, but still sometimes the sampling depth levels remained uncertain and had to be verified by salinity and oxygen samples. Some problems were caused by the small entrance port for the rosette, so that 2 Niskin bottles broke while lifting the rosette on board. Fortunately, we had no rough weather that the small entrance was therefore only a minor problem.

The preliminary CTD and oxygen data from the stations 562-570 ,604-617 and 628-630, which were obtained in Moroccan waters, as well as the preliminary cruise report were handed to the Moroccan observer Karim Hilmi after the first leg.

7. Appendix

Appendix A. maps with cruise tracks

Fig. A1 cruise track P233 a

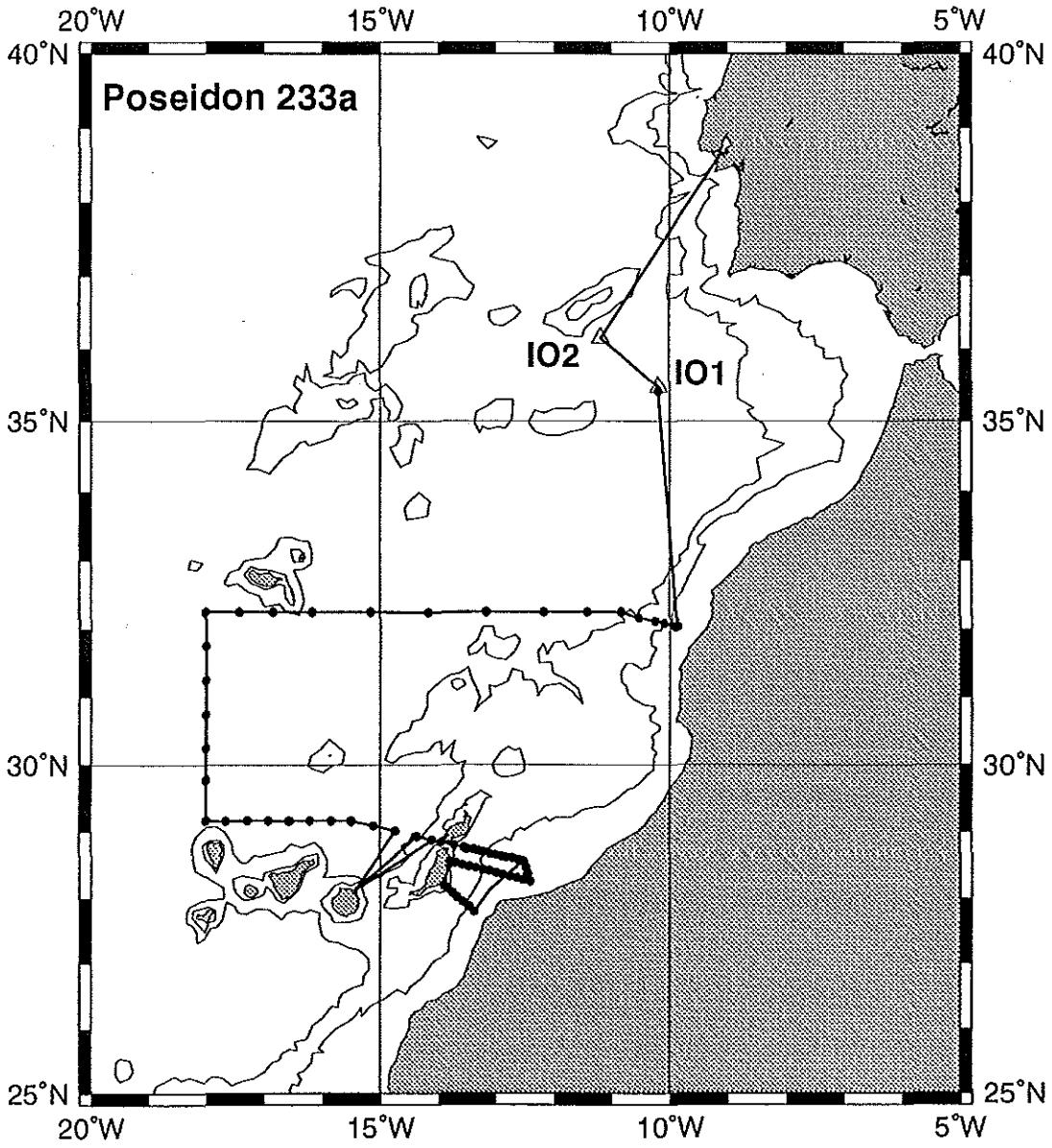
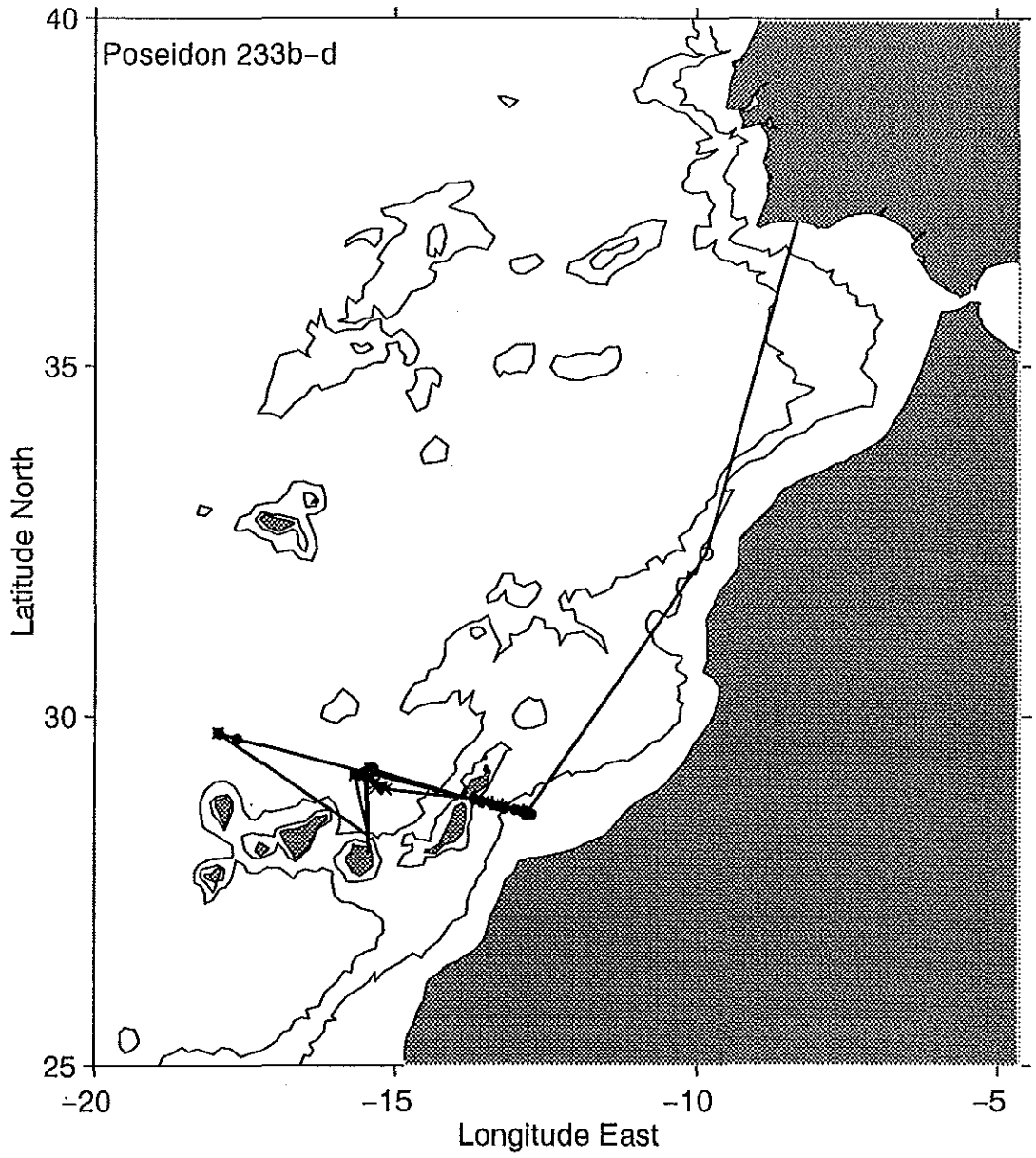
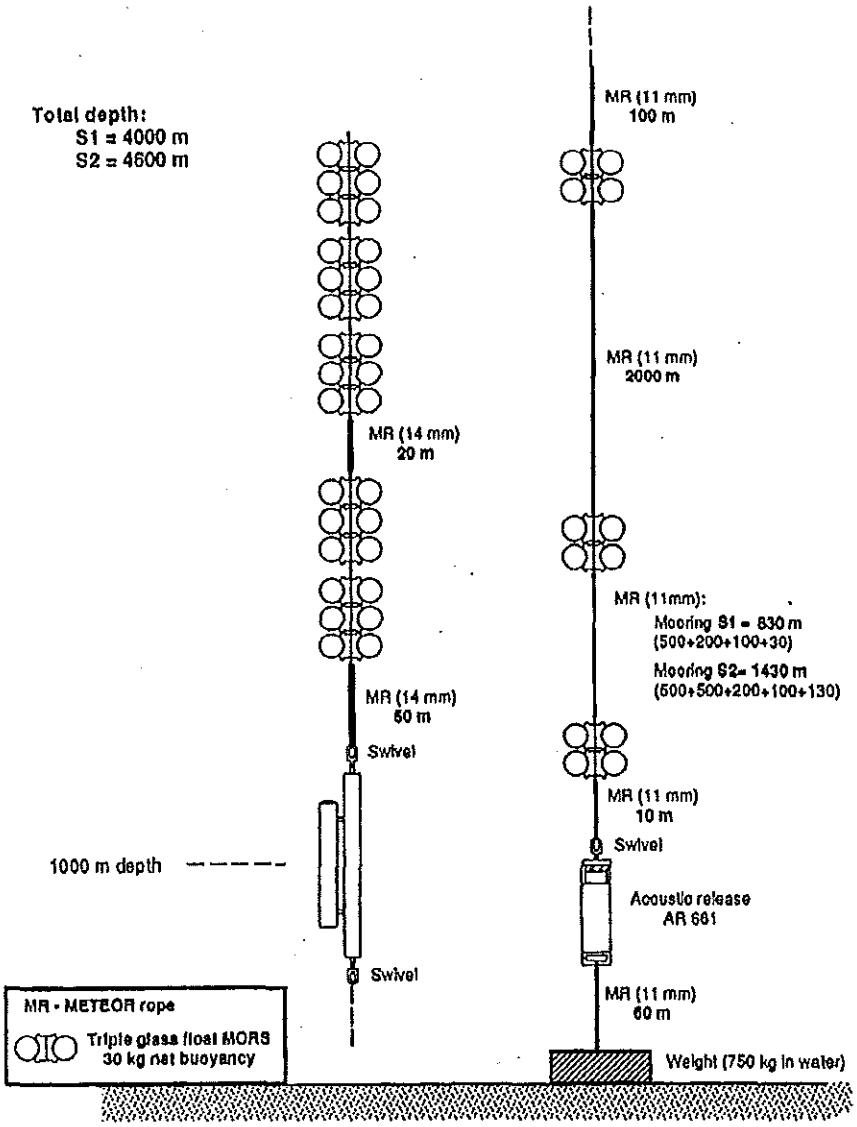


