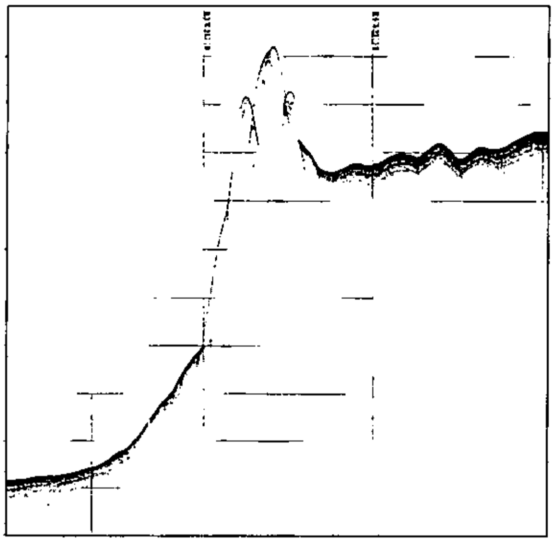
SHIPBOARD REPORT OF CRUISE 64PE138 WITH R.V. "PELAGIA"

TEXEL TO TEXEL, THE NETHERLANDS
8 MAY – 1 JUNE, 1999

GALICIA CONTINENTAL MARGIN AND NAZARÉ CANYON

H.C. DE STIGTER AND SHIPBOARD PARTY



OCEAN MARGIN EXCHANGE PROGRAMME II-II (OMEXII-II)
CARBON UPTAKE PROGRAM

Cover illustration:
Submarine mound on the continental slope off Vigo.
See Fig. 3.2.1.4 for location and scale.

CONTENTS

SUMMARY

Cruise 64PE138 with R.V."Pelagia", from May 8th to June 1st, 1999, was carried out along the western Iberian continental margin as part of Work Package III of the OMEX II-II programme. Three days of the work programme were devoted to the 'Carbon Uptake' study directed by the NIOO. Water column characteristics were studied with a CTD, and water samples were collected with a Rosette sampler. Box-, multi- and piston cores were collected for the study of sediment characteristics, sediment-water exchange processes and early diagenesis, and distribution and activity of benthic fauna. In-situ oxygen profiling and measurement of benthic fluxes was performed with the TROL and ALBEX landers. During the first part of the expedition stations offshore Galicia were sampled. The last part of the cruise was devoted to sampling in the Nazaré Canyon, offshore Portugal.

Offshore Galicia, distinct bottom nepheloid layers are only present on the shelf, whereas in deeper waters there is only a slight increase in turbidity near the bottom. Cores from the shelf consist of sand and silty clay, with abundant bioclastic material. Acoustic bottom profiling shows that the upper slope is generally devoid of a recent sediment cover. Coring confirms that ancient sedimentary rocks occur at the surface, covered only by a thin veneer of recent sandy sediment. A laterally continuous drape of hemipelagic marly ooze is present on the lower slope, with intercalations of turbidite beds occurring in the depression separating Galicia Bank from the Galician slope. Biological activity and sediment oxygen uptake decrease rapidly from the shelf toward deeper water.

In the Nazaré Canyon, pronounced bottom nepheloid layers are present down to abyssal depths, locally extending more than 1000 m upward from the bottom. Very soft silty clay with abundant plant debris and mica is retrieved in cores from the upper and middle part of the canyon. Coarse quartz sand is present on the lower part of the canyon. Benthic oxygen profiles indicate remarkably high oxygen fluxes at bathyal and abyssal depth, equal to fluxes observed on the shelf.

ACKNOWLEDGEMENTS

The results described in this report could only be obtained thanks to excellent navigation and skillful operation of sampling gear by captain Hans Groot and the crew of R.V. "Pelagia". We thank our fleet manager Theo Buisman for making all the required arrangements for the cruise. Dr. G. Monteiro of the Instituto Geológico e Mineiro, Lisboa, Portugal, provided a detailed map of the Nazaré Canyon (Vanney and Leuridan, Instituto Hidrográfico, Lisboa, Portugal, 2nd edition, 1988) which was indispensable for finding suitable sampling locations in the canyon. Cruise 64PE138 is a NIOZ contribution to the OMEX II-II programme, contract MAS 3-CT97-0076, of the European Union, DG-XII. The Carbon Uptake research was financially supported by The Netherlands Organization for Scientific Research, Earth- and Life Sciences, contract GOA 750.199.02.

1. INTRODUCTION

The continental margin represents the transition zone between the land and the open ocean. Particulate and dissolved matter originating from both the continent and the ocean comes together in this zone, where it is subject to intense mixing, sorting and transformation, and then either is retained or exits along various routes. Vast amounts of mineral detritus, produced by erosion of the continent and continental margin, are merely passively transported over the continental margin by the action of waves and currents. The coarser fractions are largely retained within sedimentary deposits of the continental shelf and slope, whereas the fine clay may spread out far into the open ocean. Although relatively inert, the mineral detritus forms the bulk of continental margin sedimentary deposits, and as such constitutes a substrate for highly active biogeochemical transformation and a matrix for burial of organic and inorganic components in the continental margin. Dissolved nutrients and trace elements, supplied to the marginal seas both by continental runoff waters and upwelled deep oceanic waters, help to sustain the high biological productivity characteristic of the continental margin. Wollast (1996) estimates that from the total of 38800 MT organic carbon produced per year in the world ocean, 10800 MT or 28% is produced in the continental margin. According to the same author, from the total of 244 MT of organic carbon buried yearly in marine sediments, as much as 240 MT or 98% is buried in the continental margin.

The continental margin thus represents a hotspot of biological and biogeochemical activity in the ocean, and lateral transport of matter appears to play a key role in determining its unique character. In recent years a number of multidisciplinary studies were carried out to examine shelf-edge exchange processes, notably SEEP I and II on the Mid Atlantic Bight (Biscaye et al., 1988, 1994), ECOMARGE in the Gulf of Lyons (Monaco et al., 1990) and OMEX I on the NW European margin (Wollast and OMEX partners, 1996). The results of these studies show that at present no single quantitative model can describe the exchange of particulate and dissolved matter across the continental margin, because of the diversity of processes occurring at the margins and the variability of coastal systems.

In view of the diversity of shelf edge configurations and hydrographic regimes present along the European continental margin, the European Union funded OMEX I programme, focusing on the broad Celtic Sea margin, was followed in 1997 by the OMEX II-II programme. This programme focuses on shelf edge exchange processes on the NW Iberian continental margin. Apart from being much narrower than the Celtic Sea margin, this margin is characterized by high biological productivity induced by seasonal wind-driven upwelling.

The present expedition 64PE138 with R.V."Pelagia", carried out from May 8th to June 1st, 1999, along the western Iberian continental margin, is part of Work Package III of the OMEX II-II programme. Additionally three days were devoted to the 'Carbon Uptake' study directed by the NIOO. The aims of the expedition were to collect data on water column characteristics, with emphasis on the distribution and fluxes of suspended particulate matter, on bottom sediment characteristics, sediment-water exchange processes and early diagenesis, and on distribution and activity of benthic fauna. During the first part of the expedition a number of stations offshore Galicia, visited during previous years, were resampled. Also some new stations were sampled along previously started sampling transects. During the last part of the cruise a special effort was made to collect samples from the Nazaré Canyon, situated offshore Portugal. Submarine canyons are considered to be major conduits for particulate matter transport from the shelf to the deep sea (e.g. Baker and Hickey, 1986; Buscail, 1990), and therefore an excursion to one of Europe's largest submarine canyons seems relevant within the scope of the OMEX studies.

References

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2. CRUISE SUMMARY

2.1 GENERAL INFORMATION

Major events and stations occupied during cruise 64PE138, with average position, water depth range, and date of occupation, are listed in Table 2.1. An overview of the study area with ship track and position of stations is shown in Figure 2.1. For a detailed account of activities see Appendix B. Start and endpoints of acoustic survey lines are in Appendix C.

Table 2.1. Major events and stations of cruise 64PE138

Event/Station	Latitude	Longitude	Depth	Date occupied
Texel departure	53°00N	004°48E		8 May 1999
Station 64PE138-01	42°38N	009°29W	195 - 219 m	12, 13 May
Station 64PE138-B1	42°38N	009°40W	1518 m	13 May
Station 64PE138-02	42°38N	010°00W	2164 - 2182 m	13, 14, 15, 16, 28 May
Station 64PE138-03	42°37N-42°38N	010°22W	2926 - 2939 m	13, 15, 17 May
Galicia Bank	42°44N	011°46W	768 m	14 May
Station 64PE138-04	42°00N	009°44W	2060 - 2067 m	16, 17, 18 May
Station 64PE138-05	42°00N	010°30W	2847 - 2853 m	17 May
Station 64PE138-06	41°52N	009°04W	107 - 113 m	18, 19 May
Vigo port call	42°15N	008°44W		18 May
Station 64PE138-07	42°00N	009°28W	1298 - 1384 m	19, 20 May
Station 64PE138-08	42°00N	009°00W	101 - 103 m	19, 20 May
Station 64PE138-09	42°09N	009°03W	131 - 132 m	20 May
Station 64PE138-10	42°00N	009°23W	379 m	20 May
Station 64PE138-11	42°00N	009°26W	932 - 935 m	20 May
Station 64PE138-12	39°39N	009°15W	327 - 344 m	22, 23 May
Station 64PE138-13	39°39N	009°20W	137 - 138 m	22, 23 May
Station 64PE138-14	39°31N	009°51W	3097 - 3292 m	23, 25 May
Station 64PE138-15	39°35N	009°36W	390 - 397 m	24 May
Station 64PE138-16	39°36N	009°24W	890 - 899 m	24 May
Station 64PE138-17	39°35N-39°36N	010°12W-010°18W	4195 - 4323 m	25, 26, 27 May
Station 64PE138-18	41°00N	009°45W	2530 m	27 May
Texel return	53°00N	004°48E		1 June 1999

2.2 DAY TO DAY ACCOUNT

R.V. Pelagia departed from Texel for cruise 64PE138 in the morning of 8 May 1999.

After four days transit, the first sampling transect, perpendicular to the Galician Margin along 42°38N, was reached shortly before noon on 12 May. This transect had been surveyed acoustically in 1997 during cruise 64PE109 and additionally in 1998 during cruise 64PE121, and the local condition of the sediment at the three projected sampling stations was already known from sampling during these previous cruises. Therefore, sampling and deployment of landers could be done without foregoing site survey with 3.5 kHz and box coring.

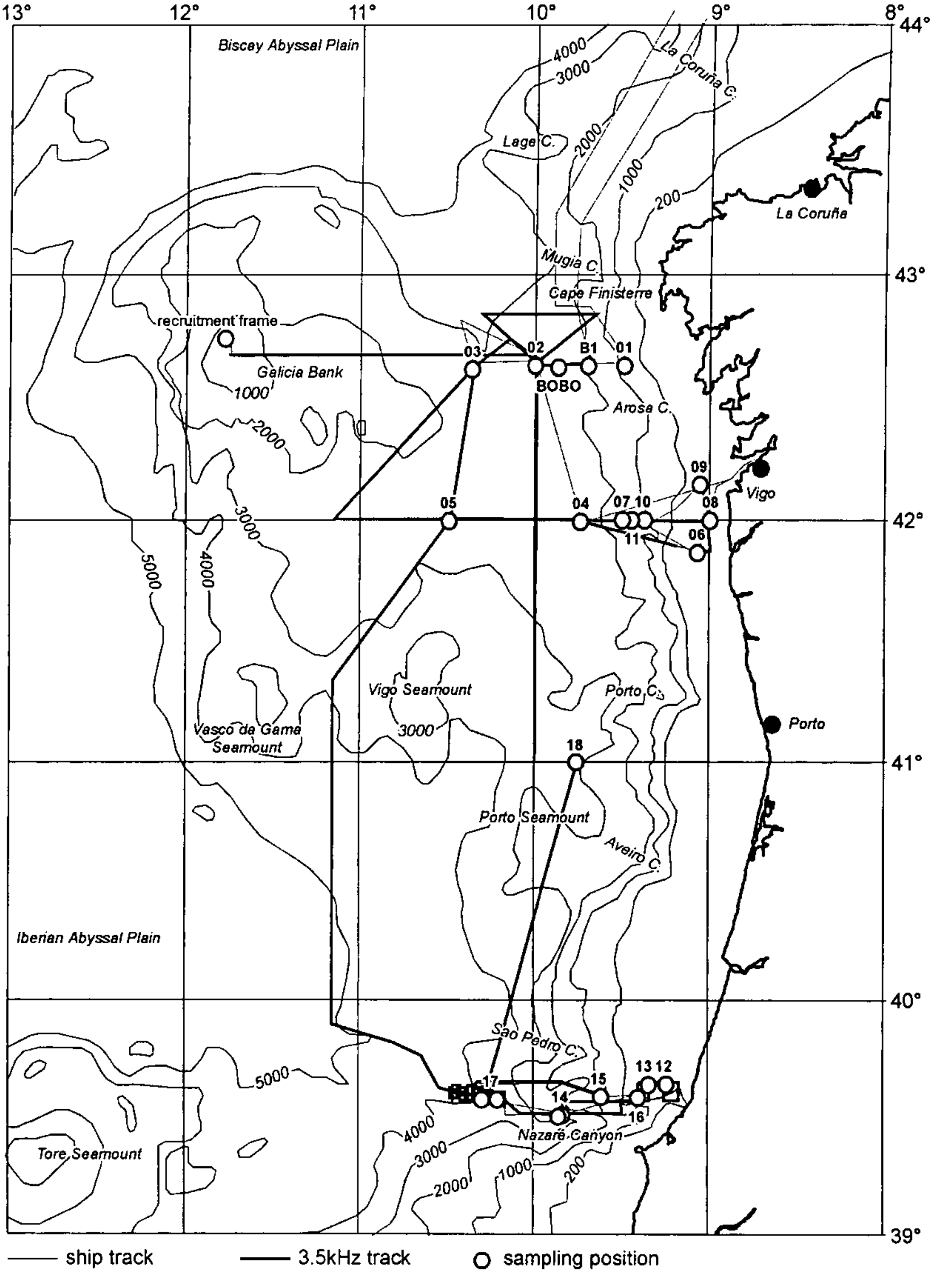


Fig. 2.1. Simplified map of the W. Iberian continental margin, with cruise track and position of sampling stations.

Activities at station 64PE138-01 commenced on 12 May with deployment of a CTD with water sampling. Two casts of the multi corer, one destined for the OMEX geochemical studies and the other for the Carbon Uptake project, had to be supplemented with a third one because during each cast four tubes failed. Subsequently one box core was collected for the Carbon Uptake studies, and then the TROL lander was deployed. R.V. Pelagia stayed overnight on station to prevent loss or damage to the lander in this much frequented fishing area. TROL was recovered at daybreak on 13 May.

An extra CTD profile was made at short distance from the shelf edge at station 64PE138-B1, to see if a distinct bottom nepheloid layer noticed on the shelf at station 64PE138-01 possibly continued as intermediate nepheloid layer beyond the shelf edge. This proved not to be the case. A B series of stations was started to accommodate for extra CTD observations, not accompanied by the normal set of benthic sampling activities. Due to strict time limitations, the B series never got beyond station 64PE138-B1.

Station 64PE138-02 was started with deployment of the ALBEX lander, to allow maximum in situ measuring time for the lander. To prevent interference with subsequent sampling activities, ALBEX was launched half a nautical mile south of the projected CTD sampling location. Two CTD casts with water sampling were made, one for general purposes, the second for radionuclide studies. Subsequently, the TROL lander was deployed, half a nautical mile north of the CTD site.

Because on board incubations of Carbon Uptake samples from station 64PE138-01 were still in progress, and there was no possibility to accommodate the scheduled incubations of station 64PE138-02, R.V. Pelagia moved westward to station 64PE138-03. Work started in the afternoon of 13 May with deployment of the CTD with water sampling, and ended with a failed multi corer cast in the evening of that day.

During the evening and night, the ship continued in westward direction along 42°40N, parallel to the sampling transect, toward Galicia Bank, with the acoustic bottom profiler switched on. At daybreak on 14 May, a benthic frame for biological recruitment experiments, deployed on Galicia Bank in June 1998, was successfully recovered.

Immediately after recovery of the recruitment frame the ship returned to station 64PE138-02, where in the afternoon of 14 May ALBEX was recovered, followed by one multi corer cast, and recovery of TROL. During the evening and night, an acoustic profile of the lower slope along 42°50N was recorded. Sampling activities at station 64PE139-02 were resumed in the morning of 15 May, with a multi corer and box corer cast destined for the Carbon Uptake study, and redeployment of ALBEX.

Subsequently, R.V. Pelagia returned, with the acoustic bottom profiler on, to station 64PE138-03 for deployment of TROL. The piston corer was launched about half a nautical mile south of the TROL site, to return bent, but nevertheless retrieving nearly a meter of sediment. Finally, another multi corer cast was made, this time successfully.

During the subsequent afternoon and evening, acoustic bottom profiling was done from station 64PE138-03 toward the southeastern slope of Galicia Bank, and from there during the night and morning of 16 May along 42°00N toward station 64PE138-04. At this station, the first on the 42°00N transect, two CTD casts were made, one for general purposes and the second for radionuclide studies, and one multi corer cast.

The entire afternoon of 16 May, R.V. Pelagia made its way back north to station 64PE138-02, under increasingly strong northerly winds, to recover ALBEX. Despite the wind and high seas and falling darkness, ALBEX was successfully recovered.

Recovery of TROL at station 64PE138-03, however, scheduled for the late afternoon of 16 May, could only take place the next morning, on 17 May.

After thus finishing activities at station 64PE138-03, the ship moved south again to station 64PE138-05 on the 42°00N transect. Two CTD casts were aborted because of electrical failure caused by the towlink. While the CTD was being repaired, a multi corer cast was made. The third CTD cast with water sampling was successful.

The ship returned to station 64PE138-04, where TROL was deployed in the late evening of 17 May.

During the night, acoustic bottom profiling along 42°00N was resumed, from the last station toward the middle shelf, and then along a different course on to station 64PE138-06. Activities started here at daybreak on 18 May with a CTD cast with water sampling, followed by two multi corer casts. The piston corer launched subsequently returned on board bent and empty, just like the previous year.

With acoustic bottom profiler on, the ship returned to station 64PE138-04 to recover TROL.

After recovery of the lander, the ship headed toward Vigo, where it arrived in front of the port in the early evening. Disembarkment of the four members of the Carbon Uptake team and entering of three new participants was accomplished in less than 15 minutes, thanks to the efficiency of the agent at Vigo.

The same evening of 18 May, TROL was deployed at station 64PE138-06. The intensive fishing on the shelf off Vigo in mind, R.V. Pelagia stayed on station overnight, and TROL was safely recovered in the morning of 19 May.

After additional acoustic surveying of the upper slope along 42°00N, a site for station 64PE138-07 was selected at approximately 1300 m depth. However, during the CTD cast the echosounder depth recording varied so much within a small geographical area that the site was considered topographically unsafe for deployment of the TROL lander. Therefore, another site at slightly greater depth was acoustically surveyed, and following successful retrieval of a box core TROL was launched.

With the aim of obtaining a long core from the muddy shelf deposits off Vigo, two piston coring attempts, preceded by acoustic surveying and box coring on 19 and 20 May, were made on the shelf off Vigo at stations 64PE138-08 and –09. Although both casts yielded sediment cores, the enterprise failed with respect to recovered core length.

After finishing station 64PE138-09 in the morning of 20 May, the upper slope between 200 and 1000 m depth was once more acoustically surveyed for a suitable location for sediment sampling. During previous cruises sampling of the upper slope had generally failed due to the steep topography and the presence of indurated older sediments. Yet, observations in this bathymetric interval were needed because the steepest gradients in benthic carbon flux occur on the upper slope. The selected station 64PE138-10 at 379 m depth yielded a near-empty box core. Only a handful of fine sand with lumps of yellowish white marl testified of the presence of probably pre-Quaternary deposits outcropping at this location, covered by a veneer of recent sand.

Successful box corer and multi corer casts were made at station 64PE138-11 located further offshore at approximately 935 m depth.

Sampling activities along the 42°00N transect were terminated in the afternoon of 20 May with recovery of TROL and casting of a multi corer and piston corer at station 64PE138-07.

Station 64PE138-05 was the starting point for a long acoustic bottom profile recorded on the 21st of May during transit to the Nazaré Canyon. Late in the afternoon of 21 May, R.V. Pelagia reached the lower end of the Nazaré Canyon. Acoustic profiling was continued in upslope direction along the axis of the canyon, up to the 3500 m isobath. From there, profiling was carried on along E-W and N-S oriented lines toward the head of the canyon near Nazaré. The acoustic profiling was finished in the morning of 22 May, with a detailed survey of the projected location of station 64PE138-12.

Sampling activities at this station included a CTD cast with water samples, two box corer casts, one for geochemical and one for biological studies, three multi corer casts, all three with some failed tubes, and one piston corer cast.

For comparison with the canyon samples, samples were also collected on the shelf immediately adjacent to the canyon at station 64PE138-13. In the afternoon of 22 May, a CTD cast with water samples was made here, as well as 2 box corer casts.

R.V. Pelagia returned to station 64PE138-12 for deployment of the TROL lander. In view of the intensive fishing around the head of the canyon, the ship stayed on station overnight, and TROL was recovered in the morning of 23 May. A second piston coring attempt with a longer coring barrel failed.

The ship then returned to station 64PE138-13, where two multi coring casts were made.

Subsequently, an acoustic profile was recorded from station 64PE138-13 to the next projected station (later 64PE138-16), with a detailed survey of the projected sampling site. The most suitable site for sediment sampling seemed to be an elevated bank on the inside bend of a canyon meander, appearing a pointbar-like body.

Because the site was considered topographically unsafe for TROL landing, the ship moved on, with acoustic profiler switched on, toward station 64PE138-14. This station was also located on a pointbar-like elevation within a canyon meander, similar but much broader than the other one. After a detailed acoustic survey and recovery of an overflowing box core, TROL was launched in the evening of 23 May.

Overnight, detailed acoustic surveying of the lower Nazaré Canyon was performed along N-S directed lines.

In the morning of 24 May a CTD cast with water samples, as well as two box and two multi corer casts, were made at station 64PE138-15, located adjacent to the canyon at approximately 390 m water depth.

In the afternoon of that same day, a CTD cast with water samples was made at station 64PE138-16, followed by one empty and one overflowing box corer cast, two failed and one successful multi corer casts, and again one failed and one overflowing box corer cast.

Sampling at station 64PE138-14 was resumed at daybreak on 25 May, with a CTD cast with water samples, followed by a box corer cast. An attempt was made to hit the canyon bed with the box corer, but as the cable length at the moment of touch-down was considerably shorter than the channel depth recorded by the echosounder, it seems that the corer landed on an elevated bank adjacent to the channel bed. Subsequently TROL was recovered, then two multi corer casts, the first one with half of the tubes failed, and a piston corer cast.

After thus finishing sampling at station 64PE138-14, the ship moved on to the lower Nazaré Canyon to station 64PE138-17. After a brief acoustic survey and an essentially failed box coring attempt, TROL was launched in the late evening of 25 May.

Overnight, detailed acoustic surveying of the lower Nazaré Canyon was performed along N-S directed lines, continuing on a previously started survey.

Sampling activities at station 64PE138-17 were resumed in the morning of 26 May, with two box corer casts. The first cast was made half a nautical mile north of the TROL site, to prevent possible interference with the lander. The second cast was made further north, nearly one nautical mile from the TROL site, with the aim of hitting the bed of one of the channels incised in the lower canyon floor. A CTD cast with water samples was made roughly 4 nautical miles east of the TROL site. This should be a safe distance away from the turbid plume stirred up by the box corer and TROL landings the previous day, supposing that any up-canyon current would not exceed 10 cm s^{-1}. In the evening of 26 May, a multi corer and an unsuccessful piston corer cast were made at three quarter of a nautical mile east of the TROL site.

Overnight, detailed acoustic surveying of the lower Nazaré Canyon was performed once more along N-S directed lines, continuing on the previously started survey.

Activities in the Nazaré Canyon were ended in the morning of 27 May with the recovery of TROL from station 64PE138-17.

Immediately afterwards, R.V. Pelagia set course to NNE for a rendez-vous with the Portuguese NRP "Almeida Carvalho" off Porto. A continuous acoustical bottom profile was made during transit. At station 64PE138-18 a CTD intercomparison exercise was made together with NRP "Almeida Carvalho". Water samples were exchanged between both ships.

From station 64PE138-18, R.V. Pelagia continued its course northwards along 010°00W, with the acoustic bottom profiler switched on. At daybreak on 28 May station 64PE138-02 was reached, where ALBEX was launched for a long-term deployment.

About 6 nautical miles to the East, the BOBOII lander was successfully recovered from where it was deployed in August 1998.

Another 7.5 nautical miles further East, a broken sediment trap mooring from the Institut für Meereskunde, Kiel, Germany, was checked to be still in place with releases responding.

After this last action, R.V. Pelagia set course to NE for its return voyage to Texel. After four days transit the ship returned safely to Texel in the morning of 1 June 1999.

3. INITIAL RESULTS

3.1 WATER COLUMN

3.1.1 CTD PROFILING

Henko de Stigter and Henk Franken

CTD casts where made at all stations except stations 64PE138-08, -09, -10 and -11, using a SeaBird SBE-9plus system equipped with a SBE-4 conductivity sensor, SBE-3 temperature sensor and SBE-13 oxygen sensor, and in addition a SeaTech transmissometer, a WET Labs AC3 system for measuring beam attenuation and chlorophyll concentration, a Chelsea fluorometer and a SeaPoint optical back scatter/turbidity sensor. Water samples were taken with a General Oceanics Rosette sampler equipped with 22 Noex bottles of 12 l each. Samples were collected from the bottom water about 3 m above the sea bed, from turbid layers at intermediate depth (if present), and depending on the number of remaining bottles at 500 m vertical intervals up to 1000 m, then at 750, 500, 300, 200, 100, 50, 25 m. Due to malfunctioning of the multivalve of the Rosette sampler in very deep water (stations 64PE138-14, -17 and –18), a number of Noex bottles closed at a wrong depth.The correct depth of closure could be reconstructed on the basis of nutrient measurements in the water samples. Water column profiles of temperature, salinity, oxygen and beam attenuation are given in Appendix E. Calibrated bottle files with determinations of oxygen and nutrients are presented in Appendix F.

The CTD profiles typically show the presence of relatively warm, saline water of reduced oxygen concentration, associated with Mediterranean Outflowing Water (MOW), at depths between 500 and 1500 m.

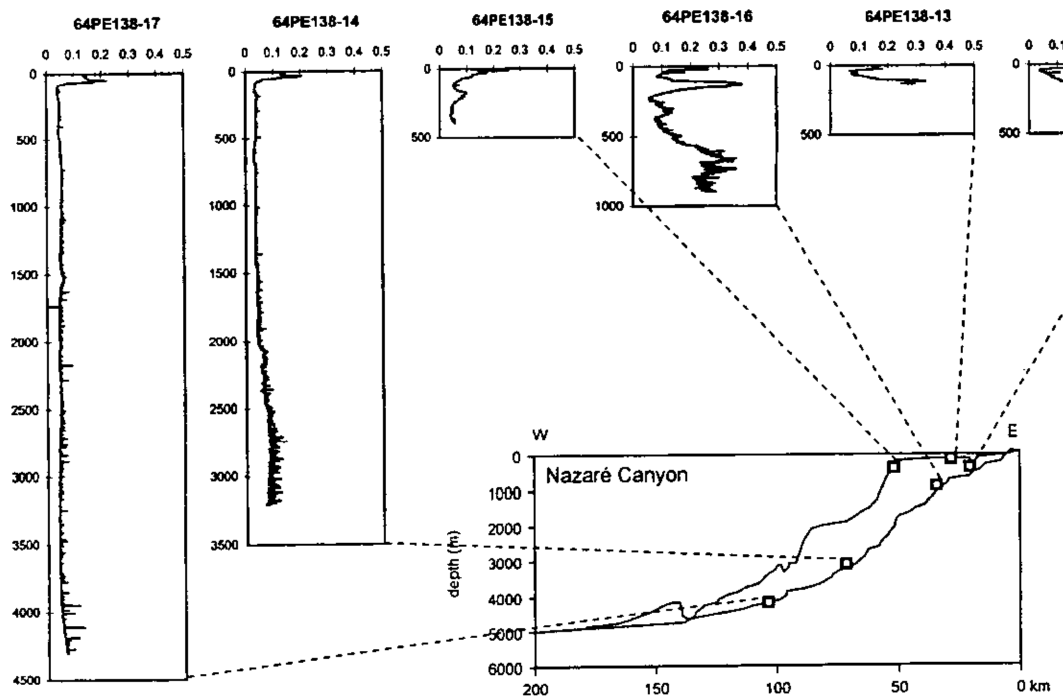


Fig. 3.1.1.1. Beam attenuation profiles in the Nazaré Canyon, showing well-developed bottom and intermediate nepheloid layers.