Fig. A2 cruise track P233 b-d



Appendix B. Moorings

Fig. B1 mooring scheme IO1, IO2



Launching information:

	IO1	IO2
top buoy in water:	06.09.1997 15:12 UTC 35° 27.00´N 10° 11.73´W	06.09.1997 05:33 UTC 36° 06.63´N 11° 11.38´W
anchor in water:	06.09.1997 16:46 UTC 35° 28.67´N 10° 11.57´W	06.09.97 07:55 UTC 36°09.28´N 11° 10.59´W
nylon rope below 2000 m	500+200+30 m	500+500+200+130+100+100 m
release		
no	201	61
interrogate	9113	5128
release	9114	5129

Table B1 Moorings
Index:
r: mooring recovered s: mooring set f: failed to recovered

ADCP: Acoustic Doppler Current Profiler ACM: Aanderaa current meters
ICM: Influx current meters (AWI type) ISP: in-situ pumps for trace metal samples
ST: particle flux trap SoSo: sound sources, transmission times are UTC

ID	Date 1997	set/ rec.	Latitude N Longitude W	Depth m	Instrumentation
P233a					
IO1	06.09.	s	35°28.5' 10°11.6'	4027	SoSo34 in 1127 m, transmitting 01:00, 09:00, 17:00
IO2	06.09.	s	36°09.0' 11°10.7'	4812	SoSo35 in 1112 m, transmitting 01:32, 09:32, 17:32
P233b					
LP-1	24.09.	r	29°45.7' 17°57.3'	4327	ACM in 859, 1551, 3798 m; ICM in 1029 m ST in 1109, 3778 m
LP-2	24.09.	s	29°45.7' 17°55.8'	4348	ACM in 517, 1190, 2991 m; ICM in 717 m; ST in 692, 2966 m
ESTOC/CI-7	25.09.	r	29°11.0' 15°27.0'	3610	ACM in 3070 m; ICM in 770, 1030 m; ST in 750, 1010, 3050 m; ISP in 870, 890 m
ESTOC/CI-8	26.09.	s	29°11.2' 15°27.3'	3610	ACM in 3070 m; ICM in 770 m, 1030m; ST in 750, 1010, 3050 m; ISP in 870 m
P233c					
ESTOC/367-3	28.09.	r	29°09.0' 15°40.0'	3610	ADCP in 190 m; ACM in 270, 500, 800, 1200, 2000, 3550 m
ESTOC/367-4	29.09.	s	29°10.1' 15°40.2'	3610	ADCP in 190 m; ACM in 270, 500, 800, 1200, 2000, 3550 m
EBC2/378-1	01.10.	r	28°42.5' 13°09.3'	996	ACM in 160, 300, 500, 720, 950 m; ST in 700 m
EBC1-1	01.10.	f	28°39.9' 12°56.8'	493	mooring with 3 ACM lost
EBC2/378-2	01.10.	s	28°42.2' 13°09.8'	998	ACM in 160, 300, 500, 720, 950 m; ST in 700 m
EBC3/377-1	02.10.	r	28°44.5' 13°18.0'	1157	ACM in 160, 300, 500, 870, 1230 m; ICM in 720 m; ST in 700 m
EBC4-1	02.10.	r	28°46.4' 13°28.0'	1287	ACM in 150, 300, 500, 800, 1230 m
EBC5-1	02.10.	r	28°48.4 13°38.8'	1044	ACM in 150, 300, 520, 950 m
EBC3/377-2	02.10.	s	28°44.3' 13°17.9'	1180	ACM in 160, 300, 500, 870, 1230 m; ICM in 720 m; ST in 700 m
EBC4-2	03.10.	s	28°46.5' 13°27.6'	1270	ACM in 150, 300, 520, 800, 1230 m
EBC5-2	03.10.	s	28°48.6' 13°38.4'	1030	ACM in 150, 300, 520, 950 m

Appendix C. Station Lists

Table C1 Station List P233 a

instruments: CTD, lowered ADCP, fluorometer (fl), multi net, plankton net (diatoms/coccolithophorids)
*station: stations not carried out during METEOR cruise 37 in January 1997.

Date	Time (UTC) start	end	Station	Profile	Position φ (N)	λ (W)	Uncorr. water depth (m)	Instruments
06.09.97	05:33	07:55	559		36° 09.01'	11° 10.67'	4780	IO2 mooring
06.09.97	15:12	16:46	560		35° 28.50'	10° 11.59'	4000	IO1 mooring
06.09.97	17:54	20:08	561	1	35° 25.07'	10° 12.13'	4106	CTD/LADCP/fl (3000 m)
	20:15	20:45			35° 25.96'	10° 11.81'	4093	plankton net coc. (100 m)
07.09.97	16:04	16:29	562	2	32° 02.08'	9° 52.11'	113	CTD/LADCP/fl
	17:08	17:57	563	3	32° 02.14'	9° 54.20'	446	CTD/LADCP/fl
	18:20	19:00			32° 02.10'	9° 54.50'	511	plankton net coc. (100 m)
	19:20	20:34	564	4	32° 02.67'	9° 55.54'	1022	CTD/LADCP/fl
	21:31	22:43	565	5	32° 05.04'	10° 05.86'	1251	CTD/LADCP/fl
	23:45	01:46	566	6	32° 06.96'	10° 15.00'	2043	CTD/LADCP/fl
08.09.97	03:30	06:06	567	7	32° 10.01'	10° 31.82'	3004	CTD/LADCP/fl
	07:43	11:22	568	8	32° 15.00'	10° 49.98'	3228	CTD/LADCP
	13:42	16:22	569	9	32° 15.00'	11° 24.83'	3330	CTD/LADCP
	20:20	23:49	570	10	32° 15.13'	12° 09.92'	3379	CTD/LADCP
09.09.97	04:15	08:18	571	11	32° 15.09'	13° 09.84'	3999	CTD
	12:32	16:33	572	12	32° 14.93'	14° 09.88'	4330	CTD
	20:56	00:16	573	13	32° 15.10'	15° 09.80'	4364	CTD/LADCP
10.09.97	05:26	08:59	574	14	32° 15.06'	16° 09.88'	4299	CTD/LADCP
	12:29	15:24	575	15	32° 15.08'	16° 49.87'	3564	CTD/LADCP
	18:26	21:41	576	16	32° 15.08'	17° 24.87'	4215	CTD/LADCP
11.09.97	00:37	03:51	577	17	32° 14.98'	17° 59.89'	4421	CTD/LADCP
	07:00	10:33	578	18	31° 45.12'	18° 00.20'	4550	CTD/LADCP
	13:42	17:28	579	19	31° 15.09'	17° 59.96'	4572	CTD/LADCP
	20:31	23:58	580	20	30° 45.09'	18° 00.13'	4538	CTD/LADCP
12.09.97	3:34	07:03	581	21	30° 15.12'	18° 00.01'	4488	CTD/LADCP
	10:00	11:08	582		29° 47.00'	18° 00.00'	4370	multi net (500 m)
	11:45	11:55			29° 46.00'	17° 59.90'	4363	plankton net dia. (100 m)
	12:23	14:11		22	29° 47.01'	18° 00.03'	4367	CTD/fl (500 m)
	15:15	18:25		23	29° 46.84'	17° 59.95'	4368	CTD/LADCP
	22:04	01:53	583	24	29° 10.07'	18° 00.10'	3768	CTD/LADCP
13.09.97	04:00	06:50	584	25	29° 10.00'	17° 39.07'	3745	CTD/LADCP
	06:50	07:05			29° 09.80'	17° 39.40'	3740	plankton net dia. (100 m)
	09:01	11:43	585	26	29° 10.08'	17° 17.01'	3914	CTD/LADCP
	13:52	17:18	586	27	29° 10.06'	16° 55.03'	3835	CTD/LADCP
	19:05	22:04	587	28	29° 09.91'	16° 34.05'	3703	CTD/LADCP
	22:07	22:55			29° 10.40'	16° 32.80'	3704	multi net (500 m)
	23:03	23:14			29° 10.40'	16° 32.90'	3705	plankton net dia. (100 m)
	23:19	00:01		29	29° 10.45'	16° 32.97'	3705	CTD/fl (500 m)

Table C1 Station List P233 a (continue)

Date	Time (UTC) start	end	Sta-tion	Pro-file	Position φ (N)	λ (W)	Uncorr. water depth (m)	Instruments
14.09.97	01:51	05:09	588	30	29° 10.09'	16° 12.05'	3655	CTD/LADCP
	07:04	10:04	589	31	29° 10.14'	15° 50.53'	3624	CTD/LADCP
	11:47	14:32	590	32	29° 10.22'	15° 30.03'	3609	CTD/LADCP
	14:55	15:55			29° 10.00'	15° 30.00'	3608	multi net (500 m)
	15:55	16:09			29° 10.00'	15° 30.00'	3608	plankton net dia. (100 m)
	16:09	17:00		33	29° 09.80'	15° 29.67'	3607	CTD/fl (500 m)
	18:58	21:54	591	34	29° 05.68'	15° 06.82'	3576	CTD/LADCP
	23:50	02:22	592	35	29° 01.07'	14° 44.01'	3513	CTD/LADCP
15.09.97	02:30	02:41			29° 00.40'	14° 43.40'	3505	plankton net dia. (100 m)
17.09.97	02:14	05:03	593	36	28° 55.99'	14° 22.00'	2966	CTD/LADCP/fl
	06:30	08:22	594	37	28° 52.61'	14° 06.16'	2090	CTD/LADCP/fl
	09:15	10:33	595	38	28° 50.96'	13° 56.21'	1067	CTD/LADCP/fl
	10:37	11:40			28° 50.80'	13° 58.00'	977	multi net (500 m)
	11:40	11:52			28° 50.80'	13° 58.00'	977	plankton net dia. (100 m)
	13:16	14:06	596	39	28° 47.97'	13° 42.53'	871	CTD/LADCP/fl
	15:19	16:33	597	40	28° 46.03'	13° 33.11'	1213	CTD/LADCP/fl
	16:39	16:49			28° 45.60'	13° 33.20'	1212	plankton net dia. (100 m)
	17:47	19:06	*598	41	28° 44.78'	13° 29.25'	1276	CTD/LADCP/fl
	19:59	21:16	599	42	28° 44.13'	13° 22.22'	1308	CTD/LADCP/fl
	22:00	23:11	*600	43	28° 43.01'	13° 17.12'	995	CTD/LADCP/fl
	23:43	00:40			28° 43.10'	13° 17.10'	993	multi net (500 m)
18.09.97	00:43	01:00			28° 44.00'	13° 17.10'	1175	plankton net dia. (100 m)
	01:50	02:40	601		28° 42.20'	13° 11.90'	1055	multi net (500 m)
	02:58	04:11		44	28° 41.97'	13° 12.14'	1055	CTD/LADCP/fl
	04:14	04:25			28° 42.20'	13° 11.10'	1038	plankton net dia. (100 m)
	05:22	06:18	602	45	28° 40.29'	13° 06.10'	798	CTD/LADCP/fl
	07:10	07:58	603	46	28° 39.52'	13° 00.51'	591	CTD/LADCP/fl
	08:57	09:31	604	47	28° 38.04'	12° 54.55'	358	CTD/fl
	10:19	10:50	605	48	28° 36.99'	12° 49.17'	248	CTD/fl
	10:55	11:07			28° 37.00'	12° 49.20'	248	plankton net dia. (100 m)
	12:06	12:35	606	49	28° 36.53'	12° 43.46'	174	CTD/fl
	13:28	13:51	*607	50	28° 35.02'	12° 37.06'	102	CTD/fl
	14:35	14:59	608	51	28° 33.53'	12° 31.99'	98	CTD/fl
	15:00	15:10			28° 33.50'	12° 32.00'	98	plankton net dia. (100 m)
	16:00	16:24	*609	52	28° 28.04'	12° 29.47'	97	CTD/fl
	17:18	17:34	*610	53	28° 22.10'	12° 27.58'	59	CTD/fl
	18:33	18:46	*611	54	28° 15.55'	12° 25.05'	48	CTD/fl
	19:36	20:48	*612	55	28° 16.98'	12° 31.90'	53	CTD/fl
	20:37	20:48	*613	56	28° 18.55'	12° 38.83'	70	CTD/fl
	21:43	21:51	*614	57	28° 19.99'	12° 45.88'	86	CTD/fl
	22:49	23:10	*615	58	28° 21.46'	12° 52.83'	98	CTD/fl

Table C1 Station List P233 a (continue)

Date	Time (UTC) start	end	Sta-tion	Pro-file	Position φ (N)	λ (W)	Uncorr. water depth (m)	Instruments
19.09.97	00:10	00:30	*616	59	28° 23.03'	12° 59.99'	121	CTD/fl
	01:51	02:53	*617	60	28° 24.78'	13° 06.87'	773	CTD/LADCP/fl
	04:01	05:14	*618	61	28° 26.03'	13° 13.97'	980	CTD/LADCP/fl
	06:22	07:35	*619	62	28° 27.53'	13° 20.80'	1116	CTD/LADCP/fl
	08:38	09:52	*620	63	28° 29.06'	13° 27.98'	1271	CTD/LADCP/fl
	10:54	12:11	*621	64	28° 30.48'	13° 34.91'	1248	CTD/LADCP/fl
	13:11	14:20	*622	65	28° 32.02'	13° 41.98'	1049	CTD/LADCP/fl
	15:08	15:35	*623	66	28° 33.59'	13° 48.01'	342	CTD/fl
	17:48	17:59	*624	67	28° 12.05'	13° 53.71'	51	CTD/fl
	18:44	19:53	*625	68	28° 09.05'	13° 50.15'	726	CTD/LADCP/fl
	20:27	21:52	*626	69	28° 05.14'	13° 45.03'	1560	CTD/LADCP/fl
	22:44	00:07	*627	70	28° 01.14'	13° 40.01'	1413	CTD/LADCP/fl
20.09.97	01:10	02:34	*628	71	27° 57.07'	13° 33.98'	1219	CTD/LADCP/fl
	03:37	04:36	*629	72	27° 53.03'	13° 27.99'	813	CTD/LADCP/fl
	05:45	06:20	*630	73	27° 48.06'	13° 22.13'	95	CTD/fl