A well-developed surface nepheloid layer (SNL) of about 50 m thickness is present at all stations. Turbidity in the surface nepheloid layer tends to decrease in offshore direction, as well as from north to south. This may be related to a decrease in productivity toward the open ocean and toward the south. Along the two northern sampling transects at 42°38N and 42°N, a well-developed bottom nepheloid (BNL) layer is only present on the shelf, extending to about 20 m above the sea bed. No evidence was found of detachment of BNL's at the shelf edge with formation of intermediate nepheloid layers (INL). In the waters overlying the continental slope, only very inconspicuous BNL's and INL's were observed. In contrast, pronounced nepheloid layers are present in the Nazaré Canyon, extending several hundred and even more than 1000 m from the bottom upward (Fig. 3.1.1.1). Beam attenuation profiles show multiple maxima, and BNL's are not clearly separated from INL's.

3.1.2 BOBO LANDER

Henk Franken

The BOttom BOundary lander (BOBO) was recovered near station 64PE138-02, after a long deployment of about 10 months. It had been launched on 13 August 1998, near the site of sediment trap mooring IM3. The lander is equipped with an RDI Accoustic Current Doppler Profiler, a SeaCat conductivity and temperature recorder from SeaBird, and two SeaPoint optical backscatter sensors. On board, there appeared to be ADCP data from only the first month of deployment, and CT data from three months.

3.1.3 OXYGEN

Rikus Kloosterhuis and Erica Koning

Oxygen samples were taken from the NOEX water sampler bottles mounted on the Rosette-CTD frame in order to calibrate the Oxygen probe also attached on the CTD frame. Sampling was done in volume calibrated 100 ml glass vials with glass stoppers.

Oxygen was measured on board using a combination of the Winkler precipitation of the oxygen and a modified spectrofotometric detection of the yellow / brown colour (Su-Cheng Pai, 1993. Marine Chemistry 41: 343-351) . The acidified brown precipitation will give a iodine and iodide clear mixture with an Absorption max. at 353-356 nm Yet the detection was done at the shoulder of the absorption max. at 456 nm , wich requires a stable spectrophotometer with a narrow monochromatic slit-opening.

Oxygen was calculated from :

$$[O_2](\mu mol/l) = [(Abs_{cor} - intercept) / (slope * d)] * V_{cor} - 1.05\ \mu mol/l$$

where:

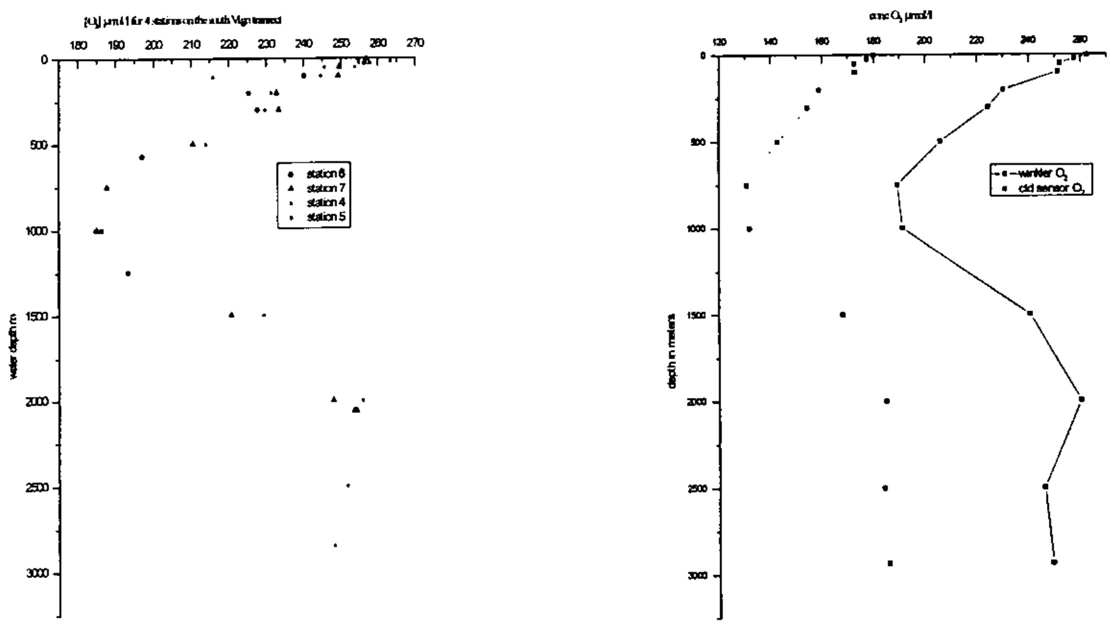
V_{cor} = (V bottle+V acid) / (V bottle - V precipitation reagents)
Abs_{cor} = Abs sample - Abs discolored sample with SO_2
d = cuvet passage length.
1.5 μmol/l = Contribution of O_2 from the precipitation reagents .

Slope and intercept were determined 3 times during the cruise, by measuring A_{456} of various strenght KJO_3 solutions (Table 3.1.3.1). The average values will be used to calculate O_2 concentrations.

Table 3.1.3.1

	Slope	Intercept	reg. coeff.
Oijkomx99_1.xls :	0.001113	0.0005	0.999993
Oijkomx99_2.xls :	0.001114	0.0005	0.999963
Oijkomx99_3.xls :	0.001112	0.0013	0.999993

All oxygen values and calibration results are reported in Appendix F. A plot of oxygen concentrations of water column samples at the 42°N transect is presented in Figure 3.1.3.1a. For comparison a depth profile of station 64PE138-03 is shown together with the CTD oxygen sensor values, revealing a constant offset. (Figure 3.1.3.1b.)
All data are preliminairy and will be corrected at NIOZ.



a. b.

Fig. 3.1.3.1 a: Oxygen concentrations of water column samples at the 42°N transect; b: oxygen profile at station 64PE138-03 with CTD oxygen sensor values, revealing constant offset.

3.1.4 SALINITY

Samples for onshore salinity calibration were taken at various depths (see Appendix F).

3.1.5 NUTRIENTS

Jan van Ooijen and Evaline van Weerlee

Summary

On this cruise samples were analyzed on silicate, ammonium, phosphate, nitrite, nitrate, dissolved inorganic carbon, iron and manganese. The obtained nutrient values are given in Appendix F. After this cruise analyses will also be done on urea and bromide.
About 7000 analyses were performed on an Autoanalyzer connected to an autosampler. The different nutrients were determined colorimetrically as described by Grashoff.

Methods

Samples were obtained from the CTD rosette sampler, the TROL bottom lander, on board flux experiments, and from sediment from a multicorer. The samples were collected in a polyethylene or polypropylene sample bottle, filtered over a 0.20 µm acrodisc filter and stored dark at 4°C in a polypropylene cup, except for the DIC samples which were collected and stored in a glass sample vial. The samples which were analyzed on Iron and Manganese were acidified with HCl ultrapure to pH=2. All samples were analyzed within 48 hours on a Technicon TrAAcs 800 autoanalyzer except for the iron and manganese analyses. Because of the large difference in nutrient content between the samples the analyses were carried out in several calibration ranges.

Standards were prepared fresh every day by diluting the stock solutions of the different nutrients in nutrient depleted surface ocean water. This water is also used as baseline water. Each run of the system had a correlation coefficient for the standards of at least 0.9998 except for the DIC analyses. The samples were measured from the lowest to the highest concentration in order to keep the carry-over effects as small as possible.

In every run a mixed nutrient standard containing silicate, phosphate, ammonium and nitrate in a constant and well known concentration, a so called nutrient-cocktail, was measured in triplo. This cocktail is used as a guide to check the performance of the analysis. The reduction efficiency of the cadmium column in the nitrate lane was at least 95 % and measured in each run.

The different nutrients were measured colorimetrically as described by Grashoff (1983).

Silicate reacts with ammoniummolybdate to a yellow complex, after reduction with ascorbic acid the obtained blue silica-molybdenum complex was measured at 800nm. Oxalic acid was used to prevent formation of the blue phosphate-molybdenum.

Phosphate reacts with ammoniummolybdate at pH 1.0, and potassiumantimonyl-tartrate was used as an inhibitor. The yellow phosphate-molybdenum complex was reduced by ascorbic acid and measured at 880nm.

Nitrate was mixed with a buffer imidazol a pH 7.5 and reduced by a copperized cadmium column to nitrite, and measured as nitrite (see nitrite).

Nitrite was diazotated with sulphanylamide and naphtylethylenediamine to a pink colored complex and measured at 550nm. The difference in the two last measurements gave the nitrate concentration.

Ammonium reacts with phenol and sodiumhypochlorite to a indophenolblue complex at pH=10.5. Sodium prusside is used as an inhibitor and sodiumcitrate is added as a buffer and complexant for calcium and magnesium. The obtained complex was measured at 630nm. Iron is first converted in Fe(II) by using hydroxylamine in a buffered medium of sodium acetate, this is then colored with ferrospectral and measured at 550 nm.

The manganese method is based on a modification of the formaldoxime reaction. The manganese-formaldoxim color is formed in a alkaline solution and measured at 480 nm. Interference of iron-formaldoxime is removed by addition of EDTA and hydroxylammoniumchloride.

Dissolved Inorganic Carbon (DIC) is measured by acidifying the sample to convert all the DIC into CO_2. This is dialyzed through a membrane into a alkaline solution of phenolftaleine. The de-colorisation is measured at 550 nm.

The standard deviations for CTD-water analyses measured during this cruise are as follows:
Within one run:

PO_4 : 0.0016 µM (0.11% of full scale value)
NH_4 : 0.017 µM (0.38% of full scale value)

NO_2 : 0.0055 µM (0.37% of full scale value)
NO_3 : 0.029 µM (0.12% of full scale value)
SiO_4 : 0.18 µM (0.35% of full scale value)

Between the different runs:
PO_4 : 0.0075 µM (0.50% of full scale value)
NH_4 : 0.050 µM (1.13% of full scale value)
NO_2 : 0.013 µM (0.87% of full scale value)
NO_3 : 0.096 µM (0.38% of full scale value)
SiO_4 : 0.22 µM (0.43% of full scale value)

Bottles which were not closed at the proper depth or bottles that have been leaking:

Station:	**Bottles:**
64PE138-04 (ROS1)	9
64PE138-07	2
64PE138-14	1, 12, 14
64PE138-17	9, 14, 15, 17
64PE138-18	6

3.1.6 SUSPENDED PARTICULATE MATTER

Henko de Stigter

For determination of the concentration and composition of suspended particulate matter (SPM) in the bottom nepheloid layer and in the overlying water column, water samples were collected at approximately 3 m above the bottom and at variable depths in the water column (see Table 3.1.6.1), using 12 liter NOEX bottles mounted on the CTD-Rosette sampler.

Table 3.1.6.1. Depth intervals sampled for SPM determinations. BNL=Bottom Nepheloid Layer; CW= Clear Water; INL=Intermediate Nepheloid Layer.

Station (cast)	NOEX bottles	Sampled depth intervals
64PE138-01	6, 17	BNL 217 m; CW 99 m
64PE138-02 (1)	6, 10, 11	BNL 2167 m; INL 1348 m ; CW 1002 m
64PE138-03	5, 9, 10	BNL 2938 m; INL 1351 m; CW 1000 m
64PE138-04 (1)	5, 7, 9	BNL 2061 m; INL 1649 m; CW 1000 m
64PE138-05 (3)	3, 12, 15, 18	BNL 2849 m; CW 1002 m; INL 502 m; INL 152 m
64PE138-06	3, 8, 13	BNL 107 m; BNL 96 m; CW 79 m
64PE138-07	3, 8, 16	BNL 1246 m; CW 1002 m; INL 570 m
64PE138-12	3, 9, 15	BNL 339 m; INL 200 m; CW 50 m
64PE138-13	3, 13	BNL 130 m; CW 52 m
64PE138-14	3, 13, 18	BNL 3149 m; CW 997 m; INL 200 m
64PE138-15	3, 12, 16	BNL 386 m; CW 302 m; INL 167 m
64PE138-16	3, 16, 18	BNL 886 m; CW 201 m; INL 128 m
64PE138-17	3, 15, 18	BNL 4220 m; CW 1000 m; INL 748 m
64PE138-18 (2)	3	BNL 2554 m

Two 5-liter subsamples were drawn off from each NOEX bottle, without previous homogenization of the NOEX bottle. SPM subsamples were filtered on board through preweighed Poretics 0.45 μm polycarbonate filters, applying underpressure with a vacuum pump. After filtration, salt water was removed by passing about 10 ml of milli-Q water through the filters, after which the filters were stored in plastic petridishes at ambient temperature for further analysis on land.

Filtration of bottom nepheloid layer samples from the shelf as well as from the Nazaré Canyon yielded appreciable amounts of SPM on the filters, as compared to the low SPM yield of most other samples.

3.1.7 RADIONUCLIDES

Sabine Schmidt

Water column

The objectives are:

- to estimate particle residence time in intermediate / bottom nepheloid layers, using ^{234}Th ($t_{1/2}$= 24.1 d) : ^{238}U and ^{228}Th ($t_{1/2}$= 1.9y) : ^{228}Ra activity ratios;
- to determine scavenging intensity onto particles and its variations within the margin, using ^{230}Th / ^{231}Pa.

For ^{234}Th and ^{228}Th measurements, each 40-liters seawater sample is filtered trough a 0.45 μm filter. Due to the short half-life of ^{234}Th and to avoid significant ingrowth corrections, the separation of ^{234}Th from its ^{238}U parent is carried out on board within 24 hours after seawater collection. For analysis, ^{229}Th yield tracer and 120 mg Fe (as $FeCl_3$) are added to the dissolved sample after acidification to pH 2. After spike equilibration, $Fe(OH)_3$ was precipitated by adding NH_4OH to pH 7. After recovery of the precipitate, the separation of ^{234}Th and ^{238}U is obtained by passage through an anion exchange column (Dowex 1x8, 100-200 mesh) under 8N HCl conditions.

Within two months after the cruise, particulate ^{234}Th will be directly measured on filters with a low background-high efficiency detector. Purification of dissolved ^{234}Th will be achieved prior to determination of chemical yield, derived from ^{229}Th, and dissolved ^{234}Th activity by γ-counting.

On board Radium is extracted from seawater by coprecipitation with $BaSO_4$. At the lab precipitates will be rinsed and dried, prior to measurements by gamma spectrometry within 6 months after the cruise.

Sampled CTD / depth (m): 1 (100, 180, 217), 2 (1000, 1400, 2172), 4 (1000, 1650, 2161), 6 (15, 80, 96, 107), 7 (569, 1002, 1247), 12 (50, 200, 338), 13 (51, 114, 130), 14 (3150), 15 (166, 300, 387), 16 (317, 805), 17 (4227)

For ^{230}Th / ^{231}Pa determination, ^{229}Th / ^{233}Pa yield tracers and 80 mg purified Fe are added to each 20 liter seawater sample. The precipitate is recovered on board. Further measurements will be done by mass spectrometry at Lamont, next autumn.

Sampled CTD / depth (m): 2 (500, 1000, 1400, 2172), 4 (500, 1000, 1650, 2161)

Sediment

By using selected isotopes with different half-lives, we will focus on the characterisation of sedimentation patterns on the Iberian margin on short-time scales. With a multitracer approach (i.e. $^{234}Th_{xs}$ (24.1 d), $^{228}Th_{xs}$ (1.9 y), $^{210}Pb_{xs}$ (22.3 y) and ^{137}Cs (30 y)), we will better constrain the determination of the bioturbation rate coefficient, and in particular test the assumption of steady state at the sea-sediment interface. The occurrence of $^{234}Th_{xs}$, when observed in the uppermost layer of cores will indicate recently deposited particles.

One core was sampled from each set of multi cores. On board, each core is sub-sampled, sliced each 0.25 cm from 0 to 2 cm, each 0.5 cm from 2 to 5 cm, then each 1 cm in the deeper part of the core. At the laboratory, sediments will be dried at 60°C, then measured by gamma spectrometry. The top of all cores (uppermost 2-3 cm) will be measured within 1 month after the cruise to detect ^{234}Th in excess. The detectors in use are two well-type high efficiency germanium crystals (215 and 430 cm^3). Measured radionuclides will be: ^{210}Pb, ^{226}Ra, ^{234}Th, ^{228}Th, ^{228}Ra, ^{137}Cs and ^{40}K (expressed in %K).

3.2 SEDIMENT CHARACTERISTICS

3.2.1 PENETRATING ECHOSOUNDER RECORDING

Henko de Stigter

3.5 kHz penetrating echosounder recordings were made along a number of lines perpendicular as well as parallel to the NW Iberian continental slope, and across and along the channel axis of the Nazaré Canyon (see Fig. 2.1.1), to obtain an overview of regional sediment distribution patterns. Line data are given in Appendix C, and detailed maps of acoustic tracks in Appendix D. Data recording was on a Dowty dry paper recorder with a setting of 0.5 second (750 m) recording interval. Ship's speed was 10 nm/h for superficial recording over long distances, 5 nm/h for detailed recording of sampling transects, and occasionally 3 nm/h for detailed '3-D' recording of potential sites for bottom lander deployments.

Along the northern sampling transect at 42°38N, the shelf and upper slope have a highly reflective seabed without apparent stratification, indicating a sandy, gravelly and in places rocky bottom. The steep slope between approximately 500 and 1500 m is represented by irregular hyperbolic reflections, indicating the presence of local rock outcrops and lack of an appreciable recent sediment cover. A well-stratified sediment cover with numerous continuous reflectors is present on the lower slope below about 1500 m, becoming thicker with increasing depth. However, toward the base of the slope the stratification locally disappears due to slumping. At the very base of the slope, erosional truncation of strata is observed (Fig. 3.2.1.1). In the trough separating the Galician slope and Galicia Bank, stratification apparently is masked below strongly reflective layers near to or at the seabed. Turbidite layers found in box and piston cores may well be responsible for this acoustic masking. Stratified sediments become again visible on the eastern slope of Galicia Bank, but they are thinner and less continuous than on the Galician slope on the opposite side of the trough, filling depressions in an acoustically unstratified subsurface.

Along the 42°N sampling transect, acoustic recording was carried out further toward the shore, across the mud belt present on the middle shelf. The recordings here show a somewhat more transparent, weakly stratified bottom. Some discontinuous transparent layers with downward-convex base may represent muddy deposits filling channels or other depressions in the seafloor (Fig. 3.2.1.2). The outer shelf and upper slope have a highly reflective seabed similar to that observed in the northern transect. Between 500 and 1500 m the slope is steep with irregular hyperbolic reflections (Fig. 3.2.1.3). Below 1500 m a well-stratified sediment cover is again present, punctured, however, by a submarine mound at 009°52W (Fig. 3.2.1.4). Further West of the seamount the stratified sediment package continues downslope, increasing in thickness, and across the trough onward to the slope of Galicia Bank. In the trough the sediment remains transparent with a well-developed stratification, suggesting that turbidites do not occur in this area (Fig. 3.2.1.5).

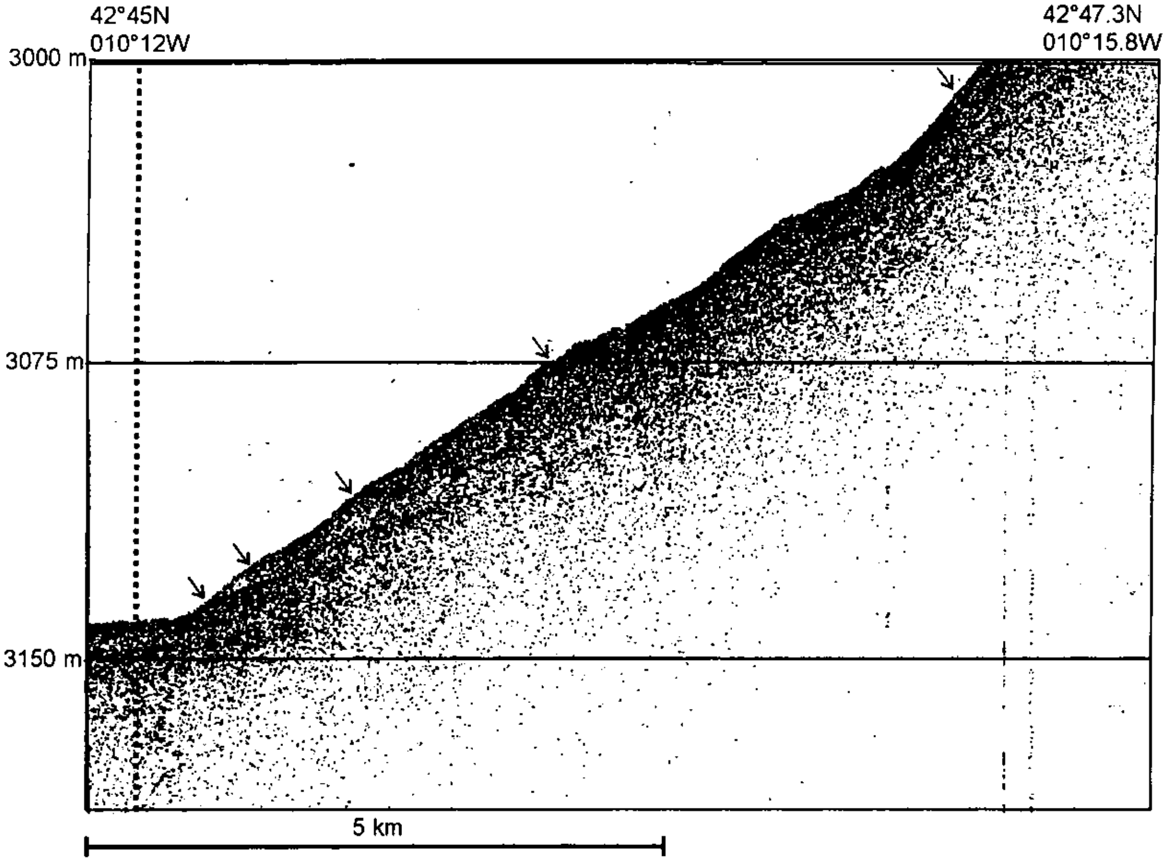


Fig. 3.2.1.1. Erosional truncation of strata at the foot of the Galician continental slope

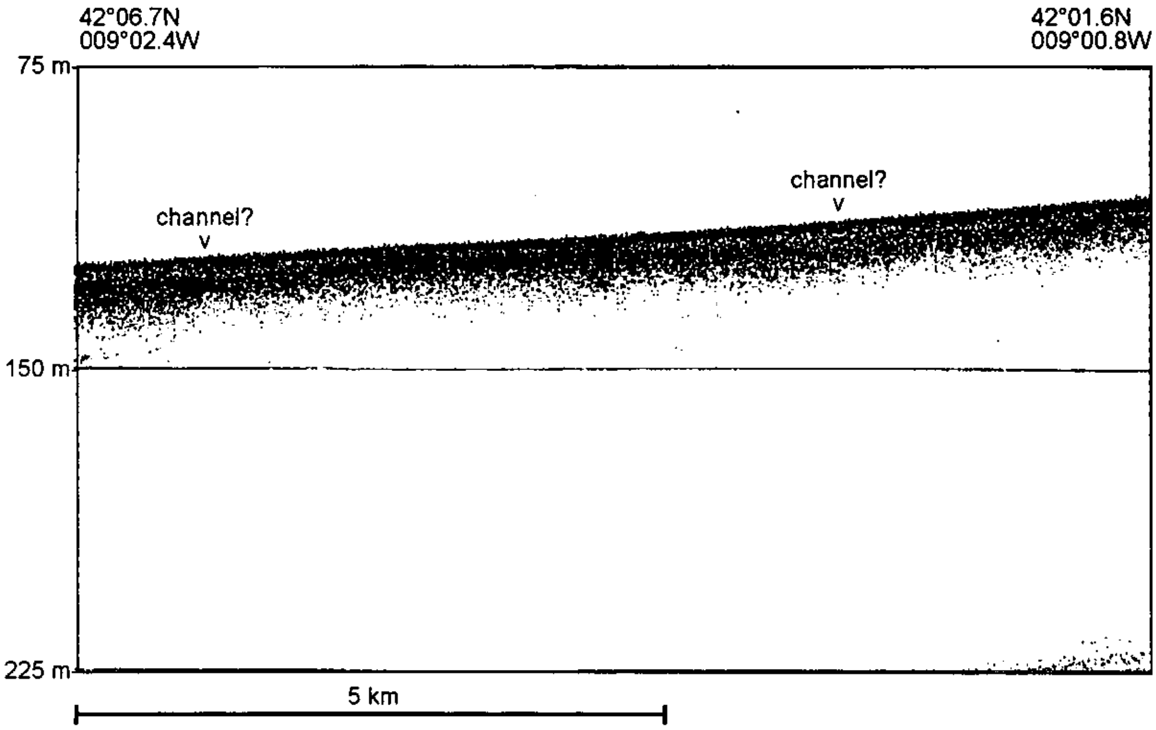


Fig. 3.2.1.2. Infilled depressions, possibly channels, in muddy shelf deposits

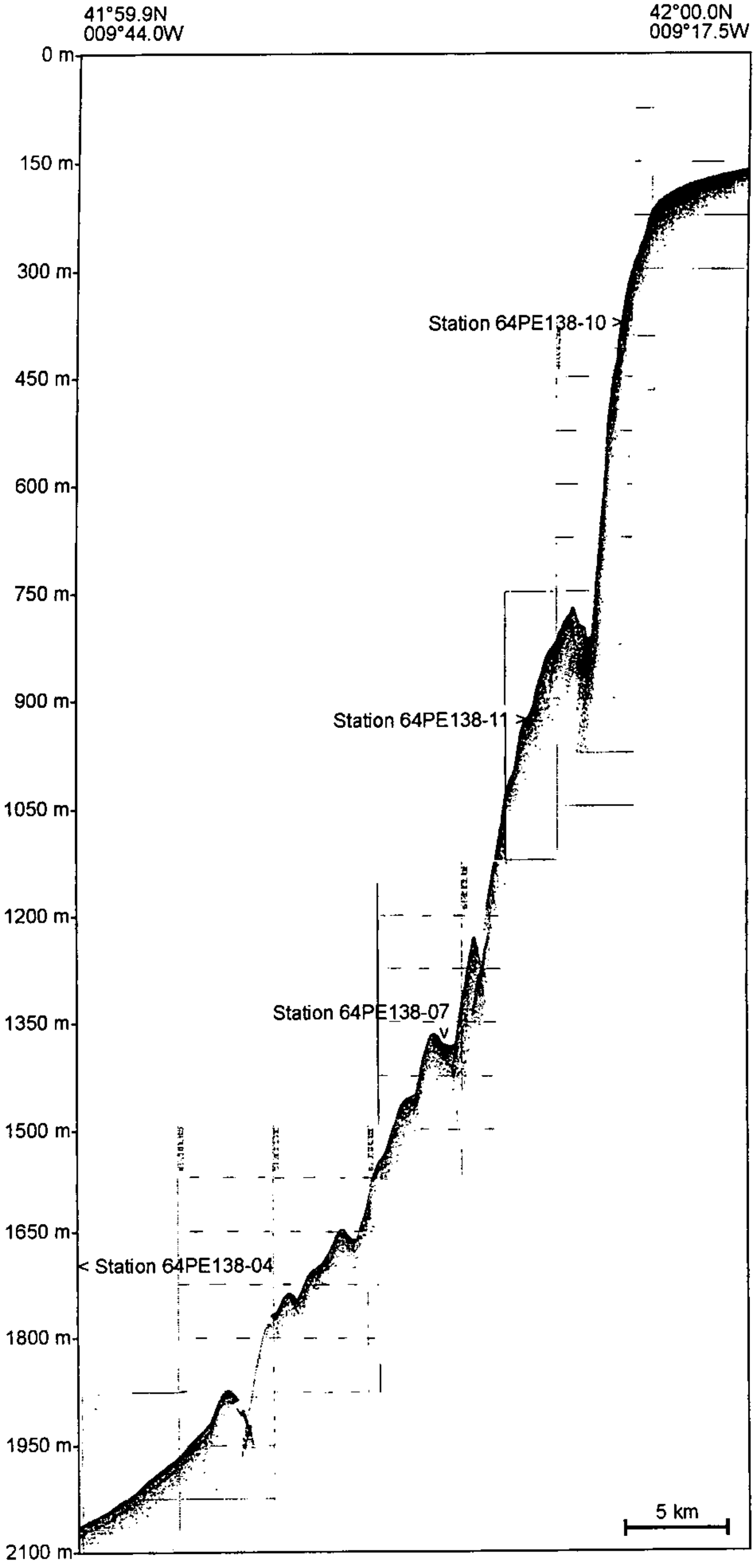

41°59.9N
009°44.0W
42°00.0N
009°17.5W
0 m
150 m
300 m
450 m
600 m
750 m
900 m
1050 m
1200 m
1350 m
1500 m
1650 m
1800 m
1950 m
2100 m
Station 64PE138-10 >
Station 64PE138-11 >
Station 64PE138-07
v
< Station 64PE138-04
5 km

Fig. 3.2.1.3

Fig. 3.2.1.3. (opposite page). The shelf edge and upper slope along 42°N transect, with position of sampling stations.

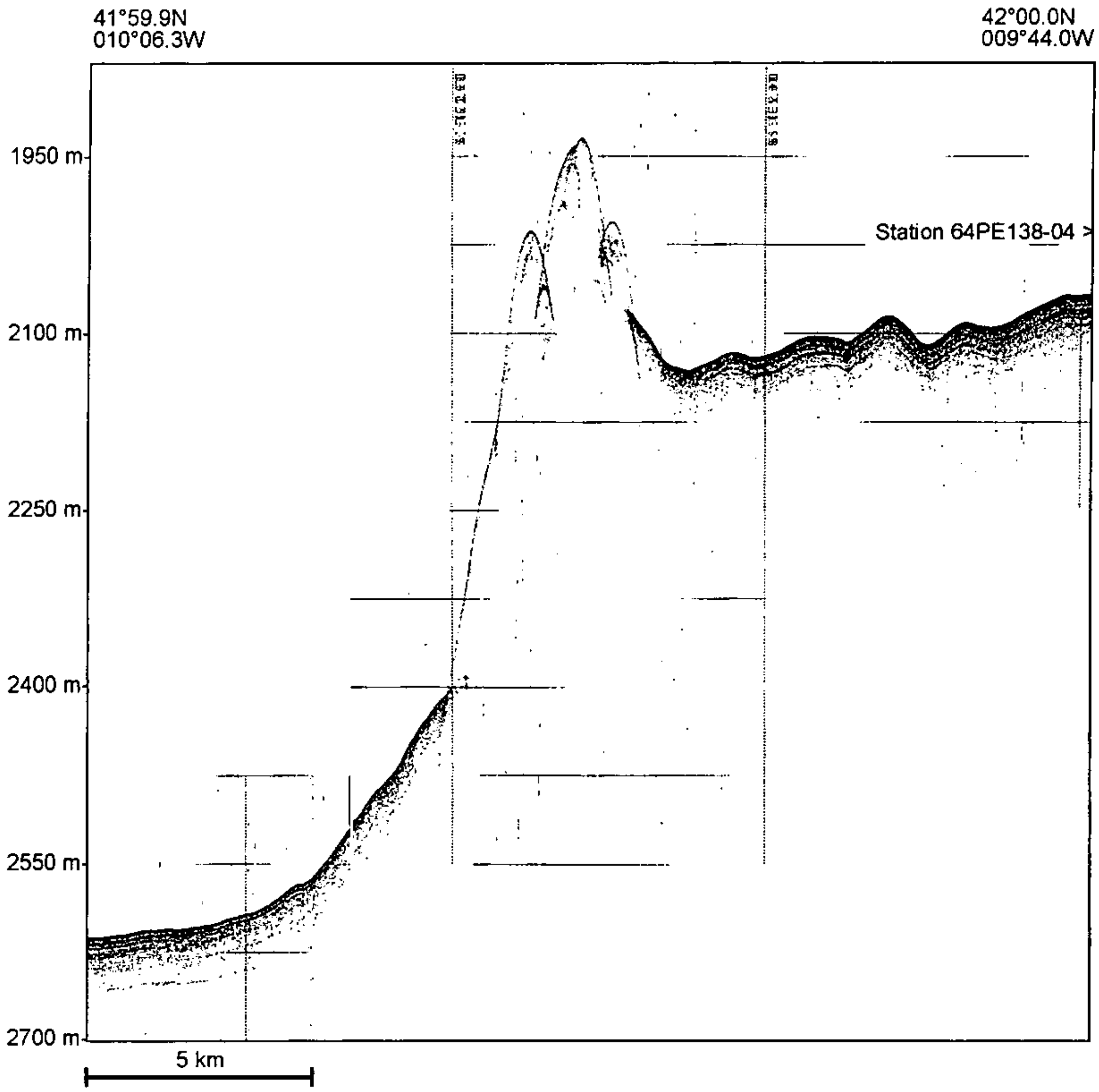


Fig. 3.2.1.4. Westward continuation of Fig. 3.2.1.3, showing a submarine mound on the lower continental slope along the 42°N transect.

From the bottom of the trough at 42°N, the stratified sediment unit seems continuous in SW direction till at least 41°30N, developing a very peculiar undulating pattern, suggestive of a drift-like sediment body with sediment waves (Fig. 3.2.1.6). Further south down the slope W of Vigo seamount and down to the edge of the abyssal plain, stratification becomes obliterated by strong reflections from surficial layers which appear continuous over the abyssal plain until the northern levee of the Nazaré Canyon. The high reflectivity of the abyssal plain seabed is likely related to the presence of turbidites (Fig. 3.2.1.7).

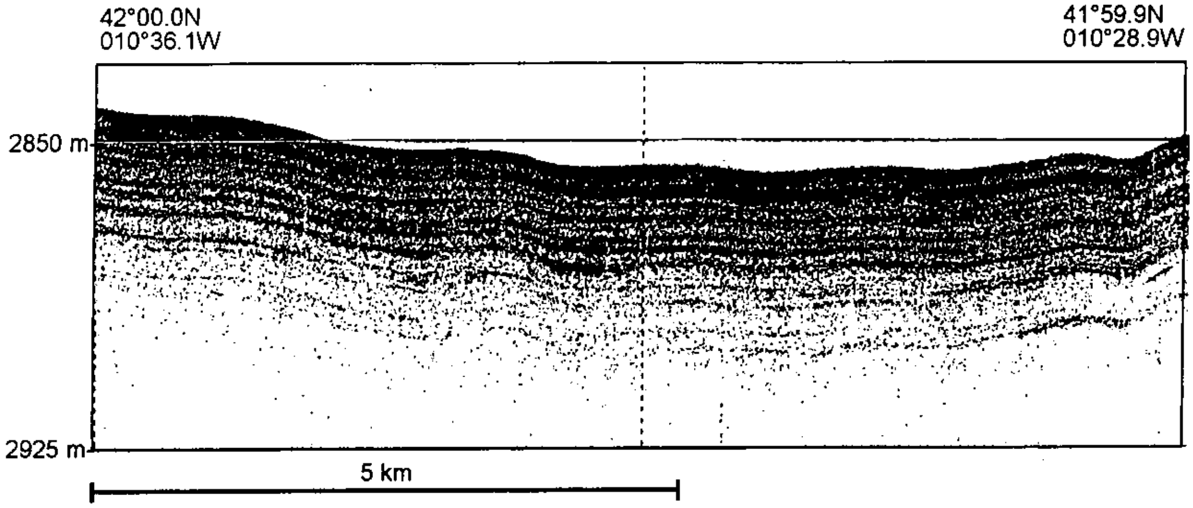


Fig. 3.2.1.5. Well-stratified, laterally continuous sediments in the depression between the Galician continental slope and Galicia Bank.

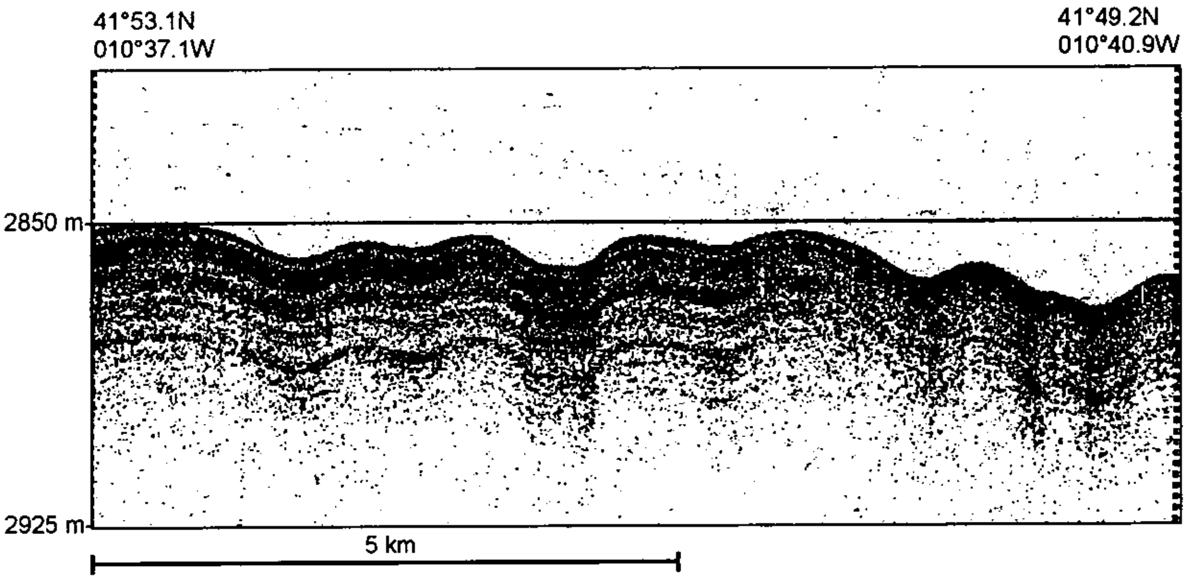


Fig. 3.2.1.6. Sediment waves SW of station 64PE138-05.

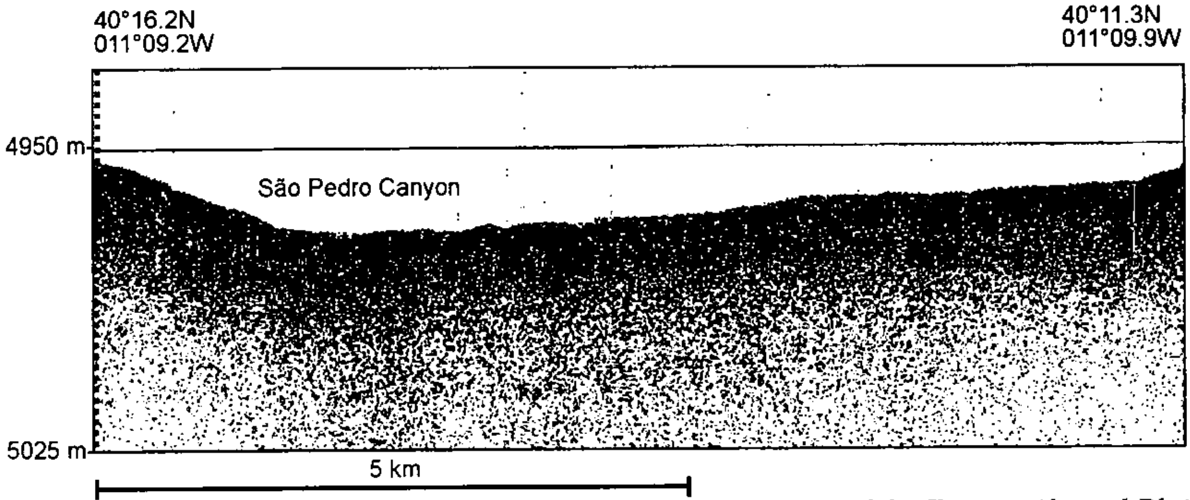


Fig. 3.2.1.7. Highly reflective turbiditic sand bottom on the edge of the Iberian Abyssal Plain.

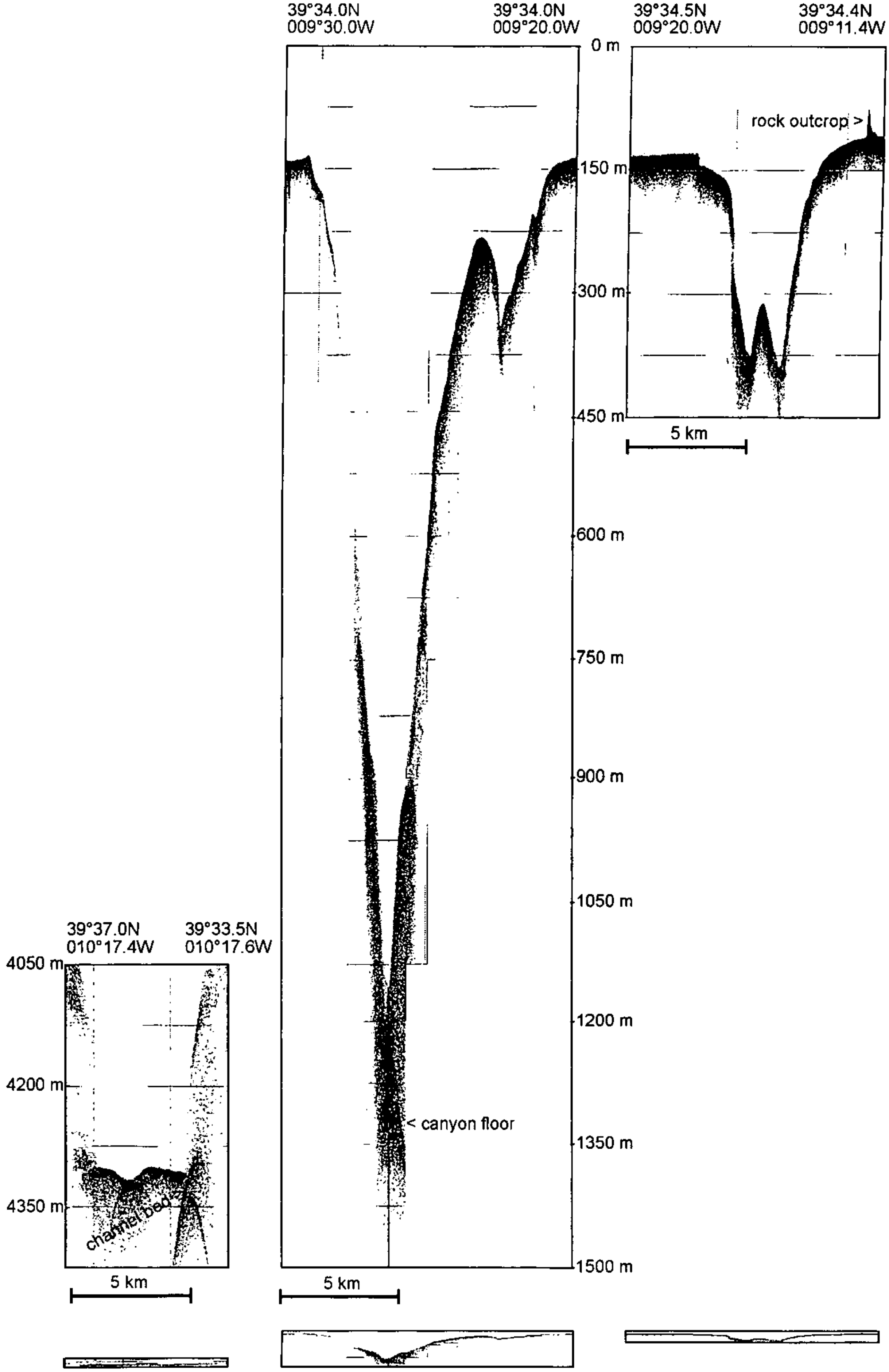

39°34.0N
009°30.0W
39°34.0N
009°20.0W
39°34.5N
009°20.0W
39°34.4N
009°11.4W
0 m
150 m
300 m
450 m
600 m
750 m
900 m
1050 m
1200 m
1350 m
1500 m
rock outcrop >
5 km
< canyon floor
39°37.0N
010°17.4W
39°33.5N
010°17.6W
4050 m
4200 m
4350 m
channel bed
5 km
5 km

Fig. 3.2.1.8. (previous page). Acoustic profiles through the Nazaré Canyon. The left and middle profile clearly show the partial or complete obscuration of the canyon floor by reflections from the canyon walls. The same profiles with no vertical exaggeration are shown at the base.

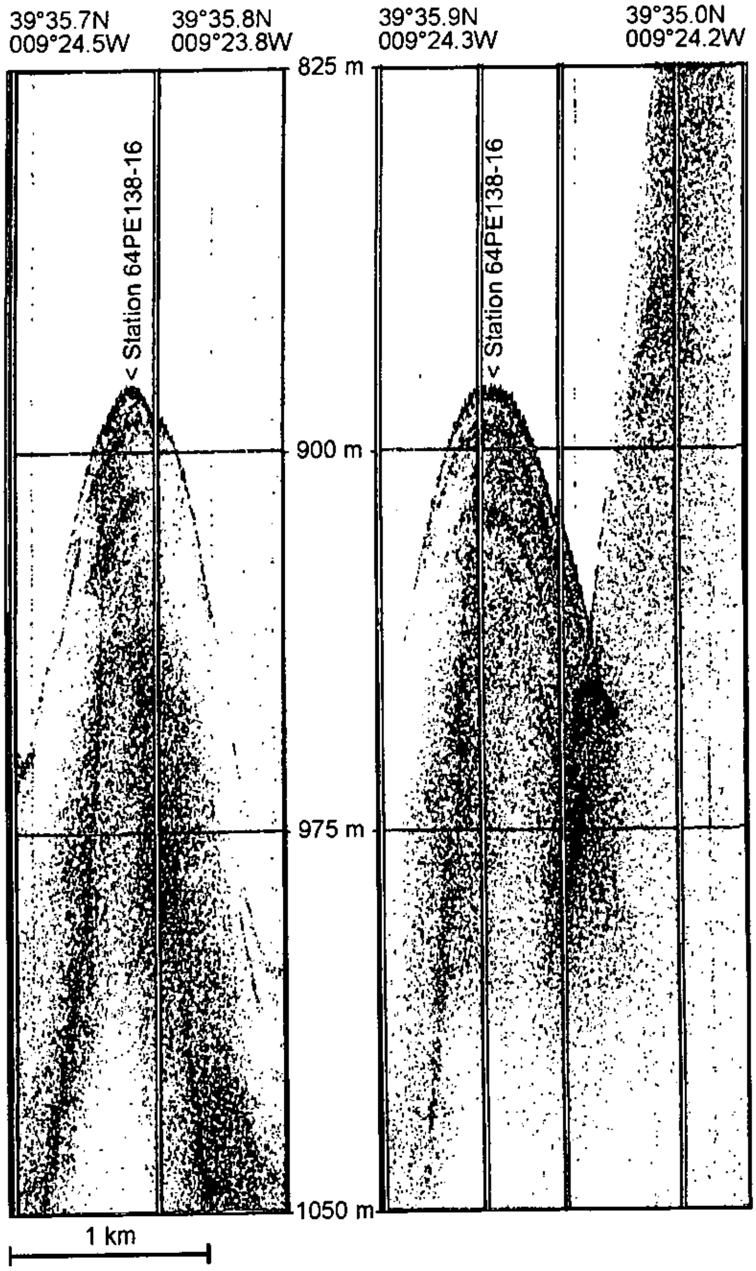


Fig. 3.2.1.9. Two perpendicular sections across a sediment accumulation on the inside bend of a canyon meander, with position of station 64PE138-16.

The seabed of the shelf and upper slope adjacent to the Nazaré Canyon appears highly reflective, on the northern side of the canyon mostly flat but on the southern side more irregular with protruding rocks. The canyon walls are poorly visible on the acoustic recordings, due to scattering of the acoustic signal on the steep slopes (3.2.1.8). Rocky outcrops produce irregular hyperbolic reflections. In the shallower part of the canyon near the coast, the meandering canyon bed is occasionally visible between the side-reflections coming from the walls, but with increasing depth the bed becomes partly or completely obliterated by side-reflections. However, from two large meander bends at 1100 and 3200 m a fairly good image of the canyon bed as well as pointbar-like sediment accumulations adjacent to the bed was obtained by recording along a closely spaced grid of survey lines at low ship speed (Fig. 3.2.1.9). Below 4000 m, the canyon bed suddenly broadens into a flat, 4-8 km wide and 70 km long plain, which opens into the abyssal plain at about 4900 m depth. The bottom of the plain is highly reflective, and is incised by a braided system of channels of 10-20 m depth. The bottom of these channels also produces strong reflections. Comparison of the position of channels in a series of closely spaced sections across the lower canyon with the positions given on the very detailed bathymetric map of of Vanney and Leuridan (Instituto Hidrográfico, Lisboa, Portugal, 2nd edition, 1988), reveals that some channels have migrated laterally since the survey of the Instituto Hidrográfico (Fig. 3.2.1.10). This would imply considerable sediment dynamics in this area. Sediment cores retrieved from the lower canyon floor show that below a thin surficial layer of mud coarse terrigenous sand is present, explaining the high reflectivity of the canyon bed.

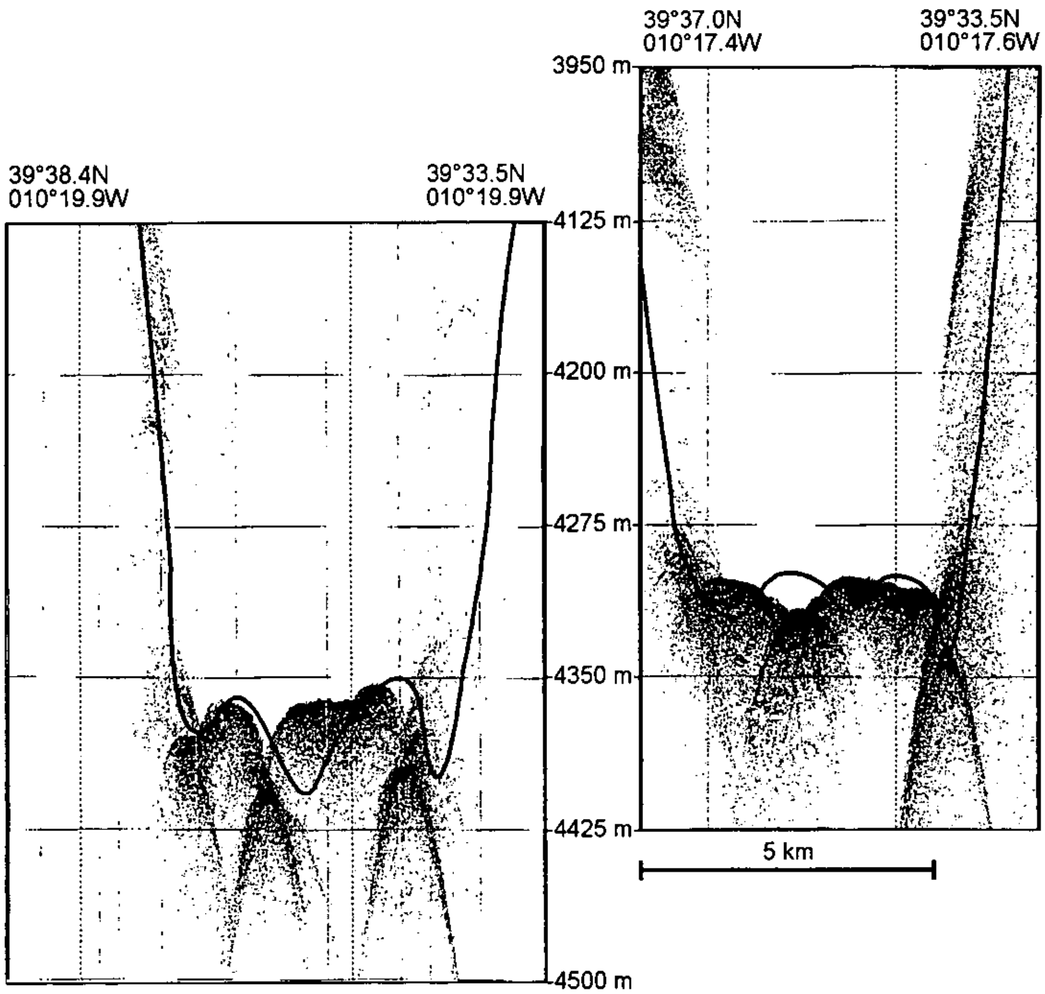


Fig. 3.2.1.10. Acoustic profiles through the lower part of the Nazaré Canyon, showing the highly reflective sandy canyon floor with incised channels. The drawn line shows sections at the same location according to the bathymetric map of Vanney and Leuridan (Instituto Hidrográfico, Lisboa, Portugal, 2nd edition, 1988).

3.2.2 BOX- AND PISTON CORES

Henko de Stigter, Willem Renema, Paulo Pedro, Jaap Kalf

Box cores were made with a standard box corer, equipped with a 30 cm ∅, 55 cm deep, cylindrical box with closing lid. Positions and water depths of the box core stations are given in Appendix B. Except for two cores destined for the Carbon Uptake program, cores were only made at stations not visited during previous years, to test the suitability of the seabottom for deployment of more delicate instruments. Subsamples of box cores were obtained by slowly inserting plastic tubes of 9 and 6 cm ∅ into the sediment. These will serve for making X-radiographs (University of Bordeaux), for age determination with planktonic foraminifera (NIOZ), and for the analysis of grain size, mineralogical composition - including clay mineralogy and heavy minerals - and aminoacids (University of Algarve, see section 3.3.2). Additionally, approximately 5 cm^3 from the upper 5 mm of box cores was collected for analysis of diatoms (University of La Coruña), and approximately 50 cm^3 from the upper 5 cm for comparison with grab samples (University of Algarve). Replicate box cores were made at stations in the Nazaré Canyon (stations 12-17) for meio- and macrofaunal studies (NIOO). Main characteristics of the surface sediments are given in Table 3.2.2.1 below.

Table 3.2.2.1. Box core sediment characterisation

Core	Sediment characterisation
64PE138-01bc	Foram-rich fine sand; sediment surface smooth
64PE138-02bc	Silty-clayey carbonaceous mud; sediment surface smooth
64PE138-07bc	Foram-rich silty carbonaceous mud; sediment surface smooth, with some small open burrows and arborescent foraminifera
64PE138-08bc	0-5 cm: fine sand with current ripples; below 5 cm: silty clay with shells
64PE138-09bc	Sandy silt; smooth sediment surface
64PE138-10bc	Empty box, except for handfull of fine-medium well-sorted sand and lumps of yellowish-white marl
64PE138-11bc	Silty-clayey carbonaceous mud; sediment surface slightly undulating, with abundant small arborescent foraminifera
64PE138-12bc1	Silty clay; sediment surface densely covered with polychaete tubes and arborescent foraminifera; strongly reduced downcore
64PE138-12bc2	Silty clay; sediment surface densely covered with polychaete tubes and arborescent foraminifera; strongly reduced downcore
64PE138-13bc1	Glauconite-rich silty clay; surface very irregular with large open burrows
64PE138-13bc2	Glauconite-rich silty clay; surface smooth
64PE138-14bc1	Soft silty-clay
64PE138-15bc1	Foram-rich clayey silt with shell debris; surface badly cracked by coring, with open burrows and some arborescent foraminifera
64PE138-15bc2	Foram-rich clayey silt with shell debris; surface irregular with open burrows, some patches of arborescent foraminifera
64PE138-16bc2	Very soft silty clay; sediment surface badly disturbed
64PE138-16bc4	Very soft silty clay; sediment surface badly disturbed
64PE138-17bc1	Failed, but remains of silty clay on core barrel and cutter
64PE138-17bc2	0-20 cm: clayey silt; sediment surface irregular, with open burrows and animal mound; below 20 cm: coarse angular sand
64PE138-17bc3	0-1 cm: soft clayey silt; sediment surface slightly undulating, with plant debris and mica; 1-10/15 cm: medium-coarse angular sand, with irregular erosive base; below 10/15 cm: compact mica-rich clayey silt

Nine piston coring attempts were made, applying a 6 or 12 m coring barrel with 9 cm ∅ plastic liner and a teflon head, a total weight of approximately 1.5 tons, and a free fall of 4.5 m. The presence of turbidite layers at stations 64PE138-03 and -07 on the Galician slope, and shell beds at Galician shelf stations 64PE138-08 and -09, and probably -06, and turbidite sands at station 64PE138-17 on the lower part of the Nazaré Canyon, explains the poor core yield at these stations. Longer cores were only retrieved from stations 64PE138-12 and -14 on the upper course of the Nazaré Canyon (see Table 3.2.2.2).