Table C2 Station List P233 b-d

Date	Time (UTC) start	end	Station	Profile	Position φ (N)	λ (W)	Uncorr. water depth (m)	Instruments
23.09.97	16:00							sail Las Palmas start P233b
24.09.97	02:58	06:30	632	74	29°44.8'	017°55.4	4325	CTD/rosette; samples for J. Scholten (GPI, Univ. Kiel)
	07:04	11:20	633		29°45.7'	017°57.3'	4331	recover mooring LP-1
	13:07	16:28	634		29°45.7'	017°55.8'	4330	set mooring LP-2
	16:53	17:19	635	75	29°45.9'	017°56.4'	4333	CTD/rosette,;150 m; plankton samples
	19:02	19:34	636	76	29°40.7'	017°37.6'	4232	CTD/rosette; 500 m plankton samples
25.09.97	07:02	12:33	637		29°11.0'	015°27.0'	3610	recover mooring CI-7
	15:00		638		29°14.9'	015°24.9'	3610	set drifting traps, 500m;
		16:30			29°14.2'	015°24.8'		set drifting traps, 200m;
	16:46	17:10		77	29°14.1'	015°24.6'		CTD/rosette, 200 m, plankton samples
	18:20	21:30	639	78	29°10.0'	015°30.0'	3610	CTD/rosette; sampling nutrients and salinity
26.09.97	07:05	10:41	640		29°11.2'	015°27.3'	3610	set mooring CI-8
	16:00							port of Las Palmas; end P233b
28.09.97	08:00							sailLas Palmas; start P233c
	14:50	17:00	641		29°09.0'	015°40.0'	3610	recover mooring 367-3
	18:06	18:30	642	79	29°10.0'	015°40.0'	3610	CTD/rosette, 200 m plankton samples
	19:26	22:02	643	80	29°10.0'	015°40.0'	3610	CTD/rosette near to the bottom
29.09.97	07:28	17:24	644		29°10.1'	015°40.2'	3610	set mooring 367-4
	19:40	20:05	645		29°02.2'	015°20.1'	3594	recover drifting traps.
30.09.97	07:00	07:18	646		29°14.9'	015°24.0'	3599	set drifting traps, 200 m;
	07:25	08:48			29°14.8'	015°24.2'	3589	set drifting traps, 500 m;
	07:58	08:50	647	81	29°14.9'	015°23.3'	3598	CTD/rosette, 200 m; plankton samples;
	09:01	09:25	648		29°14.4'	015°23.1'	3598	plankton net IEO
	18:11	18:50	649	82	28°48.1'	013°41.9'	911	CTD
	19:50	20:35	650	83	28°46.0'	013°34.0'	1184	CTD
01.10.97	07:00	08:12	651		28°42.4'	013°09.3'	996	recover mooring EBC2/378-1
	09:30	12:10	652		28°39.9'	012°56.8'	493	try to recover mooring EBC1; search; acoustic release positioned lying at bottom; not recovered

Table C2 Station List P233 b-d (continue)

Date	Time (UTC) start	end	Station	Profile	Position φ (N)	λ (W)	Uncorr. water depth (m)	Instruments
01.10.97	13:31	15:31	653		28°42.2'	013°09.8'	998	set mooring EBC2/378-2
	15:57	16:15	654	84	28°40.9'	013°11.9'	1036	CTD
	18:01	18:30	655	85	28°40.0'	013°01.0'	638	CTD
	19:32	19:32	656	86	28°38.6'	012°54.0'	360	CTD
	20:37	20:54	657	87	28°37.2'	012°49.0'	248	CTD
	21:33	21:46	658	88	28°36.1'	012°44.0'	163	CTD
02.10.97	07:02	08:20	659		28°44.5'	013°18.0'	1195	recover mooring EBC3/377-1
	09:37	10:42	660		28°46.4'	013°28.0'	1280	recover mooring EBC4-1
	12:09	12:40	661		28°48.4'	013°38.8'	1044	recover mooring EBC5-1
	14:18	15:27	662		28°44.3'	013°17.9'	1180	set mooring EBC3/377-2
	16:22	17:08	663	89	28°41.9'	013°12.1'	1051	CTD
	17:55	18:52	664	90	28°42.9'	013°16.8'	1048	CTD/rosette near EBC3; nutrient samples in AAIW core
	20:19	21:14	665	91	28°43.8'	013°22.8'	1308	CTD
03.10.97	08:00	09:02	666		28°46.5'	013°27.6'	1280	set mooring EBC4-2
	11:09	12:30	667		28°48.6'	013°38.4'	1030	set mooring EBC5-2
04.10.97	07:21	07:32	668		28°57.4'	015°09.0'	3581	recover drifting traps, 200 m
	08:10	08:31	669		28°59.5'	015°12.5'	3584	recover drifting traps, 500 m
	08:40	09:05	670	92	28°59.4'	015°12.2'	3584	CTD/rosette, 200 m; plankton samples
	12:41	15:38	671	93	29°10.0'	015°29.9'	3608	CTD/rosette, ESTOC Oct 1997 station; plankton net, 200m, IEO
05.10.97	08:00							port of Las Palmas; end of P233c
06.10.97	17:00							sail Las Palmas
07.10.97	23:38	00:43	672		29°10.0'	015°29.9'	3607	ESTOC position: flushing rosette bottles; 2000 m;
	00:43	03:20		94	29°10.2'	015°29.8'	3607	CTD/rosette near to the bottom; tracer samples; in-situ pumps, 1000 m;
	03:54	07:23			29°10.5'	015°28.7'	3607	trace metal samples;
	07:25	08:22			29°10.2'	015°21.4'	3607	trace metal special rosette, 1000 m; plankton net, 30 m, ETHZ
08.10.97	22:42	23:00	673		28°37.0'	012°49.0'	248	plankton net, 30 m, ETHZ
09.10.97	03:06	03:23	674		32°20.0'	009°50.0'	592	plankton net, 30 m, ETHZ
10.10.97	09:00							port of Portimao