Table 3.2.2.2. Summary of piston coring results

Core	Core barrel length (m)	Core length (m)	Sediment characterisation
64PE138-03pc	12	0.97	Silty clayey foram ooze with turbidite layer
64PE138-06pc	12	failed	
64PE138-07pc	6	0.85	Carbonaceous silty clay with planktonic forams, with two thin turbidites
64PE138-08pc	6	1.22	Fine sand/silty fine sand with thin shell beds
64PE138-09pc	6	1.48	Silty clay to fine sand with scattered shells
64PE138-12pc1	6	4.61	Silty clay with alternating black and gray bands
64PE138-12pc2	12	failed	
64PE138-14pc	6	6.80	Black/gray silty clay
64PE138-17pc	6	failed	

All piston were scanned for downcore magnetic susceptibility using a Bartington MS2C magnetic susceptibility meter with a 12 cm ∅ loop. Results are shown in Figures 3.2.2.1 - 3.2.2.3. In cores from the Galician slope, highest magnetic susceptibility is observed near to top of the core, corresponding to the oxidized upper layer of sediment. Turbidite layers tend to have low magnetic susceptibility. Magnetic susceptibility in cores from the Galician shelf seems inversely related to grain size, with layers of silty clay having a higher magnetic susceptibility than sandy layers. A very distinct pattern is observed in the two cores from the Nazaré Canyon; in both cores magnetic susceptibility at first increases steadily downcore, until a point where it suddenly drops to very low values. The sudden decrease in values does at first sight not correspond to any visually apparent change in lithology.

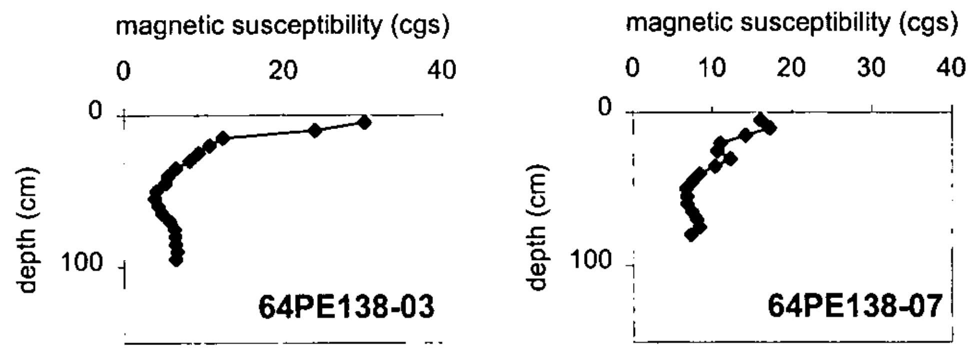


Fig. 3.2.2.1. Magnetic susceptibility of piston cores from the Galician continental slope.

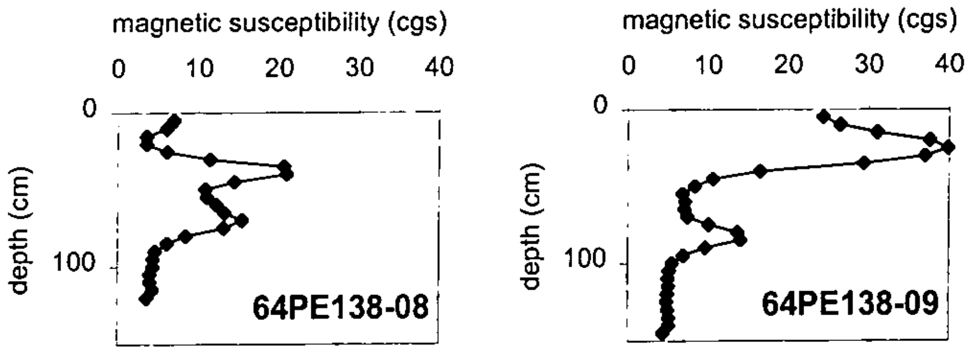


Fig. 3.2.2.1. Magnetic susceptibility of piston cores from the Galician shelf off Vigo.

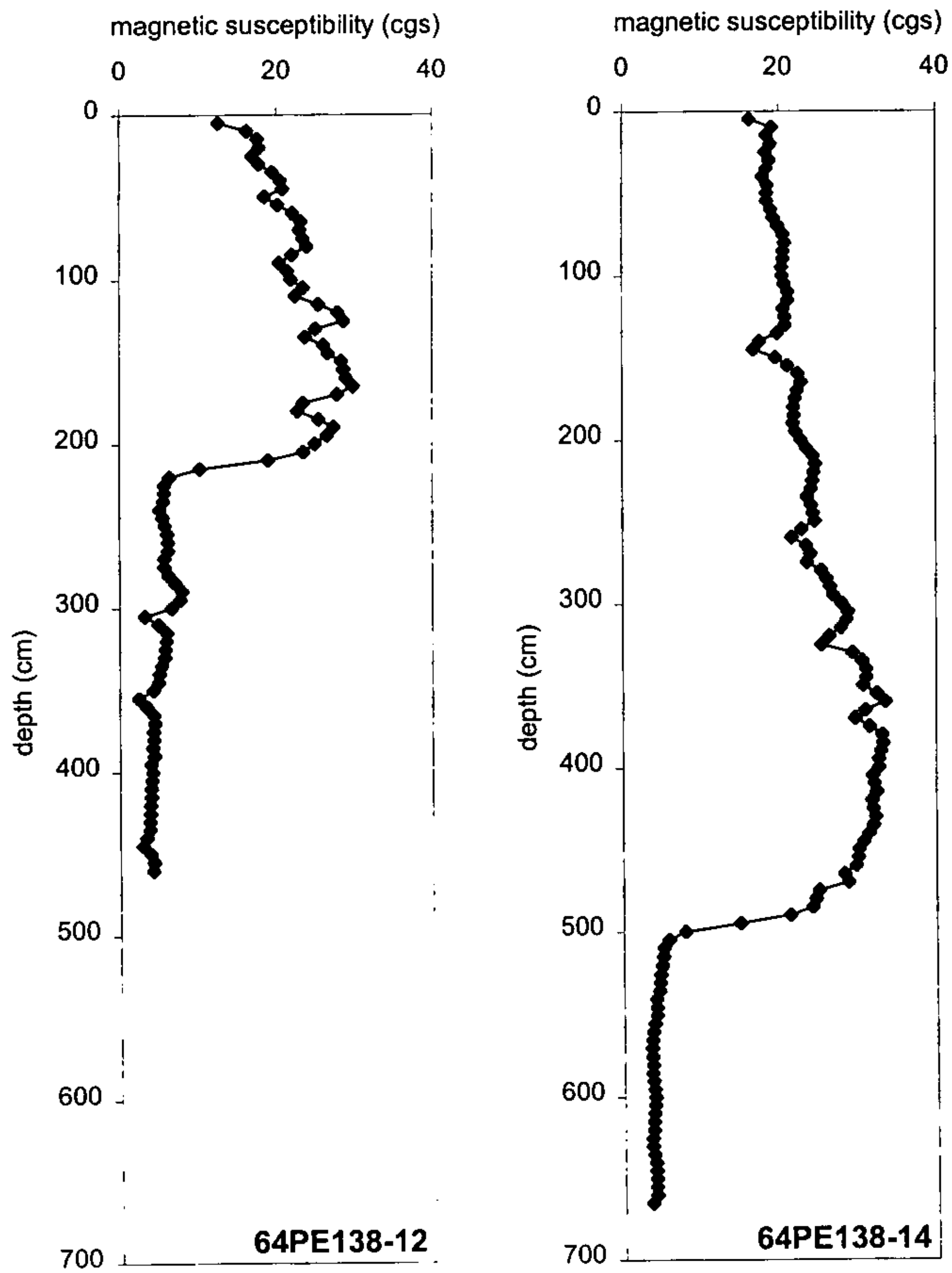


Fig. 3.2.2.3. Magnetic susceptibility of piston cores from the Nazaré Canyon.

Based on a very superficial scan of planktonic foraminifera in some sieved (>150 μm) box core and piston core samples, it seems that sediments older than late Holocene (>7 ka BP) were only recovered in piston core 64PE138-03. A dominance of left-coiled specimens in *Globorotalia hirsuta*, combined with dominantly right-coiled *Neogloboquadrina* spp.. is taken here as diagnostic for an early Holocene age.

Sediments from the Nazaré Canyon yield exceptionally low numbers of planktonic foraminifera per volume of sieved sediment. As the foraminifera seem well-preserved, their low abundance may be due to strong dilution with terrigenous mud, and thus be indicative of a very high sedimentation rate.

3.3 SEABED CHEMISTRY

3.2.1 EARLY DIAGENESIS

Rikus Kloosterhuis, Erica Koning, Claar van der Zee and Eric Epping

GENERAL INTRODUCTION

Despite the fact that ocean margin sediments (<2000 m) comprise only 16% of the global ocean area, they account for about 85% of the material accumulating in the ocean and 80-90% of the mineralization in marine sediments. Shelf morphology and local hydrodynamical conditions may significantly influence the partitioning of material entering the ocean (land run-off or in situ production) between shelf sediments (0-200 m) and the deeper ocean margin sediments (200-2000 m). A typical morphological feature of the rather narrow Iberian shelf is the presence of canyons. Their contribution to trapping and transporting material from the Iberian shelf to the abyssal is largely unknown. By comparing sediment carbon budgets for the Nazaré Canyon and for 'normal' shelf-slope-abyssal transects we aim at quantifying the relative contribution of canyons in of-shelf transport.

Organic carbon deposited at the sea floor can either be mineralized or buried in the sediment. Thus, by estimating the rates of carbon mineralization and carbon burial, the input of organic carbon can be calculated by summing these quantities.

The rate of carbon mineralization can be estimated from the rate of oxidant utilization (oxygen, nitrate, Mnox, Feox, sulphate) and/or from the production rate of end products (ammonium, inorganic carbon (CO_2 and HCO_3^-)). These rates can be calculated from pore water profiles by estimating the downward flux of oxidants or the upward flux of metabolites, assuming one-dimensional Fickian diffusion:

$$flux = -\frac{D_0}{F} \times \frac{dC}{dz},$$

where D_0 is the temperature and salinity corrected free solution molecular diffusion coefficient, F is the sediment resistivity factor, and $\frac{dC}{dz}$ is the concentration gradient of the the solute of interest. In addition fluxes can be measured directly by monitoring the concentration of solutes in a volume of water overlying a known area of sediment.

The carbon burial rate, F_b, can be estimated from:

$$F_b = (1-\phi) \times \rho_s \times C_{org} \times \omega$$

where ω denotes the sediment accumulation rate, ϕ is the sediment porosity, ρ_s is the bulk sediment density, and C_{org} is the weight percentage of organic carbon.

Constructing a carbon budget requires the following parameters to be measured:

- porosity
- resistivity
- organic carbon and total nitrogen content

-depth profiles of:

- oxygen
- nitrate\nitrite
- solid phase iron and manganese
- sulphate
- $\Sigma CO2$
- ammonium
- dissolved manganese and iron
- phosphate
- silicate

SHIPBOARD PROCEDURES

Sampling

Sediment cores (see Table 3.3.1.1) were obtained by multicoring (Barnett et al. 1983). The corer retrieves four 10 cm (i.d.) cores and eight 6.5 cm (i.d.) core. Nearly undisturbed sediment cores were taken at all stations.

Table 3.3.1.1. Position, depth, and treatment of multi cores.

Multi core	water depth (m)	Latitude N	Longitude W	pore water extraction	Sediment-water fluxes (shipboard)
64PE138-01mc1/2/3	195-213	42°38	009°29	x	x
64PE138-02mc1	2164	42°38	010°00	x	x
64PE138-03mc2	2932	42°38	010°22	x	x
64PE138-04mc	2060	42°00	009°44	x	x
64PE138-05mc	2853	42°00	010°30	x	x
64PE138-06mc1/2	113	41°52	009°04	x	x
64PE138-07mc	1387	42°00	009°29	x	x
64PE138-11mc	932	42°00	009°26	x	x
64PE138-12mc1/2/3	343-344	39°39	009°15	x	x
64PE138-13mc1/2	137	39°38-39°39	009°20	x	x
64PE138-14mc1/2	3097	39°31	009°51	x	x
64PE138-15mc1/2	395-396	39°35	009°36-009°37	x	x
64PE138-16mc3	890	39°36	009°24	x	x
64PE138-17mc	4280	39°35	010°17	x	x

Secondary oxidants and end products of carbon mineralization

Except for oxygen, pore water profiles of oxidants and end products of carbon mineralization were measured by slicing multi cores in intervals as indicated below (Table 3.3.1.2). The sediment was extruded from the multi cores by using a hydraulically operated core slicer which facilitated the simultaneous processing of 4 multicores. The pore water was separated from the sediment matrix by centrifugation.

Table 3.3.1.2. Sediment intervals for pore water extraction (mm)

0.0-2.5	10.0-15.0	30.0-40.0	70.0-90.0
2.5-5.0	15.0-20.0	40.0-50.0	90.0-110.0
5.0-7.5	20.0-25.0	50.0-60.0	110.0-130.0
7.5-10.0	25.0-30.0	60.0-70.0	130.0-150.0
150.0-170.0	170.0-190.0	190-210.0	210.0-230.0

Examples of pore water profiles of dissolved Mn and Fe are shown below (Fig. 3.3.1.1).

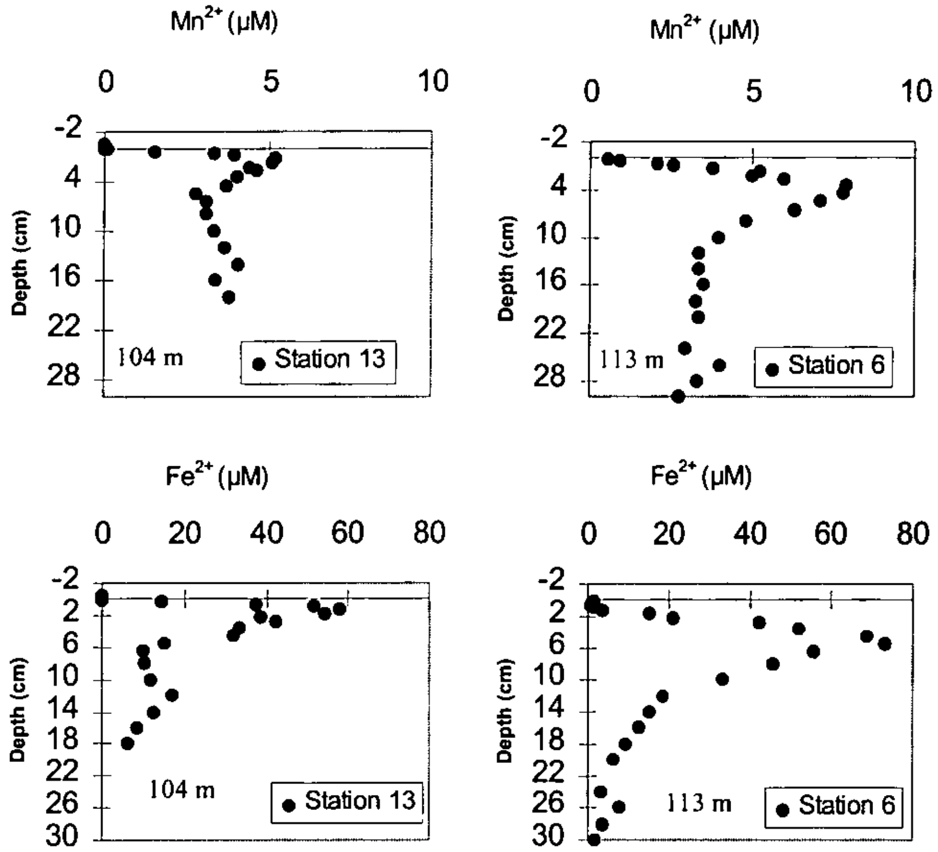


Figure 3.3.1.1. Comparison of porewater profiles for dissolved manganese and dissolved iron between 1998 (left panels) and 1999 (right panels).

Shipboard sediment-water fluxes

Sediment-water fluxes were estimated in by monitoring the concentration of solutes in the overlying water of 2-4 multicores. In order to preserve the microtopography of the sediment-water interface, the overlying water of the cores was not replaced by filtered bottom water. Instead, the bottom water overlying the core upon retrieval was monitored for concentration changes. The cores were incubated between 15 and 24 hours. Sediment-water fluxes of silicic acid plotted against waterdepth are shown in Figure 3.3.1.2.

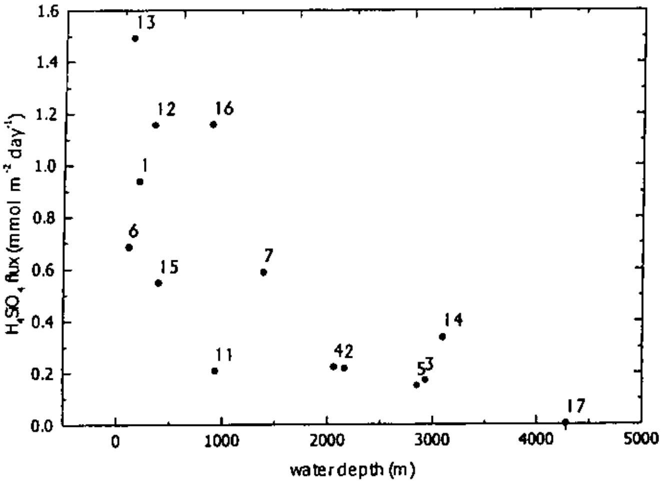


Figure 3.3.1.2. Sediment-water fluxes of silicic acid (measured shipboard) plotted against waterdepth.

IN SITU MEASUREMENTS

Oxygen

The role of oxygen in organic carbon mineralisation changes from the regeneration of oxidants in areas of high organic carbon input, to being the dominant terminal electron acceptor in areas of low organic rain rates. Therefore, the oxygen consumption rate of the sediment, expressed as the sediment-water flux of oxygen, is a good indication for the carbon mineralisation rate. These fluxes can be measured directly by monitoring the change in oxygen concentration in the water overlying an enclosed area of sediment, or can be calculated from the oxygen concentration gradient across the sediment-water interface, using Fick's first law of diffusion. Since shipboard measurements of oxygen largely overestimate the flux of oxygen it is mandatory to perform these measurements *in situ.*

The TROL (Temperature Resistivity and Oxygen Lander), is a free falling vehicle equipped with three incubation chambers and a profiling module. TROL was deployed at 9 stations (see Table 3.3.1.3) to measure oxygen microprofiles, rates of oxygen consumption, nutrient fluxes across the sediment-water interface, and the effective diffusion coefficient *in situ* by bromide addition.

Table 3.3.1.3. Geographic positions and waterdepths for the stations of TROL deployment.

Station	water depth (m)	Latitude N	Longitude W
64PE138-01	219	42°38	009°29
64PE138-02	2164	42°38	010°00
64PE138-03	2926	42°37	010°22
64PE138-04	2067	42°00	009°44
64PE138-06	117	41°52	009°04
64PE138-07	1384	42°00	009°29
64PE138-12	344	39°39	009°15
64PE138-14	3097	39°31	009°51
64PE138-17	4305	39°35	010°17

Oxygen microprofiles were measured with Clark type oxygen microelectrodes. These custom built electrodes had a tip diameter of 10-20 µm, a stirring sensitivity < 1 %, an output of 80-250 pA in air saturated seawater at 20°C, and were furnished with a guard electrode to ensure stable output currents. The concentration profiles of oxygen enable the estimation of oxygen consumption as a function of depth in the sediment, wich can be used as an index for the degradability of the organic matter. However, these measurements represent point measurements and have virtually no areal integration. Figure 3.3.1.3 shows an example of an *in situ* oxygen profile recorded with the TROL

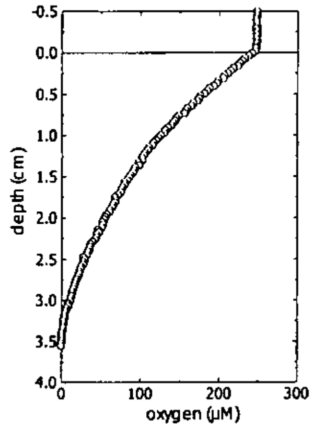


Figure 3.3.1.3. An example of an in situ oxygen profile recorded with the TROL at canyon station 64PE138-17 (4305 m).

To encompass the lateral variability in reactivity and diffusive transport, benthic chambers are deployed for the direct measurement of oxygen fluxes. The benthic chambers, enclosing an area of 144 cm^2 were equipped with custom built Clark type oxygen sensors with a guard electrode for continuously monitoring the oxygen concentration in the overlying water. These electrodes proved to give a very stable, low-noise signal, which allows the calculation of oxygen uptake rates of the sediment (Figure 3.3.1.4).

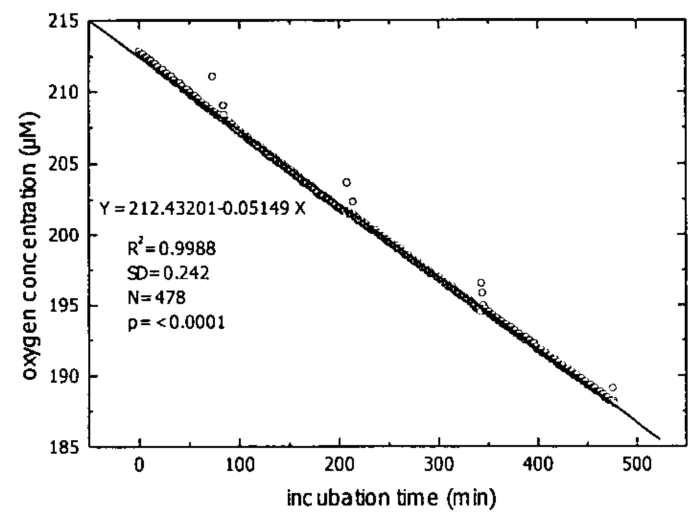


Figure 3.3.1.4. The oxygen concentration in the sediment overlying water during TROL deployment as a function of incubation time at station 64PE 138-06.

A compilation of in situ oxygen fluxes, measured by chamber incubation or calculated from oxygen microprofiles, is given in Figure 3.3.1.5.

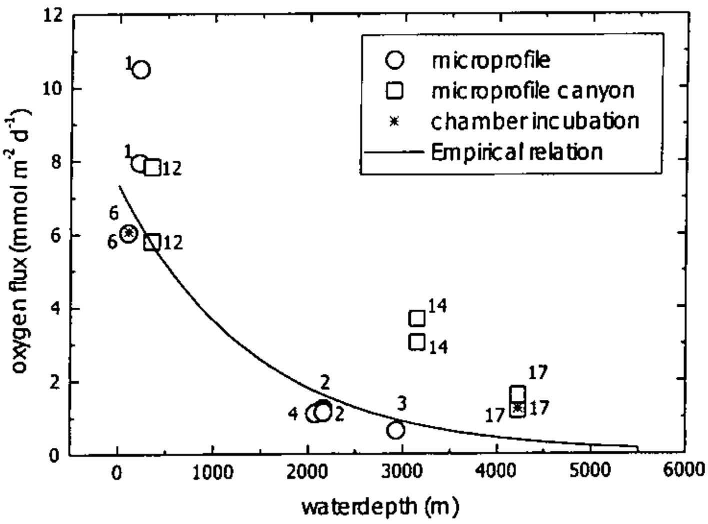


Figure 3.2.1.5. A compilation of in situ oxygen fluxes, measured by chamber incubation or calculated from oxygen microprofiles. The solid line represents the empirical relationship of aerobic carbon mineralization versus waterdepth (Middelburg et al. 1997).

Additionally, 5 pairs of syringes allowed the manipulation of the overlying water during the time course of incubation. Two chambers were configured to determine the fluxes of nutrients (ammonium, nitrate, nitrite, phosphate and silicate), dissolved inorganic carbon and oxidants across the sediment-water interface. The third module was configured to inject sodium bromide, a conservative tracer, to be used for the determination of the effective diffusion coefficient. After incubation *in situ,* the enclosed sediment was retrieved and sliced to collect the pore water for bromide analysis (NIOZ lab).

At station 64PE138-17, at a depth of 4305 m a comparison was made between a macrooptode, as developed at the department of MEE (Duineveld & Berghuis) and a custom built Clark type oxygen electrode to measure the sediment oxygen uptake. Therefore a benthic chamber module of TROL was replaced by an ALBEX chamber module equipped with an optode. The sediment-water flux of oxygen as calculated from oxygen microprofiles will serve as a reference value for this comparison.

The performance of the benthic chamber modules was excellent, whereas the profiling module suffered from electronic noise and interference between channels on several occasions. Replacing the fluor inert solution and cleaning the electronic circuitry could overcome the noise for some time.

We greatly acknowledge the assistance of Sabine Schmidt during sediment slicing and pore water extraction.

3.3.2 AMINO ACIDS

Paulo Pedro

Objectives

With the purpose of better understanding the diagenesis of carbon and nitrogen in marine sediments, and to determine the sediment origin and events on the Galicia shelf and slope, and in the Nazaré Canyon, a series of piston and box cores were collected and sampled during the second leg of Pelagia 138 / OMEX 99 Cruise. As part of the OMEX II-II work package III deliverables, analysis on the amino acids content, size fractions, and mineralogy will be performed in addition with carbon and nitrogen determinations.

Sampling and further research

The sediment core samples were obtained on 9 box core stations (Table 3.3.2.1) and five piston core stations (Table 3.3.2.2) in the Galicia area and in Nazaré Canyon area, using the two different coring devices. The box core sediments were subsampled with 6 cm diameter tubes. The sediment contained in these tubes was cut, with a hydraulic slicer, in 1 cm slices beginning from the top. All the slicing was done in a cool container at local bottom seawater temperature.

Piston core tubes were divided into 110 cm long sections, and stored at 3°C. After splitting the tubes in two halves, one part was kept intact for X ray analysis and the other was sampled in blocks of 2 cm length (Table 3.3.2.3), corresponding to a quarter of total initial section of the core. The criteria for the choice of depth intervals on sampling the piston cores was based on the magnetic susceptibility profiles determined previously and in the visual interpretation of the sediment characteristics. After sampling, all the samples (from box cores and piston cores), were frozen to –20°C awaiting transport to the laboratory.

Further studies will take place at the University of Algarve for determination and quantification of hydrolysable amino acids, total carbon, organic carbon, nitrogen, size distribution of the carbonate free fraction and mineralogy, focusing on clay mineral assemblage, in the collected material.

The determination of amino acids will be performed by reverse phase HPLC with pre-derivatization of amino acids with ortophtaldialdehide (OPA) after acid hydrolysis (HCl 6N) for 24 hours in nitrogen sealed caps at a temperature of 110°C. The grain size analysis is to be executed on a Malvern Mastersizer granulometer after elimination of carbonates with HCl 10%. The carbon and nitrogen determinations will be performed on a Carlo Erba GC Elemental Analyser, and the clay mineralogy will be determined by XRD.

Table 3.3.2.1. Sampled box cores

Core	***Depth (m)***	***Length (m)***	***Compaction (cm)***
64PE138-07bc	1384	0.41	5
64PE138-08bc	101	0.41	7
64PE138-09bc	132	0.52	12
64PE138-11bc	935	0.31	1
64PE138-12bc1	344	0.51	13
64PE138-13bc1	138	0.30	6
64PE138-14bc1	3097	0.60	18
64PE138-15bc1	392	0.38	6
64PE138-16bc2	893	0.60	6
64PE138-17bc2	4299	0.38	6

Table 3.3.2.2. Sampled piston cores.

Station	Depth (m)	Length (m)
64PE138-07pc	1390	0.85
64PE138-08pc	103	1.22
64PE138-09pc	131	1.48
64PE138-12pc1	344	4.61
64PE138-14pc	3097	6.80

Table 3.3.2.3. Length interval sampled on piston cores.

Piston core	Section	Length Intervals (cm)
64PE138-07pc	1	4-6, 10-12, 17-19, 24-26, 29-31, 40-42, 60-62, 76-78
64PE138-08pc	1	27-29, 33-35, 40-42, 51-53, 57-59, 76-78, 98-100
64PE138-08pc	2	4-6
64PE138-09pc	1	9-11, 20-22, 26-28, 40-42,48-50, 60-62, 80-82
64PE138-09pc	2	4-6, 12-14,26-28, 38-40, 50-52
64PE138-12pc1	5	10-12, 19-21
64PE138-12pc1	4	3-5, 9-11, 14-16, 27-29, 40-42, 54-56, 70-72, 90-92
64PE138-12pc1	3	30-32, 40-42, 55-57, 70-72, 100-102
64PE138-12pc1	2	20-22, 48-50, 84-86
64PE138-12pc1	1	9-11, 67-69, 87-89
64PE138-14pc		Not sampled onboard

3.4 BENTHIC FAUNA

3.4.1 CARBON UPTAKE

The short-term fate of algal carbon: application of ^{13}C-labeled algae as a tracer of labile carbon in marine sediments and benthic food webs: In situ and on deck experiments

Leon Moodley, Ko Verschuure, Gerard Duineveld and Eilke Berghuis

Introduction

The fate of phytodetritus shortly after its deposition is poorly understood in terms of which organisms have early access to it and the rates by which it is displaced and decomposed within the seabed. Understanding the fate of labile organic matter arriving at the seafloor is of great importance as it is the primary driving force of the benthic system: it has an impact on the magnitude and timing of various benthic fluxes and mineralization processes and life strategies of the benthic fauna. The initial response or processing of labile carbon by heterotrophs may be rapid and easily missed by field studies. The addition of ^{13}C enriched algae to the sediment creates the possibility of documenting the fate of a parcel of organic matter entering the benthic environment. In this cruise, we addressed this question by conducting short-term experiments (24-30 hrs). ^{13}C labeled algae was added to sediments in benthic chambers maintained either on deck at bottom water temperature or *in situ* in the ALBEX lander. The uptake or mineralization of the added algal carbon will be reflected either in the $\delta^{13}C$ of different faunal components or in the $\delta^{13}C$ of the CO_2. A list of activities is presented in Table 3.4.1.1.

Methods

Upon addition of lyophylized algal material and following a period of incubation, sediment or water samples were taken for the following analysis:

1. The response of the benthic system as a whole was examined by measuring SOC (sediment oxygen consumption) and the amount of added algae respired to CO_2. The overlying water was sampled at regular intervals for measurements of $\delta^{13}C$ of total inorganic carbon.
2. Faunal and bacterial uptake of algal carbon. Macro-and meiofauna were isolated from different sediment intervals down to 6 cm. Sediment from these intervals were also collected for the isolation of bacterial biomarkers. The $\delta\ ^{13}C$ of these components will allow us to determine the distribution of the labeled algal carbon over the different components of the benthic system.
3. Bioturbation. Transport of highly reactive organic matter from the sediment-water interface to the deeper layers will be examined through analysis of bulk $^{13}C_{org}$ in the different sediment intervals. Sediments were sampled in centimeter slices down to 10 cm.

In addition to this we sampled sediments down to 10 cm in centimeter intervals for long-term sediment slurry incubations; to measure CO_2 production in the headspace above sediment-water slurries. The CO_2 production in the head-space of these long-term sediment slurry incubations will provide insight into the amount of labile organic matter present in the sediment.

Table 3.4.1.1. List of activities at each station

	Station 64PE138-01 (213 m)	Station 64PE139-02 (2175 m)
Carbon uptake experiments	On deck	On deck + *In situ* with ALBEX lander
Sediment oxygen consumption (SOC)	Yes	*In situ*
$\delta^{13}C$ (ΣCO_2)	Yes	Yes
$\delta^{13}C$ Fauna	Yes	Yes
Bacterial biomarkers	Yes	Yes
Bioturbation (Bulk $\delta^{13}C_{org}$)	Yes	Yes

3.4.2 LIVE BENTHIC FORAMINIFERA

Henko de Stigter

For the study of live benthic foraminifera, one 6 cm Ø multi corer tube per multi cored station was sliced at 0.5 cm intervals till 2 cm depth, and then at 1 cm intervals till 10 cm depth. Flocks of fluffy material floating above the sediment-water interface were included in the 0.0-0.5 cm slice. The slices were stored in plastic bottles with 50 ml of Rose Bengal in ethanol solution (1.0 g/l) for future work.

4. TECHNICAL REPORT

Leon Wuis en Willem Polman

Bij het uitvaren op 8 mei hadden we meteen een probleem met het piston core liertje. De trommel draait een halve slag met vreemd en niet gezond geluid, en houdt het daarna voor gezien .
Henk heeft de stroomkabel doorgemeten nadat we de stoppenkast gecontroleerd hadden. De multimeter gaf niks aan, toen we de stekker bekeken zag die er niet zo goed uit maar de aansluitingen waren goed.
Een aantal alternatieven om met de pcl te kunnen werken was gauw gevonden. Het beste kon dit met de vislier en een voetblok wat we meteen geprobeerd hebben. Nu kon Henk na andere problemen te hebben opgelost verder met het doormeten van de bedieningskast etc.
Na het installeren van de piston core bom en het opbouwen van een 12 meter pijp hebben we de multi core nog gevuld met pijpen.

Op 12 mei zijn we begonnen met het monsterprogramma.
De multi core gaf wat problemen: de zuiger kwam niet helemaal terug in zijn eindstand dus de borgpen kon niet geplaatst worden zonder dat de middenzuil geborgd zou zijn. We konden aan dek het frame omlaag duwen en alsnog met de borgpen de middenzuil borgen.
Naderhand hebben we de zuiger gedemonteerd en bekeken maar deze zag er goed uit, dus hebben we deze weer terug geplaatst nadat we de zuigerstang doorgeblazen hebben met lucht om er zeker van te zijn dat deze niet verstopt is . De bus waar de zuiger in beweegt hebben we ook bekeken; hierin zat een klein beetje zand wat we weggehaald hebben. Ook 4 kleine pijpen waren tot tweemaal toe leeg ondanks dat deze wel getript waren. De oorzaak hiervan konden we niet vinden, alles zag er goed uit en werkte goed aan dek.
De kloot van de kraan viel aan dek met het ontvouwen van de kraan, gelukkig stond er niemand onder. De oorzaak hiervan was het verkeerd wegzetten of invouwen van de kraan. Wij hebben de kabel opnieuw geknepen na telefonisch overleg. Om 18.15 uur hebben we de trol weggezet voor een testmeting op een diepte van 220 meter.

Donderdag 13 mei. Vanochtend om 6.00 uur hebben we de trol opgepiept en om 6.30 uur stond de trol vast op het achterdek. Eén sedimenthapper heeft het niet gedaan. De multi core op 2923 meter diep is mislukt doordat de ring van het trigger mechanisme vast zat, de multi core heeft op de bodem gestaan daar de pijpen getekend waren door zand. Dit euvel is nu verholpen, maar in de werkplaats moet er naar gekeken worden.

Vrijdag 14 mei. Vanochtend om 6.30 uur hebben wij de verankering van Mark Lavaleye opgepiept die netjes aan de oppervlakte is gekomen.
De 19 bollen hebben de drijflijn ingehaald onderweg naar boven toe en zijn daarin verstrengeld geraakt. De verankering konden we door het mooie weer goed bergen door de snelle haak in de oppervlakteboei te slaan en zo naar binnen te halen. De tegeltjes waren niet of nauwelijks aangegroeid. De anode bij de releases was voor meer dan de helft verdwenen. Het huis van de
motor van de sedimentval zat behoorlijk onder de corrosie. Op het frame zou eigenlijk ook een hijsoog gemonteerd moeten worden, dit in verband met het overbrengen van de lander naar het achterschip met de kraan zodat je de hoogte van de hijsspruit kwijt bent.

Zaterdag 15 mei. De eerste piston core met een lengte van 12 meter op een waterdiepte van 2967 meter kwam niet verder dan 1 meter diep, de pijp ging een meter boven de kop krom. Dit betekende dat de binnenpijp er hydraulisch uit geperst moest worden. De core opbrengst

is 97 cm. De vrije val was 4 meter en de zuiger afstelling was 0,5 bar. De binnenpijp was over 1,5 meter in de lengte richting naar binnen iets ingedeukt. De wartel van de tripbom was recht en is nu krom van de klap die deze opgelopen had, de inhoud van de core was 7 cm. De viersnelheid naar bodem was 25 meter per minuut.
De kop van de piston core was verschoven zodat het borg draadje tussen de pijp en de kop gekomen is; het demonteren van de kop was niet eenvoudig.
De kop zat niet ruim daar Leon de pijp nog moest afschuren om deze te kunnen plaatsen.

Zondag 16 mei. Geen bijzonderheden.

Maandag 17 mei. De trol en de albex lander weggezet en een multi core genomen en twee ctd's, stomen naar ander station met windkracht 6.

Dinsdag 18 mei. Om 6.00 uur zijn we begonnen met een ctd en een multi core, daarna een piston core van 12 meter die krom ging en waarvan we de kop en core catcher kwijt zijn geraakt; dit op een diepte van 100 meter. De tripbom bevat 40 cm oppervlakte sediment mede doordat we een core catcher hebben gebruikt. Het sediment was vrij slap en wilde eruit lopen. De zuigerlijn heeft een slecht stuk en er is een draad van de buitenmantel gebroken waardoor wij besloten de reserve kabel maar te gebruiken.
Vandaag vindt de wissel van mensen plaats voor de deur bij Vigo.

Woensdag 19 mei. Om 10.00 uur de trol opgepiept en na het aan boord te hebben gezet zijn we gaan stomen naar een volgend station.
De piston core kabel die beschadigd is hebben we opnieuw geknepen, en kan alleen nog maar voor een 6 of 12 meter pijp gebruikt worden.
De box core K11 is vandaag in elkaar gedrukt door het A frame van het schip bij het wegzetten van de CTD, deze lag al in het water maar het A frame moest nog verder afgetopt worden en de operator had niet in de gaten dat de box core onder het frame stond.

Donderdag 20 mei. Vandaag 3 piston cores genomen van 6 meter. De inhoud van deze is 1,10, 1,30, 0,80 meter. de bodem is hier keihard, er is een hoek uit de kop, de pijp is ook niet meer helemaal recht, en een kop is in buiten diameter kleiner geworden. De laatste piston core had een opbrengst van 80 cm terwijl aan de buiten kant zichtbaar is dat de pijp er veel verder er in heeft gezeten. De box core haalde op het harde sediment 5 mm sediment en water naar boven.
De trol hebben we ook weer geborgen, deze had het goed gedaan.

Vrijdag 21 mei. Samen met Henk de giek lier kabels doorgemeten en een kabelbreuk geconstateerd dit hebben we verholpen maar de wormwiel staat vast en wil geen kant op. We hebben alle monsterapparatuur nagelopen en weer gangbaar gemaakt.

Zaterdag 22 mei. We varen voor de haven van Nazeré en hebben een mooie kijk op de kustlijn. Het sediment hier is vrij zacht; de box core kan nog net met al het lood gebruikt worden. De piston ging tot over zijn oren erin, en had een opbrengst van 4,5 meter en viel in de zuiger. De multi core moest zonder lood gebruikt (bovenste gedeelte) worden vanwege de deelbare pijpen die anders te vol waren.

Zondag 23 mei. Vandaag gingen we door het oog van de naald: we hadden de piston core arm bevestigd en de pcl laten zakken, met de kraan haalden we de bom uit de houder en net toen dit gebeurd was vouwde de peer open. Gelukkig bleef de piston core hangen in de peer. Met

de kraan draaiden we de piston core in de richting van de hulplier die meteen de zuigerlijn door haalde zodat we de piston core in de hulplier konden overnemen en het gevaar van een mogelijk ongeluk werd vermeden. De peer aan de piston core arm was los gedraaid en dit is niet gezien bij het inpikken met de kraan.
Na geëvalueerd te hebben naderhand hebben we besloten dat dit niet meer mocht gebeuren, en dat de peer van de arm gehaald wordt met het wegzetten en er weer afgehaald wordt met het binnen halen van de piston core.
De twaalf meter piston core ging 8 meter de bodem in maar kwam boven zonder steekneus en een lege pijp.

Maandag 24 mei. De pijpen zitten aan de binnen kant onder de roest, dit moest eerst met boormachine en schuurpapier verwijderd worden voordat we de binnenpijp met mof er door heen konden duwen. De roest is voornamelijk aanwezig aan de uiteinden van de binnenkant van de pijp. We hebben veel last gehad van verf in de groef waar de spijkers komen te zitten, veel spijkers konden we er niet in krijgen. Van de beschadigd steekneus hebben we op de draaibank weer een goede steekneus gemaakt, deze is nu wel korter geworden.

Dinsdag 25 mei. Vandaag om 22.00 uur kwam de box core boven met de kabel om de bovenkant van de box core heen geslagen. De mantel van de kabel en de kabel zelf was beschadigd, dus hebben we er een nieuwe eindverbinding aan geknepen. De twaalf meter piston core had vandaag een opbrengst van 6,80 meter, de core ging tot de bom in het sediment. De lier monitor had een vreemde storing, na het laatste signaal bij het naar boven halen van de box core ging de trekkrachtmeter langzaam naar de vier ton en ging het alarm af. De display begon heel snel de maximum trekkracht op te tellen in procenten.
Toen ben ik gaan vieren maar de trekkracht bleef vier ton, daarna heb ik de monitor schakelaar in gedrukt waarna de monitor weer goed functioneerde.

Woensdag 26 mei. Bij het neerzetten van de box core op de bodem zag ik de temperatuur meter omhoog gaan, en terwijl ik reageerde door de motor stop te zetten ging het alarm af. Na alles nagekeken te hebben konden we geen reden voor het alarm vinden. Toen naar de thermostaat aansluiting gekeken, deze zag er wat groenig uit. Deze toen iets geschuurd, weer aangesloten en alles werkte weer zoals het hoorde. De zes meter piston core die we op een diepte van 4323 meter genomen hebben kwam krom boven, de core catcher stond open en al het sediment was eruit gespoeld doordat de binnenpijp bij de bom kapot is gegaan door de zuiger. De triparm is iets krom, en het schanier was beschadigd maar deze is weer hersteld. De triparm moet op de pers hersteld worden.

Donderdag 27 mei. We hebben een nieuw oog aan de zuigerlijn geknepen daar deze beschadigd was door de hulplier. De box core K16 en multi core zijn vandaag nagekeken en weer klaar voor een volgende reis.
De kuubs vaten hebben we aan dek gezet, voor het vullen van deze vaten voor Wim Klein Breteler.

Vrijdag 28 mei. We hebben de Bobo lander opgehaald en stomen naar de plek waar de verankering ligt van Avan, daar gaan we even luisteren of de releases nog een signaal terug geven. Dit signaal kwam meteen dus de batterijen zijn nog goed. Na dit te hebben gedaan stomen we richting nioz haven.

Lijst met herstelwerkzaamheden en aanvullingen

- Aan de schragen van de piston core pijpen zou een oog moeten worden gelast zodat deze met een spanner aan dek vast gezet kan worden.
- De strip die van bomhouder naar dek loopt en daar vast gelast is, moet vervangen worden door een zwaarder exemplaar.
- Voor de hydraulische pers zou ook een schraag gemaakt moeten worden zodat deze op gelijke hoogte van de pijp stevig op dek kan staan.
- De rvs stangen van de uitdrukset moeten iets afgedraaid worden zodat deze ruimer en beter passen.
- Stalen steekneuzen moeten mee, in ieder geval twee.
- Een tweede uitdruk schijf maken om de binnen pijp er uit te kunnen persen.
- Een aantal M16 moeren standaard in de piston core kist voor trip arm.
- Een klein gewicht aan het eind van de pcl maken zodat deze makkelijker kan zakken.
- Multi core trigger onderdelen vast lijmen met loctite.
- Kunststof ringen voor kleine en grote pijpen als reserve mee.
- Lijm hebben we nu standaard in de kist, er moet alleen nog een kleine kwast bij. Twee doppen van kunststof moeten er nog bij voor het indrukken van draadeind.
- Nieuwe stoel voor de gele lier voor volgend jaar.

Piston core kist A rek 2

7 core catcher 90 mm
3 catcher 63 mm
3 steekneuzen / schoenen 90 mm
2 veiligheid pennen
1 klauw hamer schuurlinnen grof

Rek 2 kist B

2 x 1 triplijn.

APPENDIX A
SHIPBOARD PARTY

SCIENTIFIC PARTY

Name	Institute
Berghuis, Eilke	Dept. Mar. Ecology, NIOZ, Texel, the Netherlands
de Stigter, Henko	Dept. Mar. Chemistry and Geology, NIOZ, Texel, the Netherlands
Duineveld, Gerard	Dept. Mar. Ecology, NIOZ, Texel, the Netherlands
Epping, Eric	Dept. Mar. Chemistry and Geology, NIOZ, Texel, the Netherlands
Franken, Henk	Dept. Electronics, NIOZ, Texel, the Netherlands
Kalf, Jaap	Dept. Mar. Chemistry and Geology, NIOZ, Texel, the Netherlands
Kloosterhuis, Rikus	Dept. Mar. Chemistry and Geology, NIOZ, Texel, the Netherlands
Koning, Erica	Dept. Mar. Chemistry and Geology, NIOZ, Texel, the Netherlands
Moodley, Leon	Dept. Ecosystems, CEMO-NIOO, Yerseke, the Netherlands
Pedro, Paolo	UCTRA, Universidade do Algarve, Faro, Portugal
Polman, Willem	Dept. Mar. Engineering, NIOZ, Texel, the Netherlands
Renema, Willem	National Museum of Natural History, Leiden, the Netherlands
Schmidt, Sabine	LSCE-CNRS, Gif-sur-Yvette, France
van der Zee, Clara	Dept. Mar. Chemistry and Geology, NIOZ, Texel, the Netherlands
van Ooijen, Jan	Dept. Mar. Chemistry and Geology, NIOZ, Texel, the Netherlands
van Weerlee, Evaline	Dept. Mar. Chemistry and Geology, NIOZ, Texel, the Netherlands
Verschuure, Ko	Dept. Ecosystems, CEMO-NIOO, Yerseke, the Netherlands
Wuis, Leon	Dept. Mar. Engineering, NIOZ, Texel, the Netherlands

CREW R.V. "PELAGIA"

Name	Rank
Groot, Hans	Master
Douma, Henk	1st Officer
Drenth, Martijn	2nd Officer
Seepma, Jaap	Chief Engineer
Kalf, Jan	2nd Engineer
Stevens, Cor	Sailor
van der Heide, Roel	Sailor
Struik, Gerrit	Sailor
van de Wetering, Laurents	Cook

APPENDIX B
DIARY OF EVENTS

Activity codes	
ALBEX	ALBEX lander
BC	Box core
BOBO	BOBO lander
CTD	CTD
MC	Multi core
PC	Piston core
Recruit	Recruitment frame
ROS	CTD with Rosette sampler
TROL	TROL lander

Event codes	
BE	Begin
BO	Bottom
EN	End
DE	Deployment
RE	Recovery

Station "label"	Activity	Event	Date	Time (UTC)	Latitude N	Longitude W	Depth (m)	Remarks
64PE138-01	ROS	BE	12-May-99	9:30	42 ° 38.05	009 ° 29.01	213	
64PE138-01	ROS [CTD01]	BO	12-May-99	9:38	42 ° 38.02	009 ° 28.96		
64PE138-01	ROS	EN	12-May-99	9:53	42 ° 38.05	009 ° 29.02		
64PE138-01	MC1	BO	12-May-99	11:16	42 ° 38.26	009 ° 28.78	195	4 tub. failed
64PE138-01	MC2	BO	12-May-99	11:47	42 ° 38.08	009 ° 28.93	207	4 tub. failed
64PE138-01	MC3	BO	12-May-99	12:24	42 ° 38.01	009 ° 28.96	213	4 tub. failed
64PE138-01	BC	BO	12-May-99	15:02	42 ° 38.06	009 ° 29.00	195	
64PE138-01	TROL	DE	12-May-99	17:22	42 ° 37.98	009 ° 29.04	219	
64PE138-01	TROL	RE	13-May-99	5:00	42 ° 38.07	009 ° 29.05	196	
64PE138-B1	CTD	BE	13-May-99	6:25	42 ° 38.02	009 ° 40.00	1512	
64PE138-B1	CTD [CTD02]	BO	13-May-99	6:51	42 ° 38.00	009 ° 39.95	1518	
64PE138-B1	CTD	EN	13-May-99	7:17	42 ° 38.01	009 ° 40.11	1518	
64PE138-02	ALBEX1	DE	13-May-99	9:14	42 ° 37.59	010 ° 00.04	2170	
64PE138-02	ROS1	BE	13-May-99	9:34	42 ° 38.18	009 ° 59.95	2164	
64PE138-02	ROS1 [CTD03]	BO	13-May-99	10:13	42 ° 38.00	009 ° 59.90	2164	
64PE138-02	ROS1	EN	13-May-99	11:07	42 ° 38.00	010 ° 00.00	2164	
64PE138-02	ROS2	BE	13-May-99	11:51	42 ° 38.02	009 ° 59.99	2164	
64PE138-02	ROS2 [CTD04]	BO	13-May-99	12:30	42 ° 38.04	010 ° 00.07	2170	
64PE138-02	ROS2	EN	13-May-99	13:08	42 ° 38.06	009 ° 59.98	2170	
64PE138-02	TROL	DE	13-May-99	13:37	42 ° 38.47	010 ° 00.10	2164	
64PE138-03	ROS	BE	13-May-99	15:45	42 ° 37.99	010 ° 22.05	2939	
64PE138-03	ROS [CTD05]	BO	13-May-99	16:32	42 ° 37.97	010 ° 21.99	2939	
64PE138-03	ROS	EN	13-May-99	17:29	42 ° 38.00	010 ° 22.14	2945	
64PE138-03	MC1	BO	13-May-99	18:28	42 ° 38.02	010 ° 22.01	2939	failed
64PE138	Recruit	RE	14-May-99	5:05	42 ° 44.49	011 ° 46.23		
64PE138-02	ALBEX1	RE	14-May-99	15:10	42 ° 37.69	010 ° 00.06	2176	
64PE138-02	MC1	BO	14-May-99	16:00	42 ° 38.03	010 ° 00.01	2164	
64PE138-02	TROL	RE	14-May-99	18:17	42 ° 38.63	010 ° 00.05	2182	
64PE138-02	MC2	BO	15-May-99	4:38	42 ° 37.50	009 ° 59.96	2182	
64PE138-02	BC	BO	15-May-99	6:07	42 ° 37.51	010 ° 00.05	2182	
64PE138-02	ALBEX2	DE	15-May-99	7:09	42 ° 38.50	010 ° 00.01	2175	
64PE138-03	TROL	DE	15-May-99	9:21	42 ° 36.94	010 ° 21.93	2926	
64PE138-03	PC	BO	15-May-99	10:57	42 ° 37.53	010 ° 21.98	2933	bent
64PE138-03	MC2	BO	15-May-99	13:42	42 ° 37.55	010 ° 21.89	2932	
64PE138-04	ROS1	BE	16-May-99	6:30	41 ° 59.91	009 ° 44.03	2067	
64PE138-04	ROS1 [CTD06]	BO	16-May-99	7:06	41 ° 59.95	009 ° 44.03	2067	
64PE138-04	ROS1	EN	16-May-99	7:47	41 ° 59.97	009 ° 43.96	2067	

Station "label"	Activity	Event	Date	Time (UTC)	Latitude N	Longitude W	Depth (m)	Remarks
64PE138-04	ROS2	BE	16-May-99	8:30	41 ° 59.97	009 ° 43.92	2060	
64PE138-04	ROS2 (C7007)	BO	16-May-99	9:05	42 ° 00.00	009 ° 44.01	2067	
64PE138-04	ROS2	EN	16-May-99	9:47	41 ° 59.97	009 ° 43.99	2067	
64PE138-04	MC	BO	16-May-99	10:28	41 ° 59.96	009 ° 43.97	2060	
64PE138-02	ALBEX2	RE	16-May-99	19:58	42 ° 38.35	010 ° 00.48	2201	
64PE138-03	TROL	RE	17-May-99	6:37	42 ° 36.70	010 ° 21.86	2926	
64PE138-05	ROS1 (C7008)	BE	17-May-99	10:27	41 ° 59.87	010 ° 29.91	2853	failed
64PE138-05	ROS1	EN	17-May-99	11:02	41 ° 59.94	010 ° 30.01	2853	failed
64PE138-05	ROS2 (C7009)	BE	17-May-99	11:44	41 ° 59.94	010 ° 29.93	2853	failed
64PE138-05	ROS2	EN			°	°		failed
64PE138-05	MC	BO	17-May-99	13:13	41 ° 59.98	010 ° 30.07	2853	
64PE138-05	ROS3	BE	17-May-99	14:26	42 ° 00.02	010 ° 28.72	2847	
64PE138-05	ROS3 (C7010)	BO	17-May-99	15:20	42 ° 00.02	010 ° 28.62	2847	
64PE138-05	ROS3	EN	17-May-99	16:30	42 ° 00.01	010 ° 28.68	2847	
64PE138-04	TROL	DE	17-May-99	20:05	41 ° 59.98	009 ° 44.02	2067	
64PE138-06	ROS	BE	18-May-99	4:18	41 ° 52.03	009 ° 03.95	113	
64PE138-06	ROS (C7011)	BO	18-May-99	4:23	41 ° 52.02	009 ° 03.87	113	
64PE138-06	ROS	EN	18-May-99	4:34	41 ° 52.01	009 ° 03.94	113	
64PE138-06	MC1	BO	18-May-99	5:08	41 ° 52.01	009 ° 04.04	113	
64PE138-06	MC2	BO	18-May-99	6:05	41 ° 51.98	009 ° 03.98	113	
64PE138-06	PC	BO	18-May-99	6:39	41 ° 51.99	009 ° 03.99	113	
64PE138-04	TROL	RE	18-May-99	11:36	41 ° 59.40	009 ° 43.68		
64PE138-06	TROL	DE	18-May-99	19:37	41 ° 51.98	009 ° 04.01	107	
64PE138-06	TROL	RE	19-May-99	8:17	41 ° 51.86	009 ° 04.04	111	
64PE138-07	ROS	BE	19-May-99	11:15	41 ° 59.98	009 ° 28.13	1286	
64PE138-07	ROS (C7012)	BO	19-May-99	11:36	42 ° 00.00	009 ° 28.17	1298	
64PE138-07	ROS	EN	19-May-99	12:07	42 ° 00.01	009 ° 28.21	1304	
64PE138-07	BC	BO	19-May-99	15:41	42 ° 00.00	009 ° 29.38	1384	
64PE138-07	TROL	DE	19-May-99	17:20	42 ° 00.00	009 ° 29.38	1384	
64PE138-08	BC	BO	19-May-99	19:32	42 ° 00.00	008 ° 59.95	101	
64PE138-08	PC	BO	20-May-99	6:32	41 ° 59.99	009 ° 00.03	103	
64PE138-09	BC	BO	20-May-99	8:20	42 ° 08.98	009 ° 02.98	132	
64PE138-09	PC	BO	20-May-99	8:52	42 ° 09.01	009 ° 03.00	131	
64PE138-10	BC	BO	20-May-99	13:06	42 ° 00.03	009 ° 22.41	379	
64PE138-11	BC	BO	20-May-99	14:06	42 ° 00.01	009 ° 26.25	935	
64PE138-11	MC	BO	20-May-99	14:54	42 ° 00.00	009 ° 26.29	932	
64PE138-07	TROL	RE	20-May-99	16:02	41 ° 59.96	009 ° 29.20	1390	
64PE138-07	MC	BO	20-May-99	17:03	41 ° 59.99	009 ° 29.40	1387	
64PE138-07	PC	BO	20-May-99	18:25	41 ° 59.94	009 ° 29.40	1390	
64PE138-12	ROS	BE	22-May-99	9:45	39 ° 38.84	009 ° 14.69	320	
64PE138-12	ROS (C7013)	BO	22-May-99	9:53	39 ° 38.89	009 ° 14.70	344	
64PE138-12	ROS	EN	22-May-99	10:06	39 ° 38.94	009 ° 14.72	342	
64PE138-12	BC1	BO	22-May-99	11:24	39 ° 38.89	009 ° 14.68	344	
64PE138-12	BC2	BO	22-May-99	11:55	39 ° 38.88	009 ° 14.69	344	
64PE138-12	MC1	BO	22-May-99	12:30	39 ° 38.89	009 ° 14.69	343	
64PE138-12	MC2	BO	22-May-99	13:05	39 ° 38.86	009 ° 14.78	344	
64PE138-12	MC3	BO	22-May-99	13:45	39 ° 38.87	009 ° 14.71	344	
64PE138-12	PC1	BO	22-May-99	14:28	39 ° 38.88	009 ° 14.70	344	
64PE138-13	ROS	BE	22-May-99	16:38	39 ° 38.52	009 ° 20.07	138	
64PE138-13	ROS (C7014)	BO	22-May-99	16:42	39 ° 38.48	009 ° 20.08	138	
64PE138-13	ROS	EN	22-May-99	16:51	39 ° 38.50	009 ° 20.00	138	
64PE138-13	BC1	BO	22-May-99	17:34	39 ° 38.51	009 ° 20.00	138	
64PE138-13	BC2	BO	22-May-99	18:02	39 ° 38.55	009 ° 19.95	137	