Table C3 Sampling Levels for Each Station P233 a

Samples: O (oxygen), N (nutrients), Cl (chlorophyll), S (salinity), Co (Coccolithophorids), D (diatoms), I (stable isotopes), - no bottle closed, * bottle closed while lifting

	station											
pres (dbar)	561	562	563	564	565	566	567	568	569	570	571	572
bucket	-	Co	Co	Co	-	Co	-	Co	Co	Co	-	Co
10	S	O,N,Cl S,Co	O,N,Cl S,Co	-	O,N,Cl S	O,N,Cl S,Co	O,N,Cl S	-	O,N,Cl S,Co	O,N,Cl S,Co	O,N,Cl S,Co	O,N,Cl S,Co
25		O,N,Cl Co	O,N,Cl Co	O,N,Cl S,Co	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl S,Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co
50		O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co
75		O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	open	O,N,Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co
100	O	O,N,Cl Co	O,N,Cl Co	O,N.Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl Co	open	O,N,Cl Co	O,N,Cl Co
125		-	O,N,Cl Co	O,N,Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl	Co*	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co
150		-	O,N,Cl Co	O,N,Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl	-	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co
200		-	O,N,Cl Co	O,N,Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co
250		-	O,N Co	O,N Co	O,N	O,N Co	O,N	O,N Co	O,N Co	O,N Co	O,N Co	O,N Co
300		-	O,N Co	O,N Co	O,N	O,N	-	-	-	-	-	-
400		-	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N
500	-	-	-	-	-	-	-	-	-	-	-	-
600		-	-	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N
800	O	-	-	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N
900	-	-	-	-	-	-	-	-	-	-	-	-
1000	O	-	-	-	O,N	O,N	-	O,N	O,N	O,N	O,N	O,N
1100	O	-	-	-	O,N	O,N	O,N	O,N	O,N	O,N	-	-
1150	-	-	-	-	-	-	-	-	-	-	O,N	O,N
1200	O	-	-	-	O,N	O,N	O,N	O,N	O,N	O,N	-	-
1300	O	-	-	-	-	O,N	O,N	O,N	O,N	O,N	O,N	O,N
1500	O	-	-	-	-	O,N,	O,N	O,N	O,N	O,N	O,N	O,N
1800		-	-	-	-	O,N	O,N	-	-	-	-	-
2000		-	-	-	-	O,N S	O,N	O,N	O,N	O,N	O,N	O,N
2500		-	-	-	-	-	O,N	O,N	O,N	O,N	O,N	O,N
2800	-	-	-	-	-	-	-	-	-	-	-	-
3000	O,S	-	-	-	-	-	-	O,N	O,N	O,N	O,N	O,N
3500	-	-	-	-	-	-	-	-	-	-	O,N	O,N
4000	-	-	-	-	-	-	-	-	-	-	-	-
bottom	-	O,N,Cl S,Co	O,N S	O,N S	O,N S	-	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S

Table C3 Sampling Levels for Each Station P233 a (continue)

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

	station											
pres (dbar)	573	574	575	576	577	578	579	580	581	582	583	584
bucket	Co	Co	Co	Co	Co	-	Co	-	-	Co,D,I	Co	Co,D
10	O,N,Cl S,Co	O,N,Cl S,Co	O,N,Cl S,Co	-	O,N,Cl S,Co	O,N,Cl S	O,N,Cl Co	open	O,N,Cl S	O,N,Cl S,CoD	open	O,N,Cl S,Co,D
25	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl S,Co	O,N,Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl S	O,N,Cl	O,N,Cl Co,D,I	O,N,Cl S,Co	O,N,Cl Co,D
50	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl	O,N,Cl Co,D,I	O,N,Cl Co	O,N,Cl Co,D
75	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl	O,N,Cl Co,D	O,N,Cl Co	O,N,Cl Co,D
100	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl	O,N,Cl Co	open	open	O,N,Cl Co,D	O,N,Cl Co	O,N,Cl Co,D
125	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	open	O,N,Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl	O,N,Cl Co,D	O,N,Cl S, Co	O,N,Cl Co,D
150	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl	O,N,Cl Co,D,I	O,N,Cl Co	O,N,Cl Co,D
200	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl	O,N,Cl Co,D	O,N,Cl Co	O,N,Cl Co,D
250	O,N Co	O,N Co	O,N Co	-	O,N Co	O,N	O,N Co	O,N	O,N	O,N Co,D	O,N Co	O,N Co,D
300	-	-	-	-	-	-	-	-	-	O,N Co,D,I	-	-
400	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N
500	-	-	-	-	-	-	-	-	-	O,N S, I	-	-
600	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N
800	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N
900	-	-	-	-	-	-	-	-	-	O,N	-	-
1000	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N
1100	-	-	-	-	-	-	-	-	-	O,N	-	-
1150	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	-	O,N	O,N
1200	-	-	-	-	-	-	-	-	-	O,N	-	-
1300	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N
1500	O,N	O,N	O,N	O,N	O,N	O,N	O,N	open	O,N	O,N	O,N	O,N
1800	-	-	-	-	-	-	-	-	-	O,N	-	-
2000	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N
2500	O,N	O,N	O,N	O,N	O,N	O,N	O,N	open	O,N	O,N	O,N	O,N
2800	-	-	-	-	-	-	-	-	-	O,N	-	-
3000	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N
3500	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N
4000	-	-	-	-	-	-	-	-	-	O,N	-	-
bottom	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S

Table C3 Sampling Levels for Each Station P233 a (continue)