Station "label"	Activity	Event	Date	Time (UTC)	Latitude N	Longitude W	Depth (m)	Remarks
64PE138-12	TROL	DE	22-May-99	18:57	39 ° 38.90	009 ° 14.70	344	
64PE138-12	TROL	RE	23-May-99	7:35	39 ° 38.84	009 ° 14.57	343	
64PE138-12	PC2	BO	23-May-99	8:25	39 ° 38.90	009 ° 14.68	327	
64PE138-13	MC1	BO	23-May-99	9:31	39 ° 38.51	009 ° 20.03	137	
64PE138-13	MC2	BO	23-May-99	9:56	39 ° 38.49	009 ° 19.99	137	
64PE138-14	BC1	BO	23-May-99	17:36	39 ° 30.75	009 ° 50.98	3097	
64PE138-14	TROL	DE	23-May-99	19:15	39 ° 30.76	009 ° 50.99	3097	
64PE138-15	ROS	BE	24-May-99	6:53	39 ° 34.99	009 ° 36.43	391	
64PE138-15	ROS	BO	24-May-99	7:01	39 ° 35.01	009 ° 36.44	390	
64PE138-15	ROS	EN	24-May-99	7:16	39 ° 34.86	009 ° 36.38	387	
64PE138-15	BC1	BO	24-May-99	8:12	39 ° 35.01	009 ° 36.44	392	
64PE138-15	BC2	BO	24-May-99	8:47	39 ° 35.00	009 ° 36.51	397	
64PE138-15	MC1	BO	24-May-99	9:25	39 ° 34.98	009 ° 36.52	396	
64PE138-15	MC2	BO	24-May-99	9:58	39 ° 35.02	009 ° 36.46	395	
64PE138-16	ROS	BE	24-May-99	11:43	39 ° 35.73	009 ° 24.24	890	
64PE138-16	ROS	BO	24-May-99	12:01	39 ° 35.74	009 ° 24.28	893	
64PE138-16	ROS	EN	24-May-99	12:23	39 ° 35.77	009 ° 24.23	893	
64PE138-16	BC1	BO	24-May-99	13:20	39 ° 35.84	009 ° 24.35	899	failed
64PE138-16	BC2	BO	24-May-99	14:00	39 ° 35.74	009 ° 24.27	893	
64PE138-16	MC1	BO	24-May-99	14:46	39 ° 35.75	009 ° 24.24	893	failed
64PE138-16	MC2	BO	24-May-99	15:30	39 ° 35.76	009 ° 24.26	890	failed
64PE138-16	MC3	BO	24-May-99	17:07	39 ° 35.72	009 ° 24.24	890	
64PE138-16	BC3	BO	24-May-99	18:01	39 ° 35.74	009 ° 24.24	890	failed
64PE138-16	BC4	BO	24-May-99	18:36	39 ° 35.76	009 ° 24.25	893	
64PE138-14	ROS	BE	25-May-99	4:10	39 ° 30.75	009 ° 50.03	3128	
64PE138-14	ROS	BO	25-May-99	5:05	39 ° 30.74	009 ° 50.00	3109	
64PE138-14	ROS	EN	25-May-99	6:05	39 ° 30.73	009 ° 50.04	3164	
64PE138-14	BC2	BO	25-May-99	7:14	39 ° 30.74	009 ° 49.96	3292	
64PE138-14	TROL	RE	25-May-99	8:27	39 ° 30.50	009 ° 50.97	3134	
64PE138-14	MC1	BO	25-May-99	9:52	39 ° 30.75	009 ° 51.05	3097	1/2 failed
64PE138-14	MC2	BO	25-May-99	12:19	39 ° 30.77	009 ° 51.05	3097	
64PE138-14	PC	BO	25-May-99	14:27	39 ° 30.76	009 ° 50.98	3097	
64PE138-17	BC1	BO	25-May-99	19:43	39 ° 34.74	010 ° 17.50	4305	failed
64PE138-17	TROL	DE	25-May-99	20:46	39 ° 34.78	010 ° 17.49		
64PE138-17	BC2	BO	26-May-99	6:21	39 ° 35.23	010 ° 17.44	4299	
64PE138-17	BC3	BO	26-May-99	8:32	39 ° 35.67	010 ° 17.47	4323	
64PE138-17	ROS	BE	26-May-99	11:10	39 ° 34.76	010 ° 12.45	4195	
64PE138-17	ROS	BO	26-May-99	12:20	39 ° 34.75	010 ° 12.50	4195	
64PE138-17	ROS	EN	26-May-99	13:51	39 ° 34.75	010 ° 12.49	4195	
64PE138-17	MC	BO	26-May-99	15:38	39 ° 34.76	010 ° 16.51	4280	
64PE138-17	PC	BO	26-May-99	18:27	39 ° 34.75	010 ° 16.52	4287	
64PE138-17	TROL	RE	27-May-99	6:10	39 ° 34.95	010 ° 17.32		
64PE138-18	ROS1	BE	27-May-99	15:00	40 ° 59.99	009 ° 44.97	2530	aborted
64PE138-18	ROS1	EN	27-May-99	15:00	40 ° 59.99	009 ° 44.97	2530	aborted
64PE138-18	ROS2	BE	27-May-99	15:09	41 ° 00.02	009 ° 44.97	2524	
64PE138-18	ROS2	BO	27-May-99	15:53	41 ° 00.00	009 ° 45.00	2530	
64PE138-18	ROS2	EN	27-May-99	16:45	40 ° 59.98	009 ° 45.01	2530	
64PE138-02	ALBEX3	RE	28-May-99	5:09	42 ° 38.03	010 ° 00.00	2164	
64PE138	BOBOII	RE	28-May-99	6:54	42 ° 37.66	009 ° 52.38	1951	

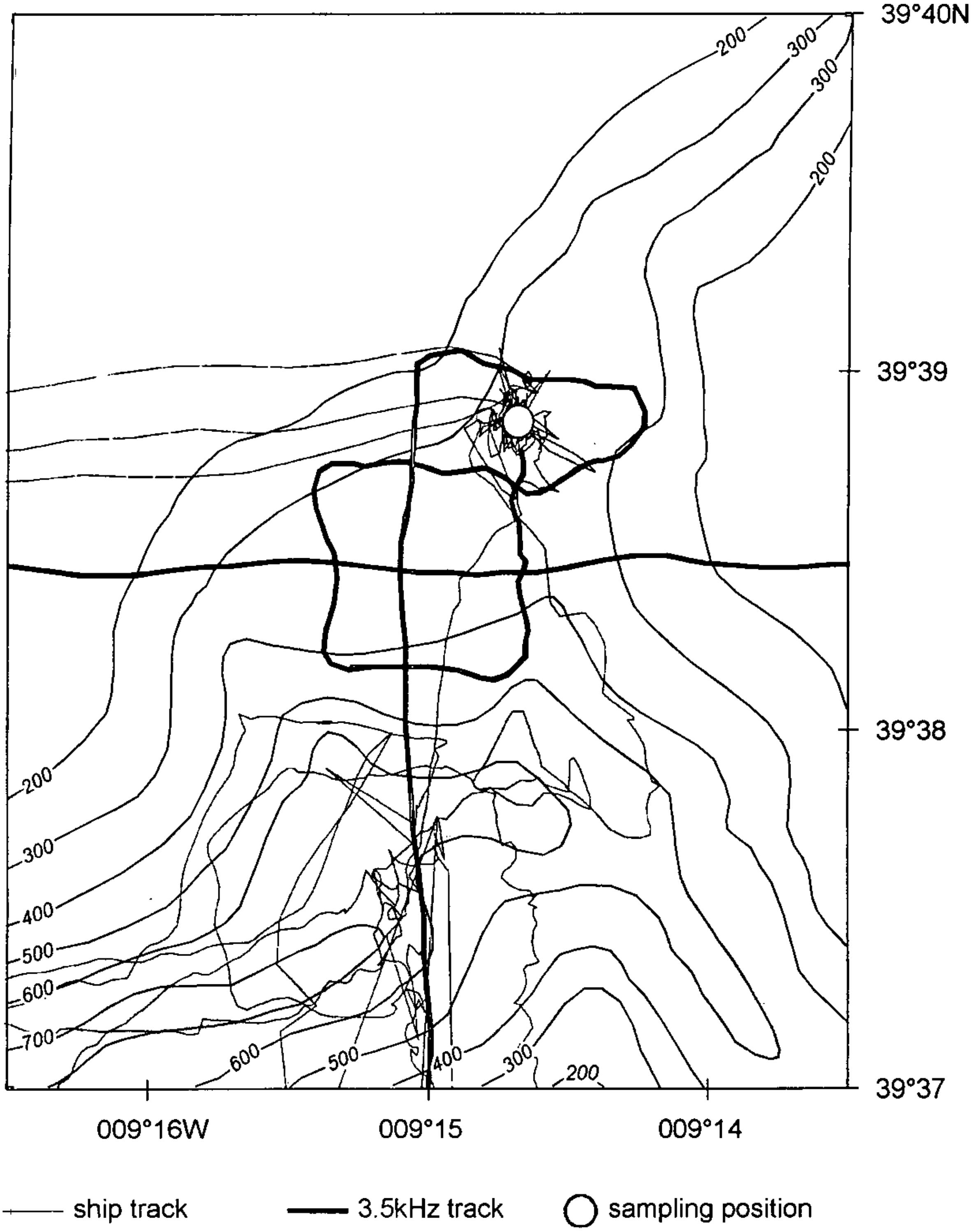
APPENDIX C:
ACOUSTIC TRACKLINES

Start of Line			**End of Line**				
Date&Time UTC	Latitude N	Longitude W	Date&Time UTC	Latitude N	Longitude W	Speed nm/h	Heading
5/13/99 7:16	42 ° 37.99	009 ° 40.10	5/13/99 9:03	42 ° 37.51	010 ° 00.00	8.2	268
5/13/99 19:39	42 ° 39.98	010 ° 21.91	5/14/99 4:06	42 ° 40.25	011 ° 46.23	7.3	270
5/14/99 6:20	42 ° 40.02	011 ° 46.04	5/14/99 8:03	42 ° 40.00	011 ° 28.23	7.6	90
5/14/99 8:03	42 ° 40.00	011 ° 28.23	5/14/99 14:01	42 ° 40.02	010 ° 00.84	10.8	90
5/14/99 14:01	42 ° 40.02	010 ° 00.84	5/14/99 14:16	42 ° 37.92	009 ° 59.98	8.8	163
5/14/99 18:34	42 ° 38.65	009 ° 59.98	5/14/99 20:20	42 ° 50.14	009 ° 39.65	10.7	52
5/14/99 20:20	42 ° 50.14	009 ° 39.65	5/15/99 1:58	42 ° 49.97	010 ° 20.02	5.3	270
5/15/99 1:58	42 ° 49.97	010 ° 20.02	5/15/99 4:00	42 ° 37.68	009 ° 59.94	9.4	130
5/15/99 7:17	42 ° 38.48	010 ° 00.04	5/15/99 8:18	42 ° 43.90	010 ° 09.90	8.9	307
5/15/99 8:18	42 ° 43.90	010 ° 09.90	5/15/99 9:21	42 ° 38.11	010 ° 21.90	10.0	237
5/15/99 9:21	42 ° 38.11	010 ° 21.90	5/15/99 9:43	42 ° 36.95	010 ° 21.94	3.1	181
5/15/99 14:42	42 ° 37.53	010 ° 22.00	5/15/99 19:50	42 ° 00.05	011 ° 10.14	10.1	224
5/15/99 19:50	42 ° 00.05	011 ° 10.14	5/16/99 5:19	41 ° 59.94	009 ° 59.72	5.5	90
5/16/99 5:19	41 ° 59.94	009 ° 59.72	5/16/99 6:30	42 ° 00.02	009 ° 43.95	9.9	90
5/17/99 6:57	42 ° 35.38	010 ° 21.75	5/17/99 10:09	42 ° 00.09	010 ° 29.87	11.2	190
5/17/99 20:28	41 ° 59.91	009 ° 44.01	5/18/99 2:22	41 ° 59.94	009 ° 00.02	5.5	90
5/18/99 2:22	41 ° 59.94	009 ° 00.02	5/18/99 3:29	41 ° 52.74	008 ° 59.97	6.4	180
5/18/99 3:29	41 ° 52.74	008 ° 59.97	5/18/99 4:08	41 ° 51.97	009 ° 04.00	4.8	256
5/18/99 7:54	41 ° 52.42	009 ° 11.06	5/18/99 11:53	41 ° 59.72	009 ° 42.34	6.1	287
5/19/99 10:10	42 ° 00.09	009 ° 25.05	5/19/99 10:27	41 ° 59.96	009 ° 28.91	10.1	267
5/19/99 10:27	41 ° 59.96	009 ° 28.91	5/19/99 11:08	41 ° 59.93	009 ° 28.05	~3	92
5/19/99 13:03	41 ° 59.93	009 ° 28.01	5/19/99 15:03	41 ° 59.21	009 ° 29.44	~3	236
5/20/99 7:16	41 ° 59.85	009 ° 00.12	5/20/99 8:13	42 ° 08.98	009 ° 03.02	9.9	347
5/20/99 11:00	42 ° 00.04	009 ° 20.98	5/20/99 12:26	41 ° 59.98	009 ° 27.22	3.2	269
5/20/99 23:36	41 ° 60.00	010 ° 30.21	5/21/99 4:42	41 ° 20.27	011 ° 09.65	9.7	217
5/21/99 4:42	41 ° 20.27	011 ° 09.65	5/21/99 6:41	41 ° 00.69	011 ° 09.95	9.9	181
5/21/99 8:09	41 ° 02.83	011 ° 09.96	5/21/99 15:18	39 ° 53.17	011 ° 09.97	9.7	180
5/21/99 15:18	39 ° 53.17	011 ° 09.97	5/21/99 17:03	39 ° 49.00	010 ° 49.08	9.5	105
5/21/99 17:03	39 ° 49.00	010 ° 49.08	5/21/99 17:52	39 ° 45.68	010 ° 39.58	9.8	114
5/21/99 17:52	39 ° 45.68	010 ° 39.58	5/21/99 18:54	39 ° 37.12	010 ° 32.90	9.7	149
5/21/99 18:54	39 ° 37.12	010 ° 32.90	5/21/99 19:34	39 ° 35.42	010 ° 24.63	9.9	105
5/21/99 19:34	39 ° 35.42	010 ° 24.63	5/21/99 20:29	39 ° 35.02	010 ° 13.46	9.4	93
5/21/99 20:29	39 ° 35.02	010 ° 13.46	5/21/99 20:45	39 ° 34.06	010 ° 10.20	10.1	111
5/21/99 20:45	39 ° 34.06	010 ° 10.20	5/21/99 21:16	39 ° 30.57	010 ° 05.12	10.1	132
5/21/99 21:16	39 ° 30.57	010 ° 05.12	5/21/99 21:43	39 ° 30.47	009 ° 59.89	9.0	91
5/21/99 21:43	39 ° 30.47	009 ° 59.89	5/21/99 21:57	39 ° 29.77	009 ° 57.25	9.2	109
5/21/99 21:57	39 ° 29.77	009 ° 57.25	5/21/99 22:08	39 ° 29.94	009 ° 55.06	9.3	84
5/21/99 22:08	39 ° 29.94	009 ° 55.06	5/22/99 1:31	39 ° 29.99	009 ° 29.98	5.7	90
5/22/99 1:31	39 ° 29.99	009 ° 29.98	5/22/99 2:20	39 ° 34.00	009 ° 30.04	4.9	359
5/22/99 2:20	39 ° 34.00	009 ° 30.04	5/22/99 3:40	39 ° 33.97	009 ° 20.12	5.7	90
5/22/99 3:40	39 ° 33.97	009 ° 20.12	5/22/99 4:30	39 ° 38.46	009 ° 19.95	5.4	2
5/22/99 4:30	39 ° 38.46	009 ° 19.95	5/22/99 5:50	39 ° 38.48	009 ° 10.06	5.7	90
5/22/99 5:50	39 ° 38.48	009 ° 10.06	5/22/99 6:38	39 ° 34.06	009 ° 10.01	5.5	180
5/22/99 6:38	39 ° 34.06	009 ° 10.01	5/22/99 7:19	39 ° 34.04	009 ° 14.94	5.6	270
5/22/99 7:19	39 ° 34.04	009 ° 14.94	5/22/99 8:14	39 ° 38.53	009 ° 15.10	4.9	358
5/22/99 8:14	39 ° 38.53	009 ° 15.10	5/22/99 9:40	39 ° 38.78	009 ° 14.67	~4	53
5/23/99 10:09	39 ° 38.58	009 ° 20.03	5/23/99 10:37	39 ° 38.42	009 ° 24.09	6.7	267
5/23/99 10:37	39 ° 38.42	009 ° 24.09	5/23/99 10:53	39 ° 36.05	009 ° 23.97	8.9	178

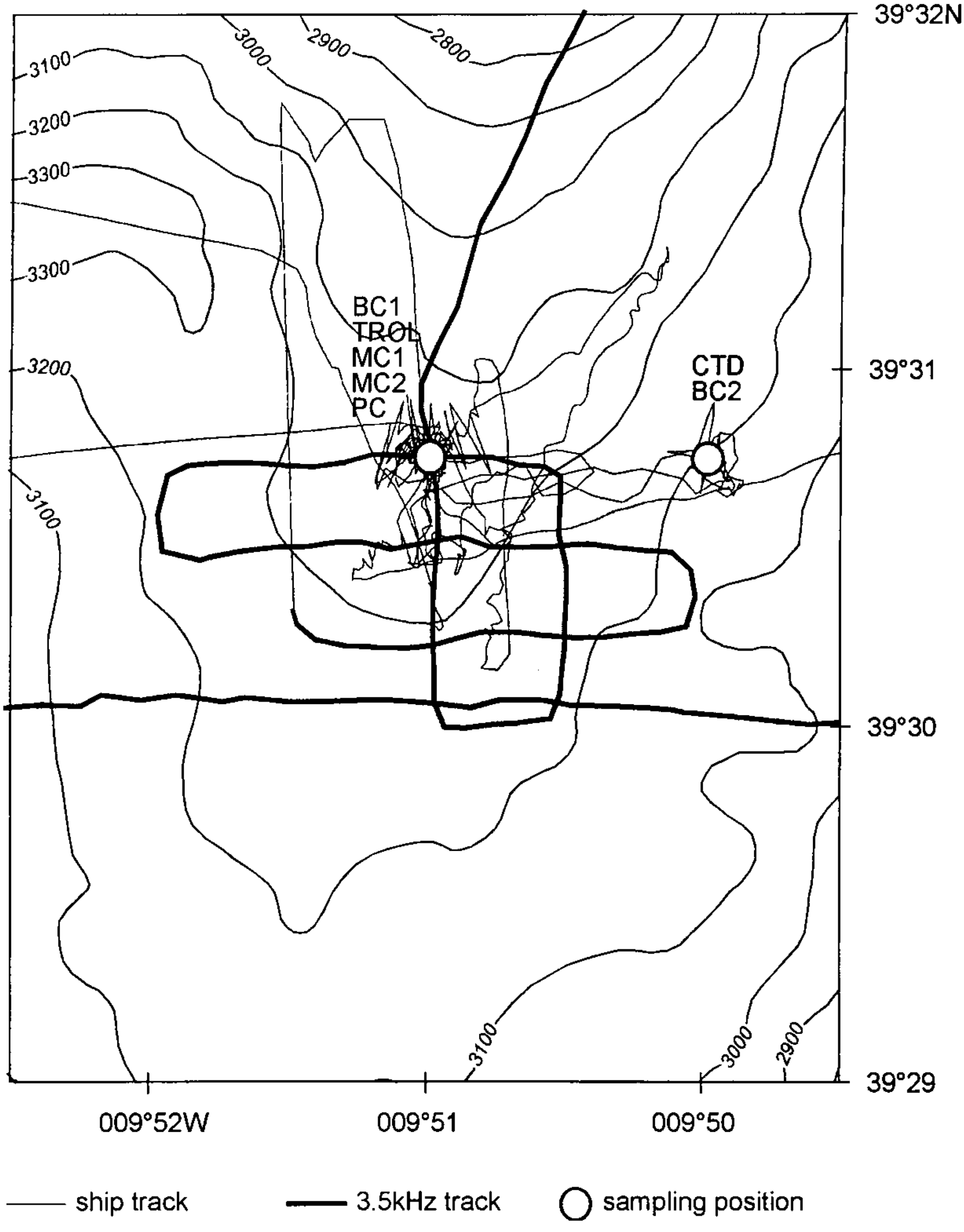
Start of Line Date&Time UTC	Latitude N	Longitude W	**End of Line** Date&Time UTC	Latitude N	Longitude W	Speed nm/h	Heading
5/23/99 10:53	39 ° 36.05	009 ° 23.97	5/23/99 11:46	39 ° 35.45	009 ° 23.94	~4	177
5/23/99 12:26	39 ° 35.51	009 ° 23.86	5/23/99 12:35	39 ° 34.06	009 ° 24.04	9.8	186
5/23/99 12:35	39 ° 34.06	009 ° 24.04	5/23/99 14:42	39 ° 33.96	009 ° 49.99	9.4	270
5/23/99 14:42	39 ° 33.96	009 ° 49.99	5/23/99 15:02	39 ° 31.06	009 ° 50.97	9.0	195
5/23/99 15:02	39 ° 31.06	009 ° 50.97	5/23/99 16:29	39 ° 30.33	009 ° 51.48	~4	209
5/23/99 22:16	39 ° 31.97	010 ° 10.01	5/23/99 23:03	39 ° 35.89	010 ° 09.96	5.0	0
5/23/99 23:03	39 ° 35.89	010 ° 09.96	5/23/99 23:23	39 ° 35.94	010 ° 12.48	5.8	271
5/23/99 23:23	39 ° 35.94	010 ° 12.48	5/23/99 23:53	39 ° 33.05	010 ° 12.54	5.8	181
5/23/99 23:53	39 ° 33.05	010 ° 12.54	5/24/99 0:16	39 ° 33.02	010 ° 14.72	4.4	269
5/24/99 0:16	39 ° 33.02	010 ° 14.72	5/24/99 1:07	39 ° 36.91	010 ° 14.97	4.6	357
5/24/99 1:07	39 ° 36.91	010 ° 14.97	5/24/99 1:31	39 ° 36.98	010 ° 17.39	4.7	272
5/24/99 1:31	39 ° 36.98	010 ° 17.39	5/24/99 2:15	39 ° 33.52	010 ° 17.55	4.7	182
5/24/99 2:15	39 ° 33.52	010 ° 17.55	5/24/99 2:37	39 ° 33.45	010 ° 19.85	4.8	268
5/24/99 2:37	39 ° 33.45	010 ° 19.85	5/24/99 3:37	39 ° 38.38	010 ° 19.92	4.9	359
5/24/99 3:37	39 ° 38.38	010 ° 19.92	5/24/99 5:46	39 ° 38.49	009 ° 50.10	10.7	90
5/24/99 5:46	39 ° 38.49	009 ° 50.10	5/24/99 6:48	39 ° 35.05	009 ° 36.64	10.6	108
5/25/99 17:48	39 ° 34.50	010 ° 17.51	5/25/99 18:11	39 ° 36.07	010 ° 17.49	4.1	1
5/25/99 22:28	39 ° 37.98	010 ° 20.01	5/25/99 22:51	39 ° 37.90	010 ° 22.49	5.0	268
5/25/99 22:51	39 ° 37.90	010 ° 22.49	5/25/99 23:40	39 ° 34.05	010 ° 22.42	4.7	179
5/25/99 23:40	39 ° 34.05	010 ° 22.42	5/26/99 0:07	39 ° 34.00	010 ° 24.99	4.4	268
5/26/99 0:07	39 ° 34.00	010 ° 24.99	5/26/99 0:57	39 ° 38.09	010 ° 24.99	4.9	0
5/26/99 0:57	39 ° 38.09	010 ° 24.99	5/26/99 1:21	39 ° 37.94	010 ° 27.52	4.9	266
5/26/99 1:21	39 ° 37.94	010 ° 27.52	5/26/99 2:08	39 ° 34.06	010 ° 27.54	5.0	180
5/26/99 20:27	39 ° 33.02	010 ° 13.73	5/26/99 21:10	39 ° 37.03	010 ° 13.79	5.6	359
5/26/99 21:10	39 ° 37.03	010 ° 13.79	5/26/99 21:33	39 ° 36.97	010 ° 16.24	4.9	268
5/26/99 21:33	39 ° 36.97	010 ° 16.24	5/26/99 22:16	39 ° 33.58	010 ° 16.20	4.7	179
5/26/99 22:16	39 ° 33.58	010 ° 16.20	5/26/99 22:42	39 ° 33.52	010 ° 18.64	4.3	268
5/26/99 22:42	39 ° 33.52	010 ° 18.64	5/26/99 23:30	39 ° 37.53	010 ° 18.77	5.0	359
5/26/99 23:30	39 ° 37.53	010 ° 18.77	5/26/99 23:54	39 ° 37.50	010 ° 21.15	4.6	269
5/26/99 23:54	39 ° 37.50	010 ° 21.15	5/27/99 0:33	39 ° 34.09	010 ° 21.28	5.3	182
5/27/99 0:33	39 ° 34.09	010 ° 21.28	5/27/99 0:57	39 ° 34.01	010 ° 23.66	4.6	268
5/27/99 0:57	39 ° 34.01	010 ° 23.66	5/27/99 1:38	39 ° 37.47	010 ° 23.82	5.1	358
5/27/99 1:38	39 ° 37.47	010 ° 23.82	5/27/99 2:03	39 ° 37.53	010 ° 26.18	4.4	272
5/27/99 2:03	39 ° 37.53	010 ° 26.18	5/27/99 2:41	39 ° 34.54	010 ° 26.26	4.7	181
5/27/99 2:41	39 ° 34.54	010 ° 26.26	5/27/99 3:03	39 ° 34.51	010 ° 28.72	5.2	269
5/27/99 3:03	39 ° 34.51	010 ° 28.72	5/27/99 3:38	39 ° 37.54	010 ° 28.79	5.2	359
5/27/99 3:38	39 ° 37.54	010 ° 28.79	5/27/99 4:33	39 ° 34.70	010 ° 17.39	10.1	108
5/27/99 6:28	39 ° 35.07	010 ° 16.81	5/27/99 14:59	41 ° 00.01	009 ° 44.96	10.4	16
5/27/99 19:08	41 ° 01.20	010 ° 00.12	5/28/99 4:44	42 ° 37.90	010 ° 00.10	10.1	0

APPENDIX D
MAPS OF STATIONS AND TRACKLINES

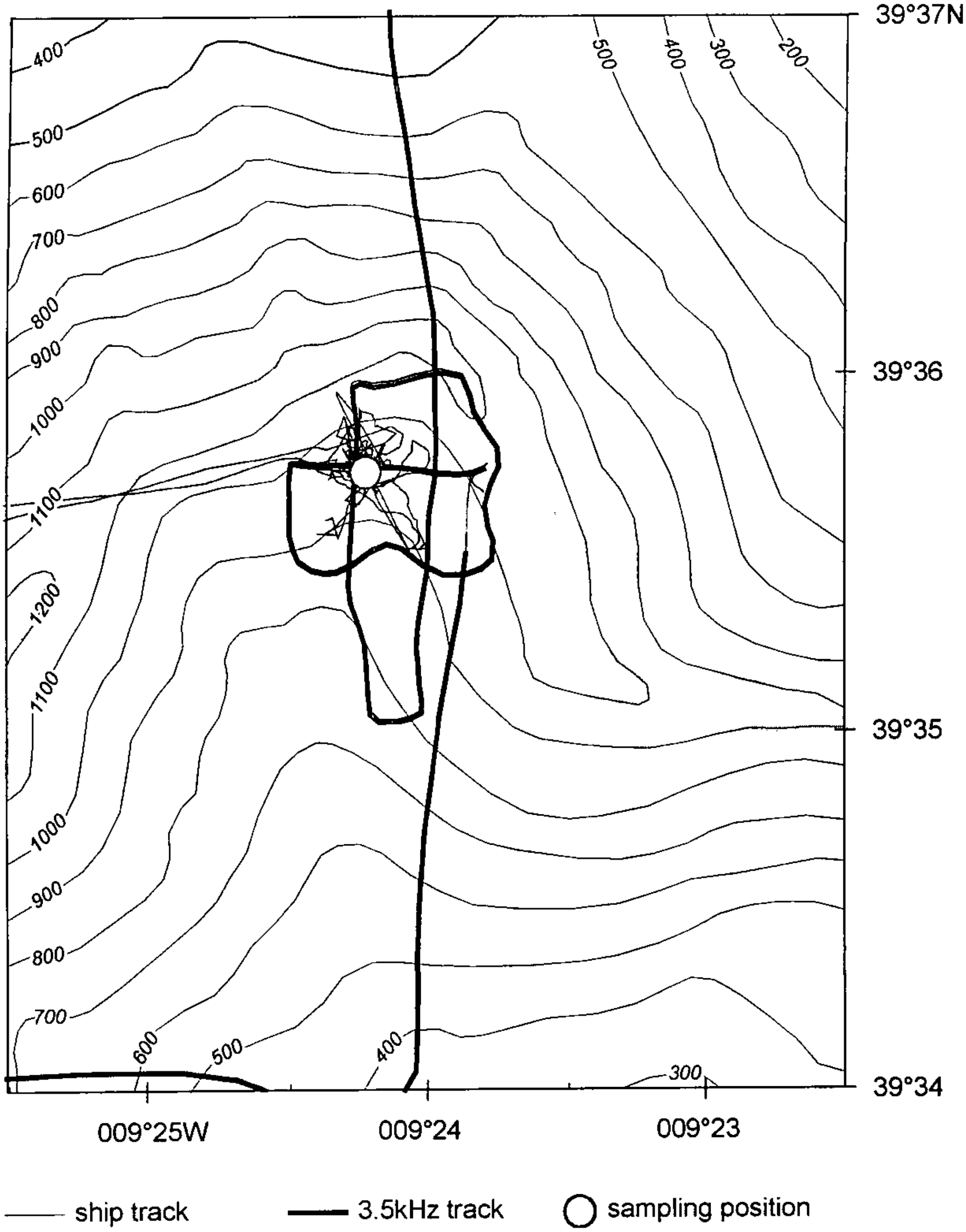
Station 64PE138-12



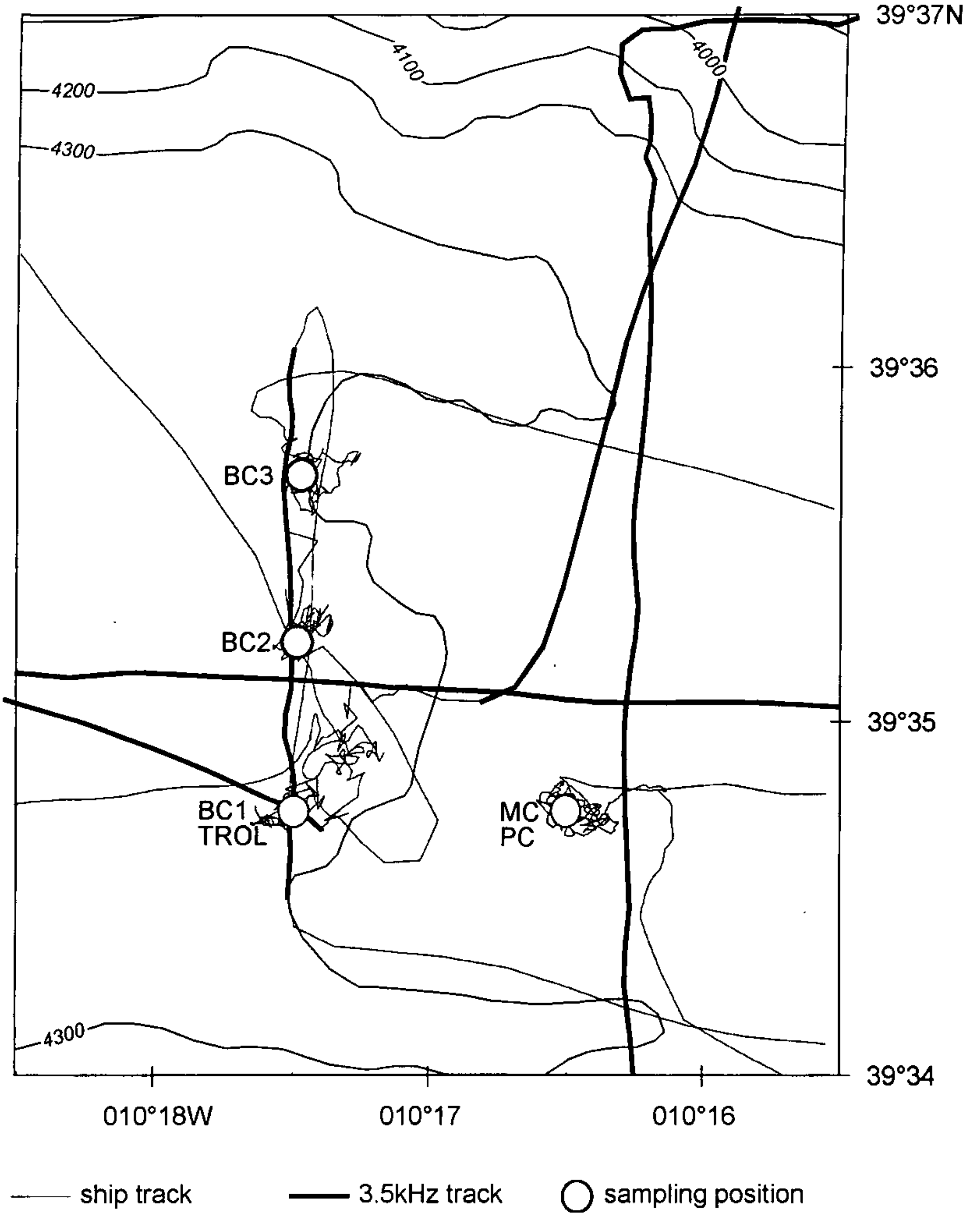
Station 64PE138-14



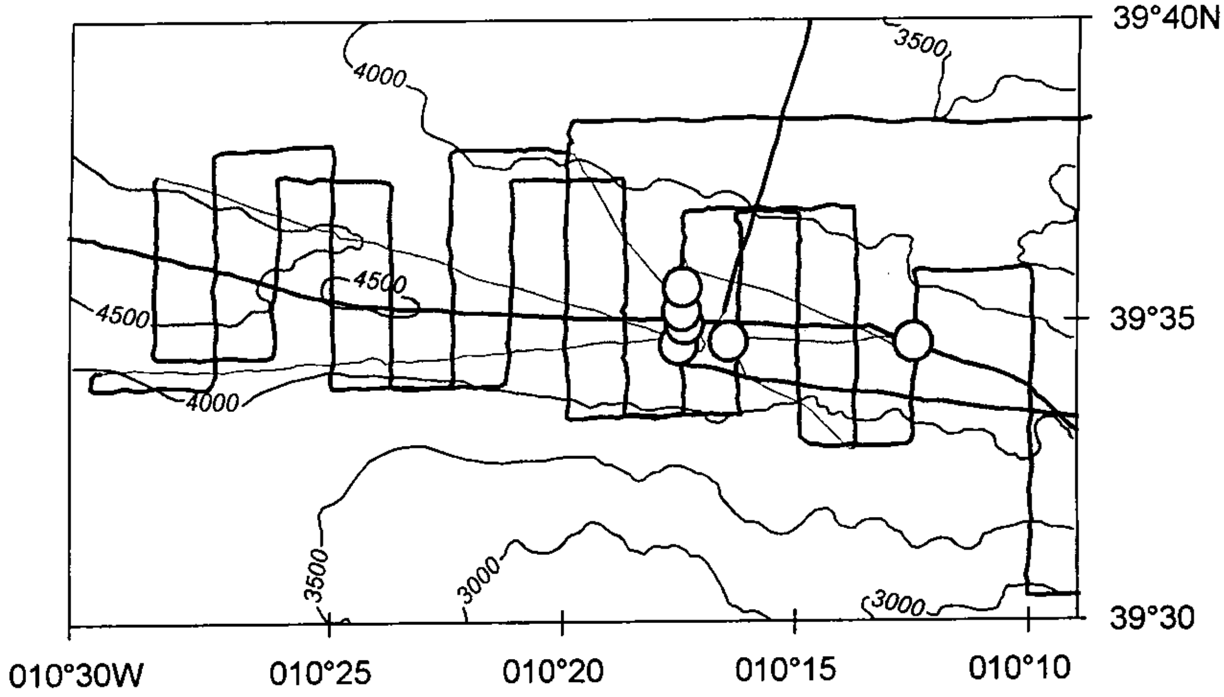
Station 64PE138-16



Station 64PE138-17



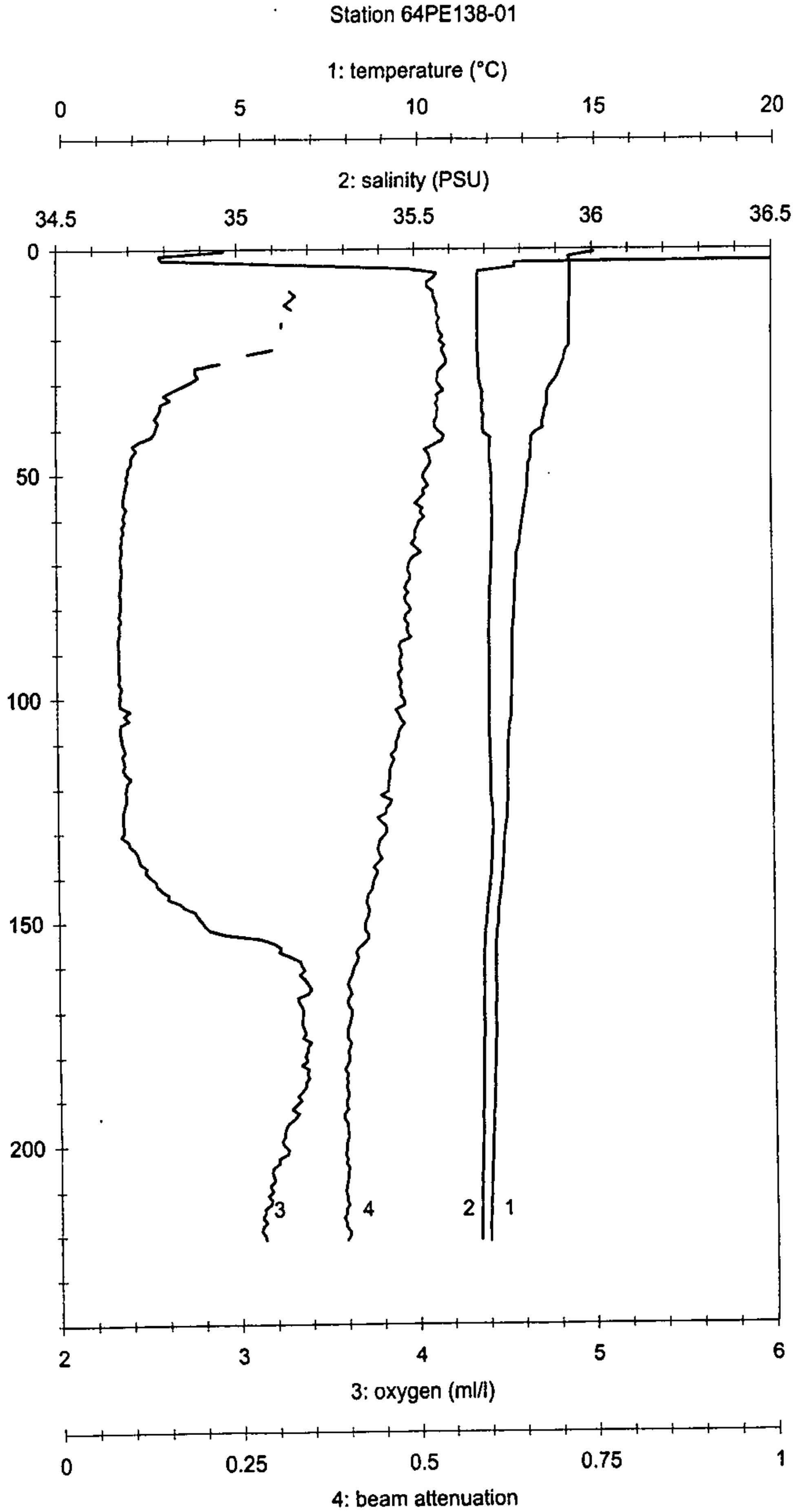
Station 64PE138-17

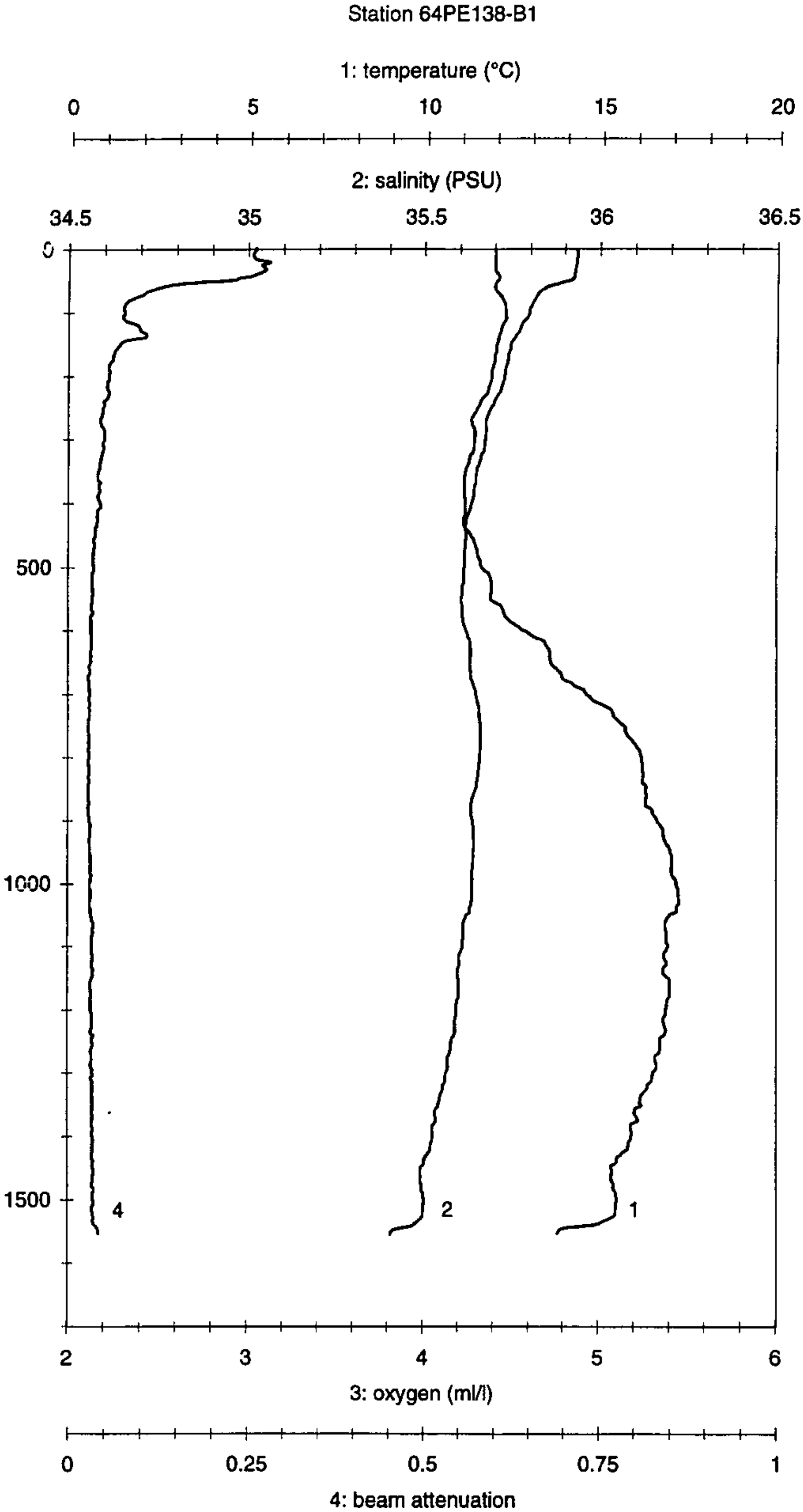


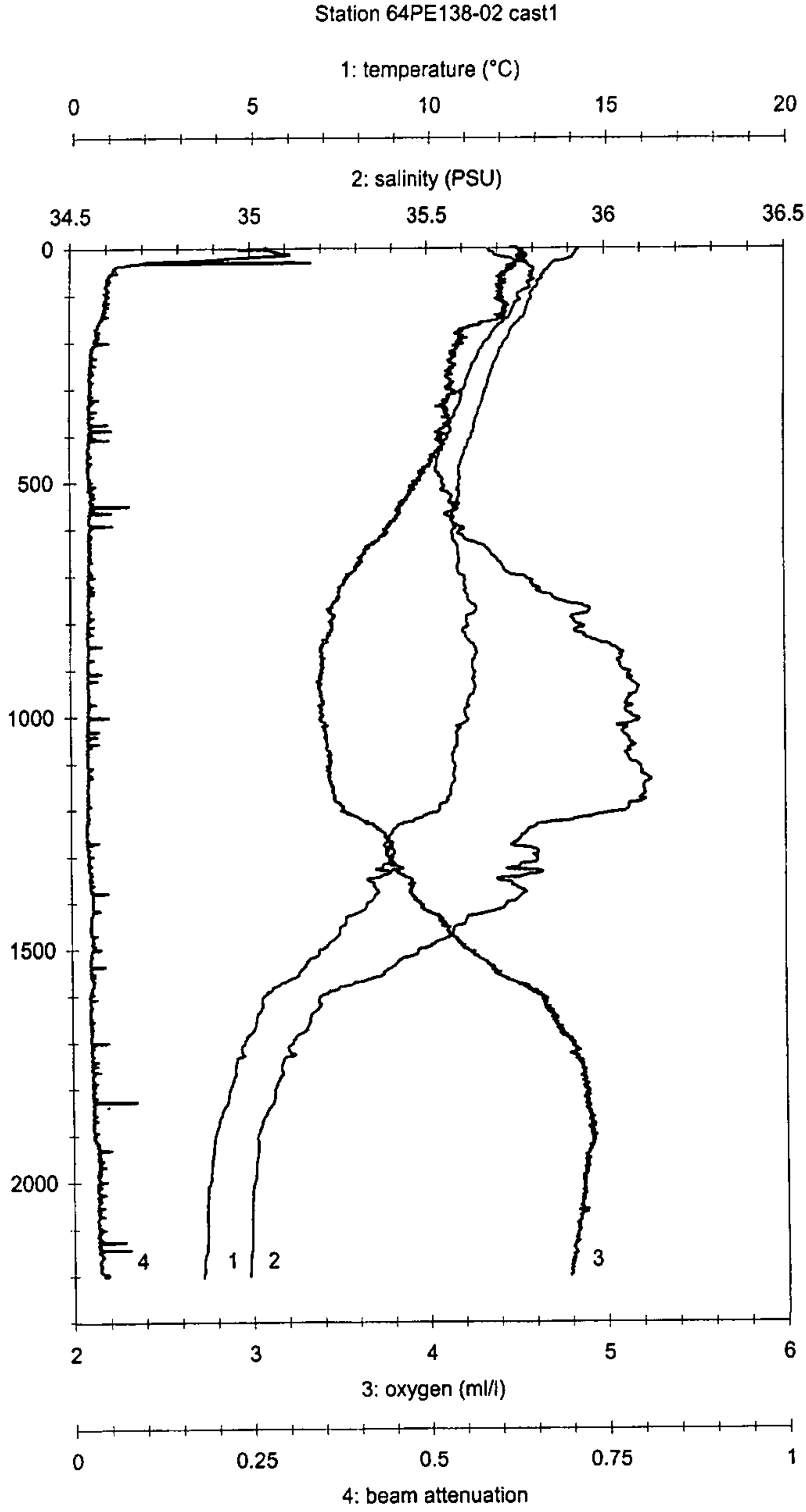
ship track — 3.5kHz track — sampling position

APPENDIX E
CTD PROFILES

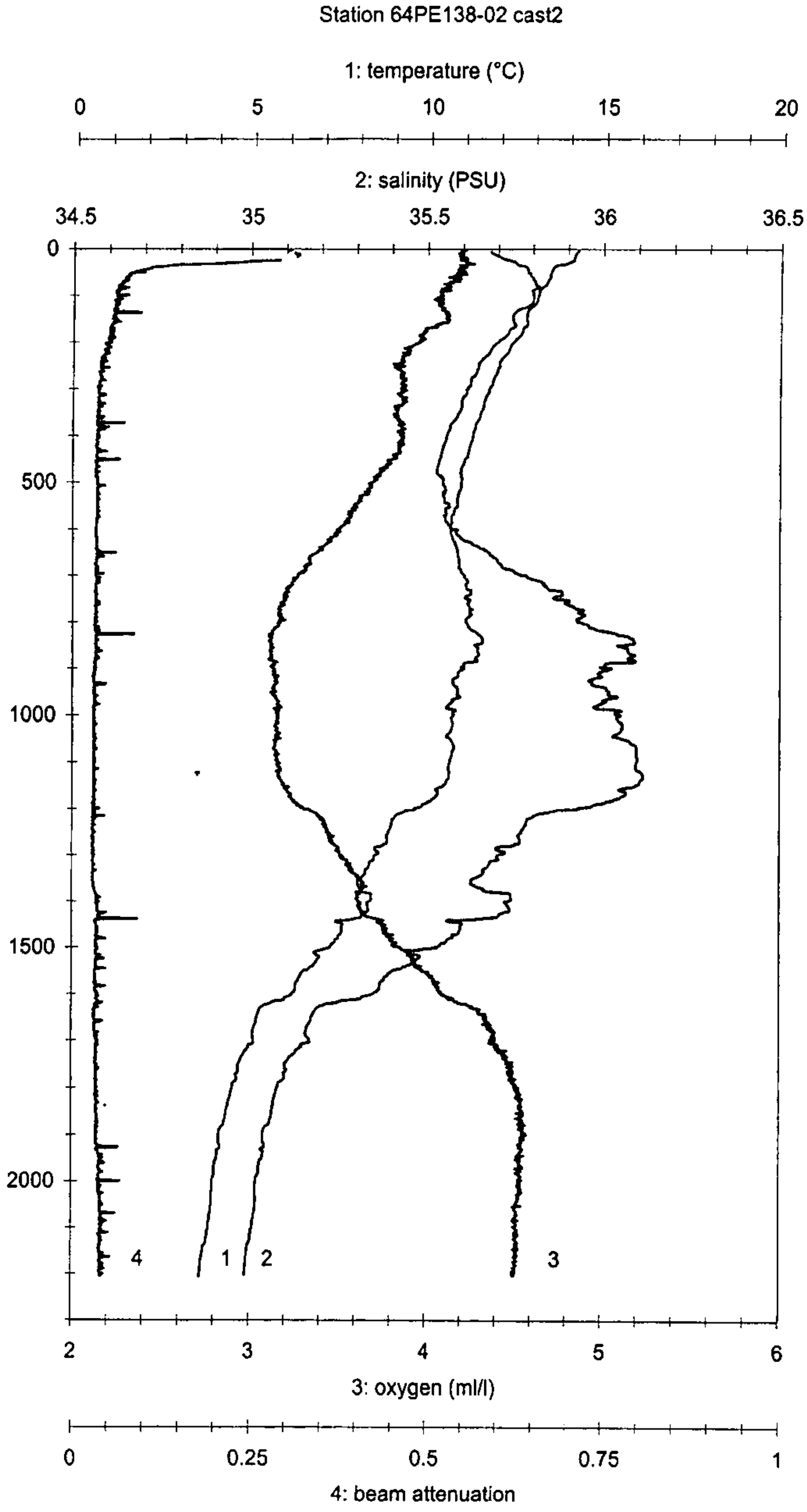
note: beam attenuation error values removed from profiles.