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

	station										
pres (dbar)	585	586	587	588	589	590	591	592	593	594	595
bucket	-	Co	Co,D,I	Co	-	Co,D,I	-	Co,D	Co	Co	Co,D,I
10	O,N,Cl S	O,N,Cl S,Co	O,N,Cl S,Co,D	O,N,Cl S,Co	O,N,Cl S	O,N,Cl S,Co,D	O,N,Cl S	O,N,Cl S,Co,D	O,N,Cl S,Co	O,N,Cl S,Co	O,N,Cl S,Co,D
25	O,N,Cl	O,N,Cl Co	O,N,Cl Co,D,I	O,N,Cl Co	O,N,C	O,N,Cl Co,D,I	O,N,Cl	O,N,Cl Co,D	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co,D,I
50	O,N,Cl	O,N,Cl Co	O,N,Cl S,Co,D,I	O,N,Cl Co	O,N,C	O,N,Cl Co,D,I	O,N,Cl	O,N,Cl Co,D	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co,D,I
75	O,N,Cl	O,N,Cl Co	O,N,Cl Co,D	O,N,Cl Co	O,N,Cl	O,N,Cl Co,D	O,N,Cl	O,N,Cl Co,D	O,N,Cl Co	O,N,Cl Co	O,N,Cl S,Co,D
100	O,N,Cl	O,N,Cl Co	O,N,Cl S,Co,D	O,N,Cl Co	O,N,Cl	O,N,Cl Co,D	O,N,Cl	O,N,Cl Co,D	O,N,Cl Co	O,N,Cl Co	O,N,Cl S,Co,D
125	O,N,Cl	O,N,Cl Co	O,N,Cl Co,D	O,N,Cl Co	O,N,Cl	O,N,Cl Co,D	O,N,Cl	O,N,Cl Co,D	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co,D
150	O,N,Cl	O,N,Cl Co	O,N,Cl S,Co,D,I	O,N,Cl Co	O,N,Cl	O,N,Cl Co,D,I	O,N,Cl S	O,N,Cl Co,D	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co,D,I
200	O,N,Cl	O,N,Cl Co	O,N,Cl Co,D	O,N,Cl Co	O,N,Cl	O,N,Cl Co,D	O,N,Cl	O,N,Cl Co,D	O,N,Cl Co	O,N,Cl Co	O,N,Cl Co,D
250	O,N	O,N Co	O,N S,Co,D	O,N Co	O,N	O,N Co,D	O,N	O,N S,Co,D	O,N Co	O,N Co	O,N Co,D
300	-	-	O,N Co,D,I	-	-	O,N Co,D,I	-	-	-	O,N Co	O,N S,Co,D,I
400	O,N	O,N	O,N S	O,N	O,N S	O,N	O,N	O,N	O,N	O,N	O,N
500	-	-	O,N S, I	-	-	O,N S, I	-	-	-	-	O,N S, I
600	O,N	O,N	O,N S	O,N	O,N	O,N	O,N	O,N	O,N	O,N	O,N
800	O,N	O,N	O,N S	O,N	O,N	O,N	O,N	O,N	broken	O,N	O,N S
900	-	-	O,N S	-	-	O,N	-	-	-	-	-
1000	O,N S	O,N	O,N S	O,N	O,N	O,N	O,N S	O,N	O,N S	O,N	O,N
1100	-	-	O,N S	-	-	O,N	-	-	-	O,N	-
1150	O,N	O,N	-	O,N	O,N	-	O,N	O,N	O,N	-	-
1200	-	-	O,N S	-	-	O,N	-	-	-	O,N	-
1300	O,N	O,N	O,N S	O,N	O,N	O,N	O,N	O,N	O,N	O,N	-
1500	O,N	O,N	O,N S	O,N	O,N S	O,N	O,N	O,N S	O,N	O,N	-
1800	-	-	O,N S	-	-	O,N	-	-	-	O,N	-
2000	O,N	O,N	O,N S	O,N	O,N	O,N	O,N	O,N	O,N	O,N	-
2500	O,N	O,N	O,N S	O,N	O,N	O,N	O,N	O,N	O,N	-	-
2800	-	-	O,N S	-	-	O,N	-	-	-	-	-
3000	O,N	O,N	O,N S	O,N	O,N	O,N	O,N	O,N	O,N	-	-
3500	O,N	O,N	O,N S	O,N	O,N	O,N	O,N	O,N	O,N	-	-
4000	-	-	-	-	-	-	-	-	-	-	-
bottom	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S

Table C3 Sampling Levels for Each Station P233 a (continue)

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

	station											
pres (dbar)	596	597	598	599	600	601	602	603	604	605	606	607
bucket	-	Co,D	-	-	Co,D,I	Co,D,I	-	Co	-	Co,D	-	-
10	O,N,Cl S	O,N,Cl S,Co,D	O,N,Cl	O,N,Cl S	O,N,Cl S,Co,D	O,N,Cl S,Co,D	O,N,Cl S	O,N,Cl S,Co	O,N,Cl S	O,N,Cl S,Co,D	O,N,Cl S	O,N,Cl S
25	O,N,Cl	O,N,Cl S,Co,D	O,N,Cl	O,N,Cl	O,N,Cl Co,D,I	O,N,Cl Co,D,I	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl Co,D	O,N,Cl	O,N,Cl
50	O,N,Cl	O,N,Cl Co,D	O,N,Cl	O,N,Cl	O,N,Cl Co,D,I	O,N,Cl Co,D,I	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl Co,D	O,N,Cl	O,N,Cl
75	O,N,Cl	O,N,Cl S,Co,D	O,N,Cl	O,N,Cl	O,N,Cl Co,D	O,N,Cl Co,D	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl Co,D	O,N,Cl	O,N,Cl
100	O,N,Cl	O,N,Cl S,Co,D	O,N,Cl	O,N,Cl	O,N,Cl Co,D	O,N,Cl Co,D	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl Co,D	O,N,Cl	-
125	O,N,Cl	O,N,Cl S,Co,D	O,N,Cl	O,N,Cl	O,N,Cl Co,D	O,N,Cl Co,D	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl Co,D	O,N,Cl	-
150	O,N,Cl	O,N,Cl S,Co,D	O,N,Cl	O,N,Cl	O,N,Cl Co,D,I	O,N,Cl Co,D,I	O,N,Cl	O,N,Cl Co	O,N,Cl	O,N,Cl Co,D	O,N,Cl	-
200	O,N,Cl	O,N,Cl S,Co,D	O,N,Cl	O,N,Cl	O,N,Cl Co,D	O,N,Cl Co,D	O,N,Cl	O,N,Cl S,Co	O,N,Cl S	O,N,Cl Co,D	-	-
250	O,N	O,N S,Co,D	O,N	O,N	O,N Co,D	O,N Co,D	O,N	O,N Co	O,N	-	-	-
300	-	O,N S,Co,D	-	O,N	O,N Co,D,I	O,N Co,D,I	-	O,N	O,N	-	-	-
400	O,N	O,N S,Co	O,N	O,N	O,N	O,N	O,N	O,N	-	-	-	-
500	-	-	-	-	O,N I	O,N I	-	-	-	-	-	-
600	O,N	O,N S	O,N	O,N	O,N	O,N	O,N	-	-	-	-	-
800	O,N	O,N S	O,N	O,N	O,N	O,N	-	-	-	-	-	-
900	-	-	-	-	-	-	-	-	-	-	-	-
1000	-	O,N S	O,N	-	O,N	O,N	-	-	-	-	-	-
1100	-	O,N S	O,N	open	-	-	-	-	-	-	-	-
1150	-	-	-	-	-	-	-	-	-	-	-	-
1200	-	O,N S	O,N	O,N	-	-	-	-	-	-	-	-
1300	-	-	-	O,N	-	-	-	-	-	-	-	-
1500	-	-	-	-	-	-	-	-	-	-	-	-
1800	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-
2500	-	-	-	-	-	-	-	-	-	-	-	-
2800	-	-	-	-	-	-	-	-	-	-	-	-
3000	-	-	-	-	-	-	-	-	-	-	-	-
3500	-	-	-	-	-	-	-	-	-	-	-	-
4000	-	-	-	-	-	-	-	-	-	-	-	-
bottom	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S	O,N S,D	O,N,Cl S	O,N,Cl S

Table C3 Sampling Levels for Each Station P233 a (continue)

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

	station											
pres (dbar)	608	609	610	611	612	613	614	615	616	617	618	619
bucket	Co,D	-	-	-	-	-	-	-	-	-	-	-
10	O,N,Cl S,Co,D	O,N,Cl S	O,N,Cl S	O,N,Cl S	N S	O,N,Cl S	open	N S	O,N,Cl S	N S	O,N,Cl S	N S
25	O,N,Cl Co,D	O,N,Cl	O,N,Cl	O,N,Cl	N	O,N,Cl	N S	N	O,N,Cl	N	O,N,Cl	N
50	O,N,Cl Co,D	O,N,Cl	O,N,Cl	-	N	O,N,Cl	N	N	O,N,Cl	N	O,N,Cl	N
75	O,N,Cl Co,D	O,N,Cl	-	-	-	-	N	N	O,N,Cl	N	O,N,Cl	N
100	-	-	-	-		-	-	-	O,N,Cl	N	O,N,Cl	N
125	-	-	-	-	-	-	-	-	-	N	O,N,Cl	N
150	-	-	-	-	-	-	-	-	-	N	O,N,Cl	N
200	-	-	-	-	-	-	-	-	-	N	O,N,Cl	N S
250	-	-	-	-	-	-	-	-	-	N	O,N	N
300	-	-	-	-	-	-	-	-	-	N	O,N	N
400	-	-	-	-	-	-	-	-	-	N	O,N	N
500	-	-	-	-	-	-	-	-	-	-	-	-
600	-	-	-	-	-	-	-	-	-	N	O,N	N
800	-	-	-	-	-	-	-	-	-	-	O,N	N
900	-	-	-	-	-	-	-	-	-	-	-	-
1000	-	-	-	-	-	-	-	-	-	-	-	N
1100	-	-	-	-	-	-	-	-	-	-	-	N
1150	-	-	-	-	-	-	-	-	-	-	-	-
1200	-	-	-	-	-	-	-	-	-	-	-	-
1300	-	-	-	-	-	-	-	-	-	-	-	-
1500	-	-	-	-	-	-	-	-	-	-	-	-
1800	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-
2500	-	-	-	-	-	-	-	-	-	-	-	-
2800	-	-	-	-	-	-	-	-	-	-	-	-
3000	-	-	-	-	-	-	-	-	-	-	-	-
3500	-	-	-	-	-	-	-	-	-	-	-	-
4000	-	-	-	-	-	-	-	-	-	-	-	-
bottom	O,N,Cl S,D	O,N,Cl S	O,N,Cl S	O,N,Cl S	N S	O,N,Cl S	N S	N S	O,N,Cl S	N S	O,N S	N S

Table C3 Sampling Levels for Each Station P233 a (continue)

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

	station										
pres (dbar)	620	621	622	623	624	625	626	627	628	629	630
bucket	-	-	-	-	-	-	Co	-	-	-	-
10	O,N,Cl S,	N S	O,N,Cl S,	O,N,Cl S,	O,N,Cl S,	O,N,Cl S,	O,N,Cl S,,Co	N S	O,N,Cl S,	O,N,Cl S,	O,N,Cl S,
25	O,N,Cl	N	O,N,Cl	O,N,Cl	O,N,Cl	O,N,Cl	O,N,Cl Co	N	O,N,Cl	O,N,Cl	O,N,Cl
50	O,N,Cl	N	O,N,Cl	O,N,Cl	O,N,Cl	O,N,Cl	O,N,Cl Co	N	O,N,Cl	O,N,Cl	O,N,Cl
75	O,N,Cl	N	O,N,Cl	O,N,Cl	-	O,N,Cl	O,N,Cl Co	N	O,N,Cl	O,N,Cl	O,N,Cl
100	O,N,Cl	N	O,N,Cl	O,N,Cl	-	O,N,Cl	O,N,Cl Co	N	O,N,Cl	O,N,Cl	-
125	O,N,Cl	N	O,N,Cl	O,N,Cl	-	O,N,Cl	O,N,Cl Co	N	O,N,Cl	O,N,Cl	-
150	O,N,Cl	N	O,N,Cl	O,N,Cl	-	O,N,Cl S	O,N,Cl Co	N	O,N,Cl S	O,N,Cl	-
200	O,N,Cl	N	O,N,Cl	O,N,Cl	-	O,N,Cl	O,N,Cl Co	N	O,N,Cl	O,N,Cl S	-
250	O,N	N	O,N	O,N	-	O,N	O,N Co	N	O,N	O,N	-
300	O,N S	N	O,N	O,N	-	O,N	O,N S,Co	N	O,N	O,N	-
400	O,N	N	O,N	-	-	O,N	O,N	N	O,N S	O,N	-
500	-	-	-	-	-	-	-	-	-	-	-
600	O,N	N	O,N	-	-	O,N	O,N	N	O,N S	O,N	-
800	O,N	N	O,N	-	-	-	O,N	N	O,N S	O,N	-
900	-	-	-	-	-	-	-	-	-	-	-
1000	O,N	open	O,N	-	-	-	O,N	N	O,N S	-	-
1100	O,N	N	-	-	-	-	O,N	open	O,N	-	-
1150	-	-	-	-	-	-	-	-	-	-	-
1200	O,N	N	-	-	-	-	O,N	N	O,N	-	-
1300	-	-	-	-	-	-	O,N	N	-	-	-
1500	-	-	-	-	-	-	O,N	-	-	-	-
1800	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-
2500	-	-	-	-	-	-	-	-	-	-	-
2800	-	-	-	-	-	-	-	-	-	-	-
3000	-	-	-	-	-	-	-	-	-	-	-
3500	-	-	-	-	-	-	-	-	-	-	-
4000	-	-	-	-	-	-	-	-	-	-	-
bottom	O,N S	N S	O,N S	O,N S	O,N S	O,N S	O,N S	N S	O,N S	O,N S	O,N S