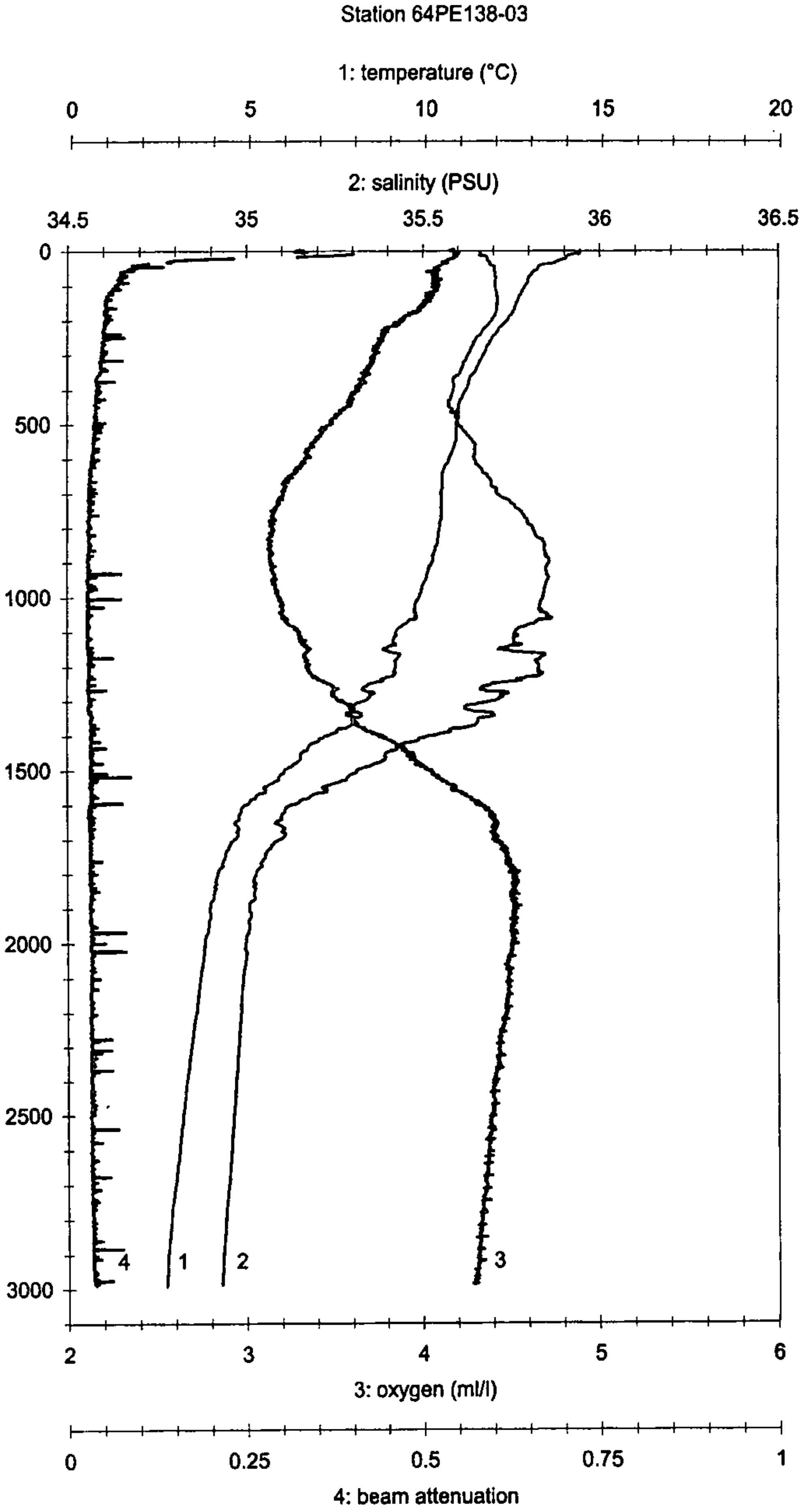

Station 64PE138-01
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
50
100
150
200
3
4
2
1
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation


Station 64PE138-B1
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
500
1000
1500
4
2
1
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation

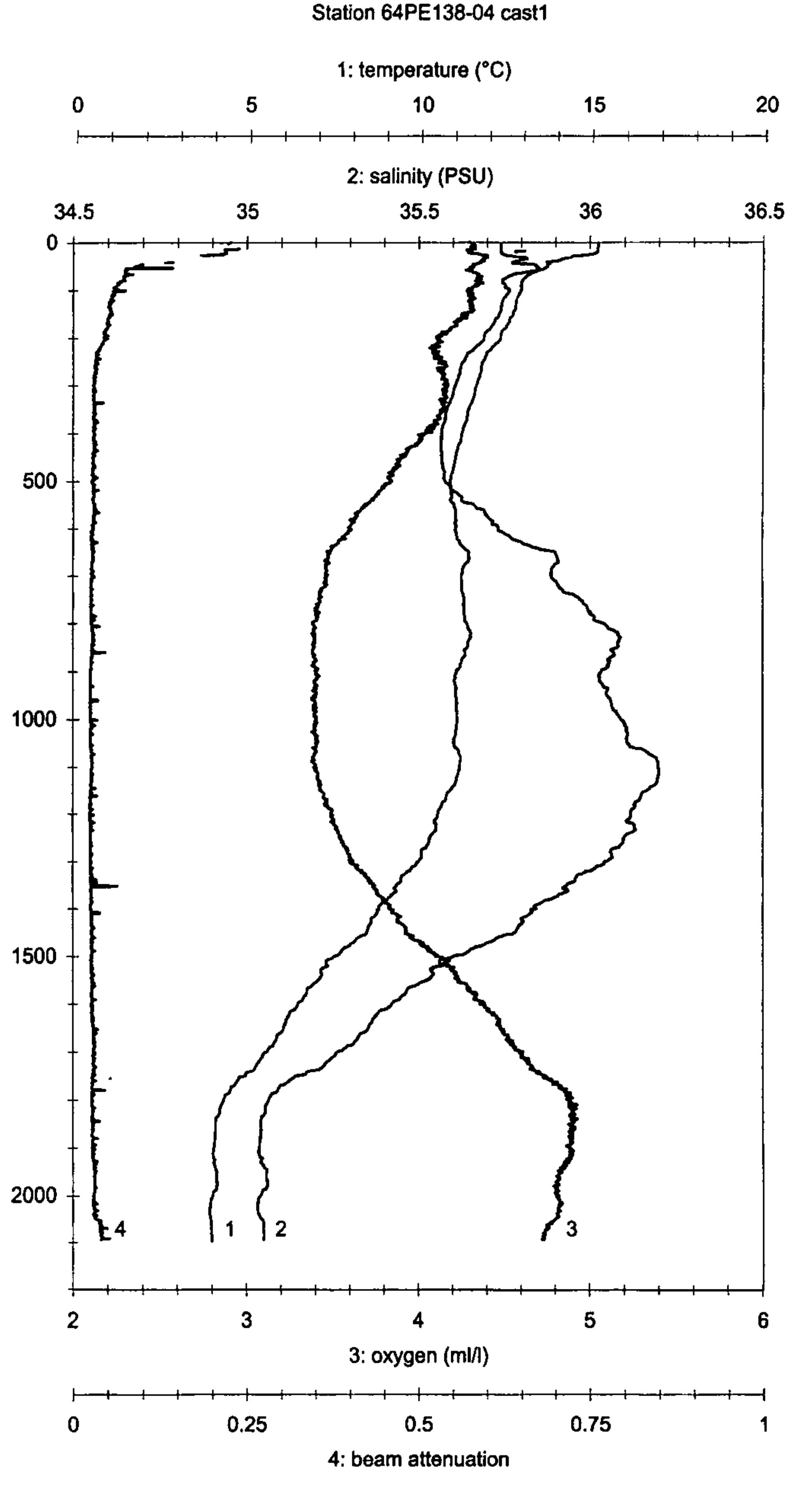


Station 64PE138-02 cast1
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
500
1000
1500
2000
4
1
2
3
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation

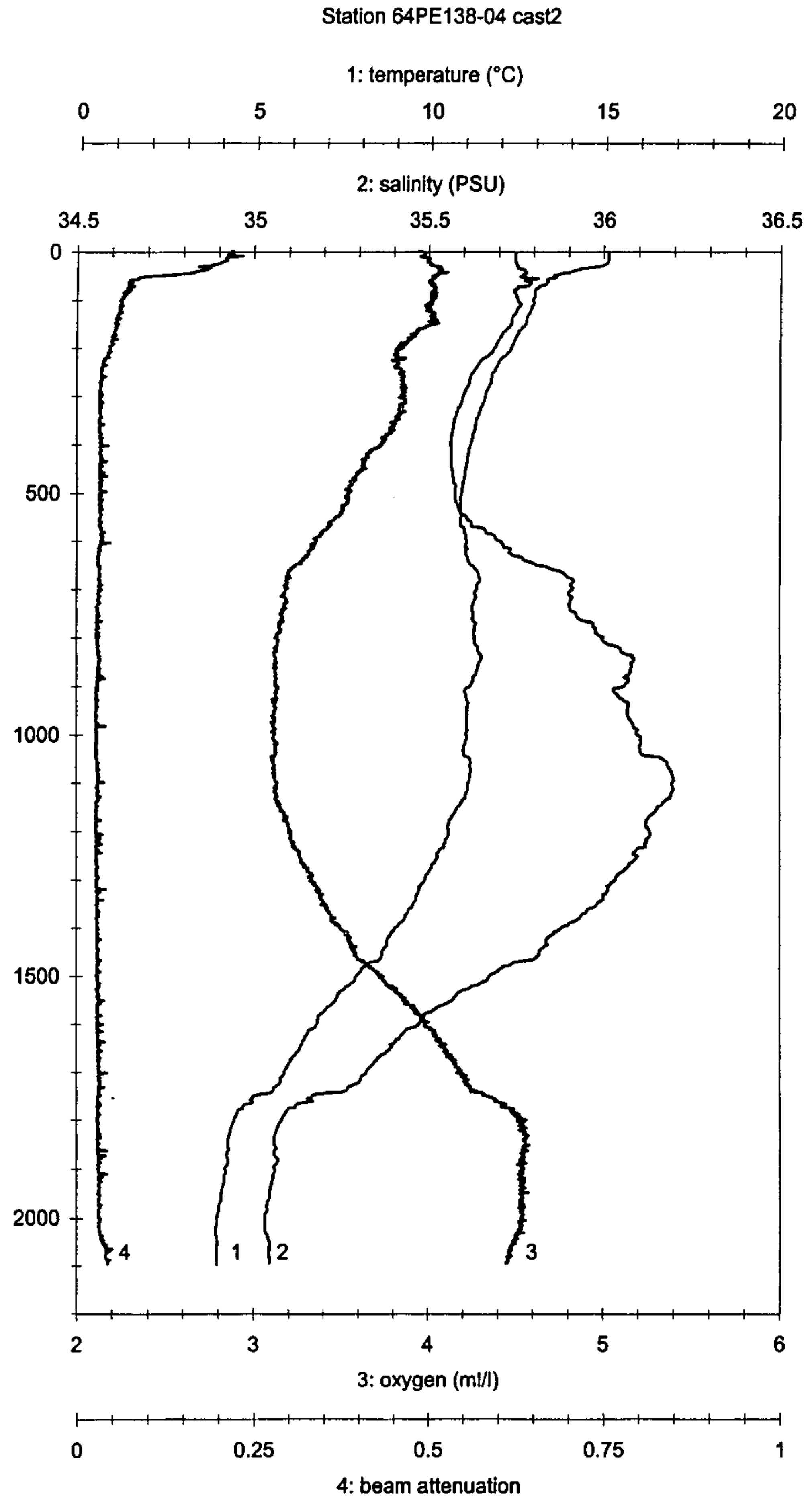

Station 64PE138-02 cast2
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
500
1000
1500
2000
4
1
2
3
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation

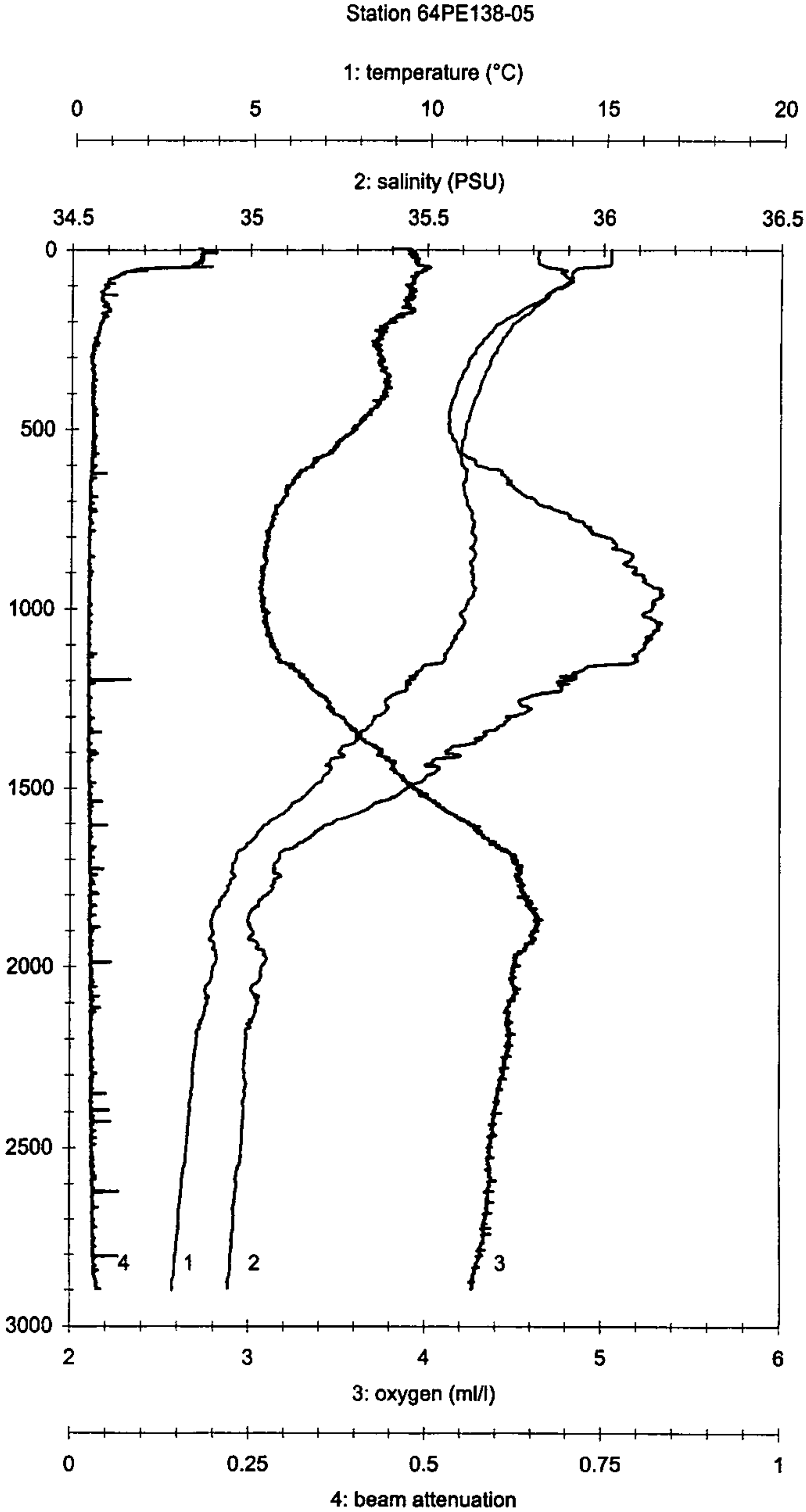


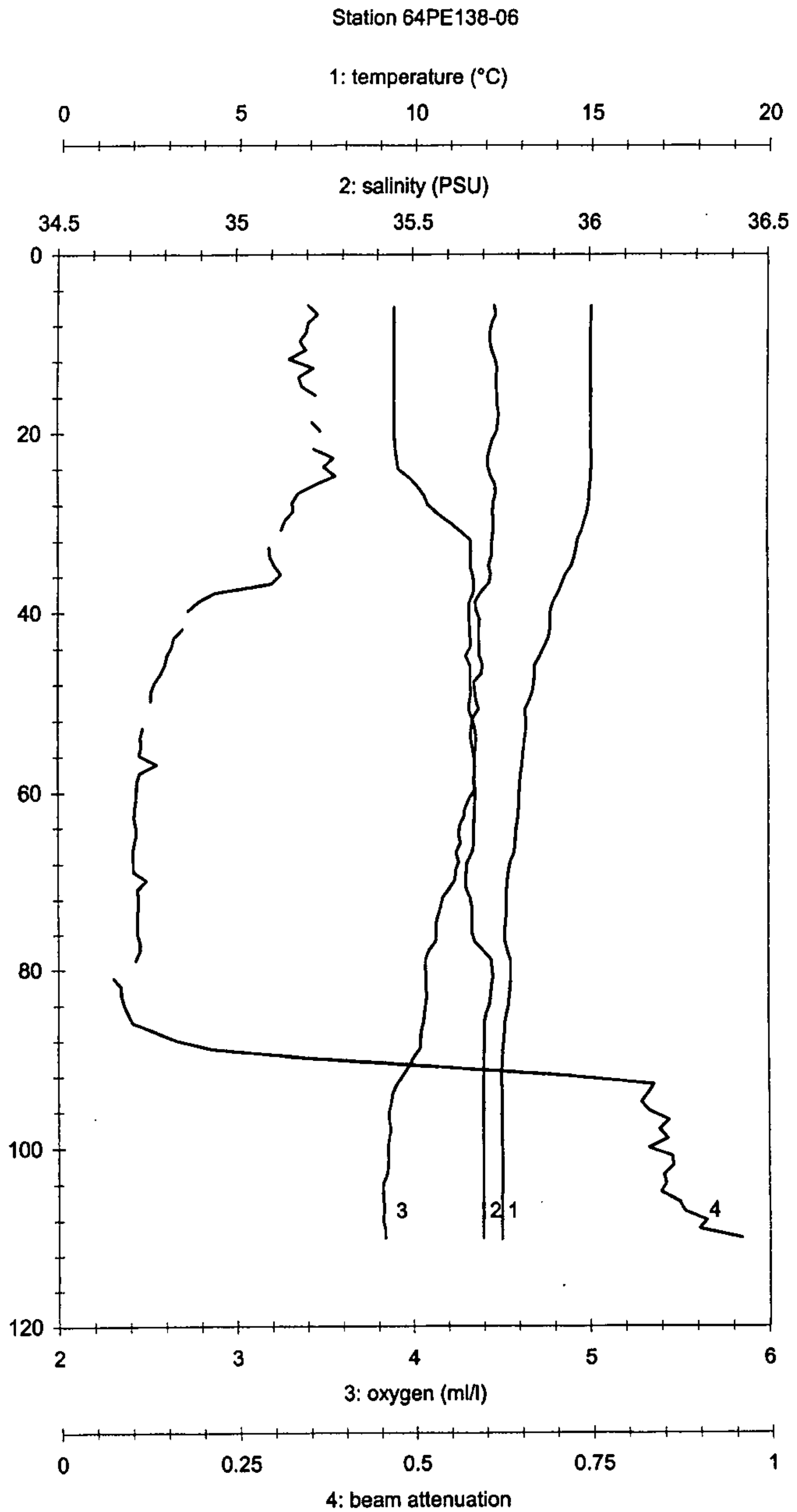
Station 64PE138-03
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
500
1000
1500
2000
2500
3000
4
1
2
3
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation

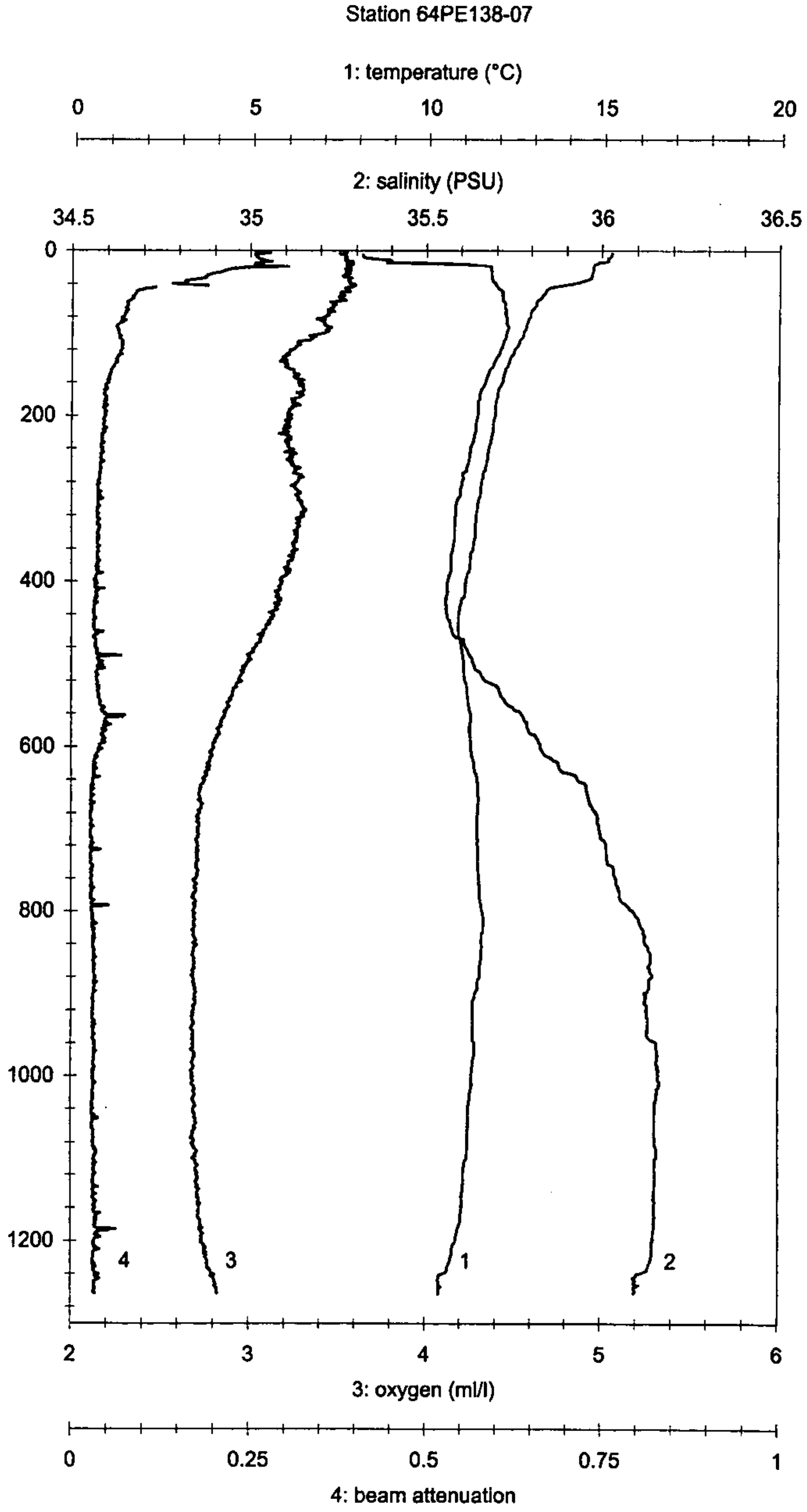


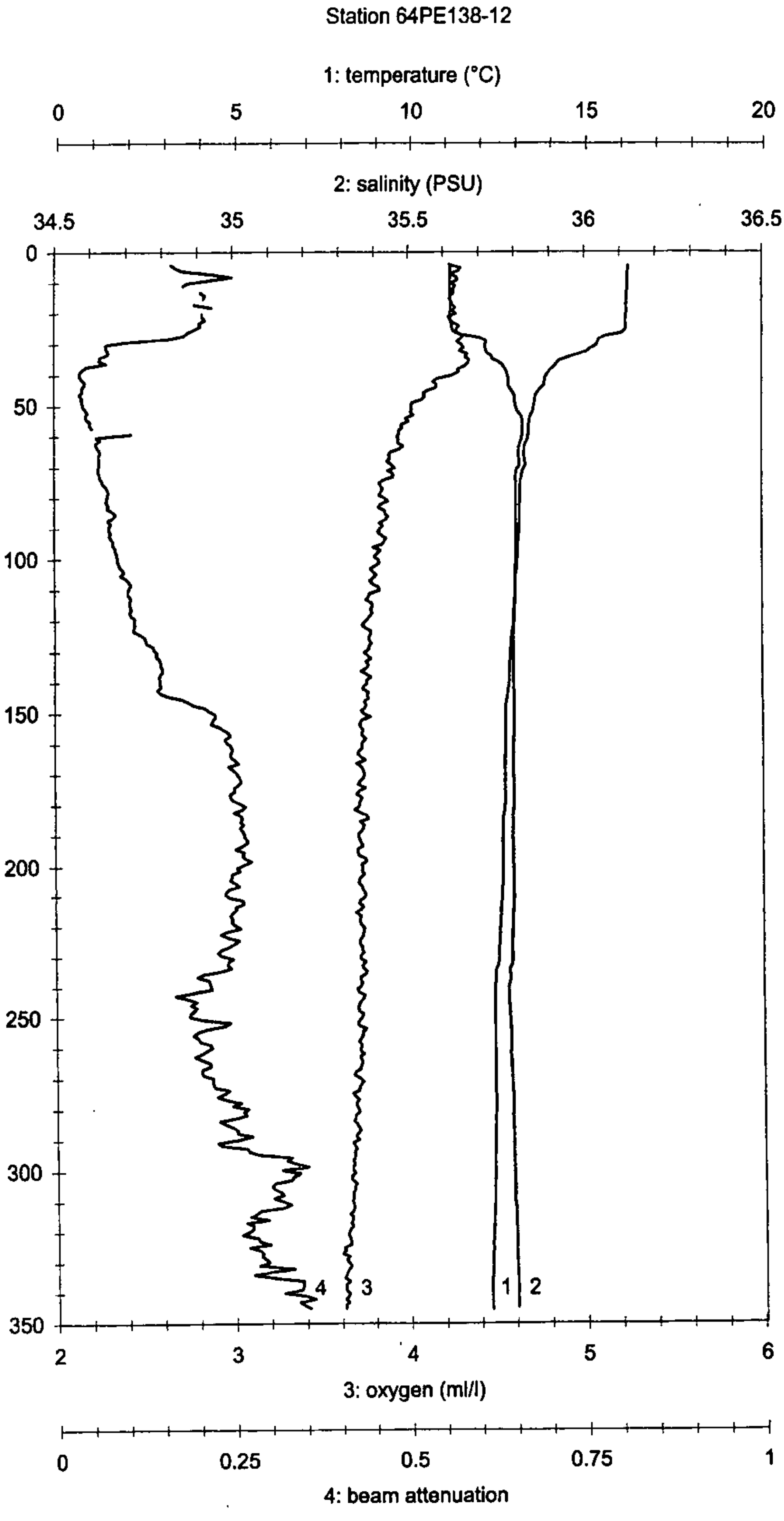
Station 64PE138-04 cast1
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
500
1000
1500
2000
4
1
2
3
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation

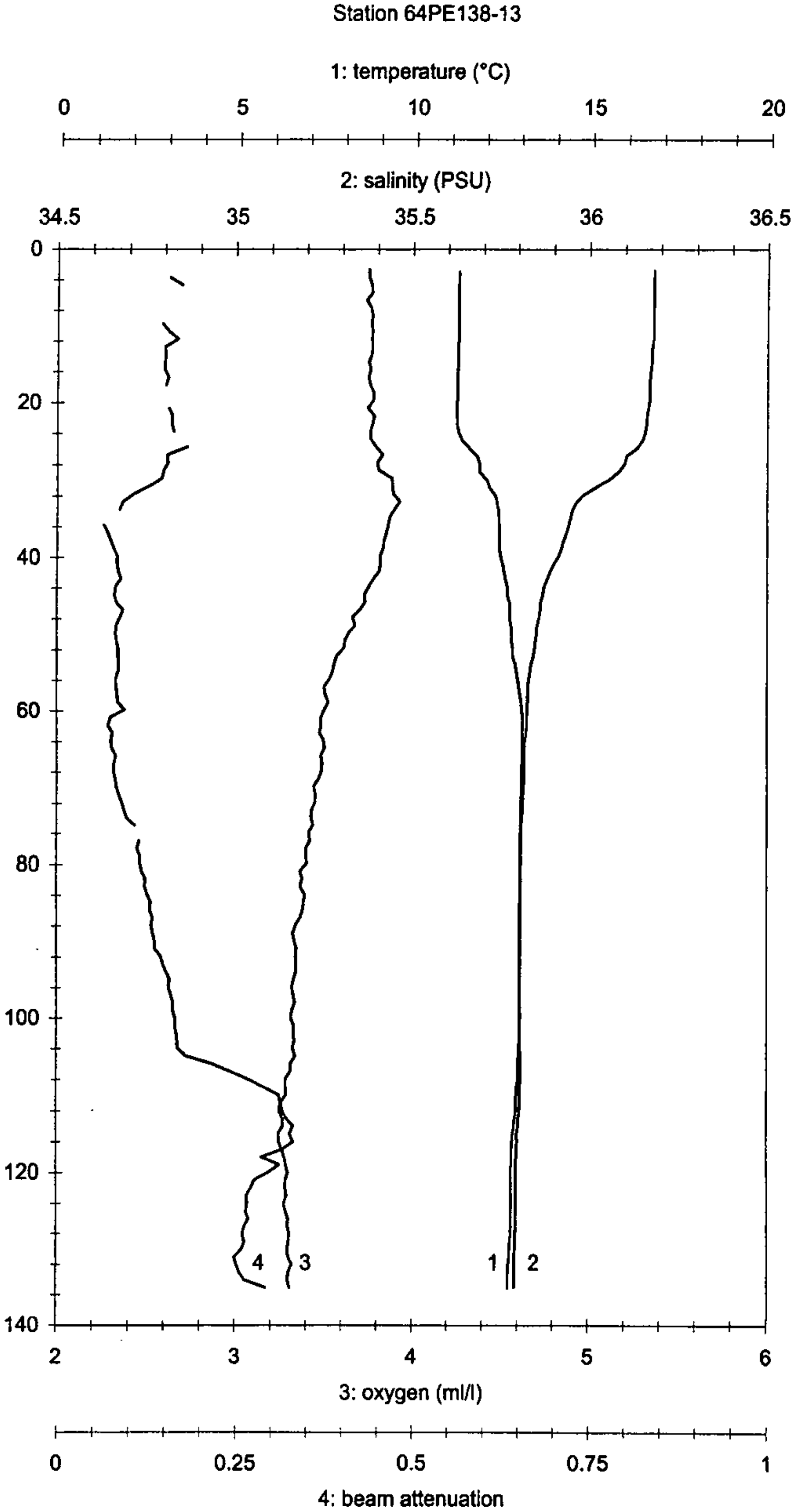

Station 64PE138-04 cast2
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
500
1000
1500
2000
4
1
2
3
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation


Station 64PE138-05
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
500
1000
1500
2000
2500
3000
4
1
2
3
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation

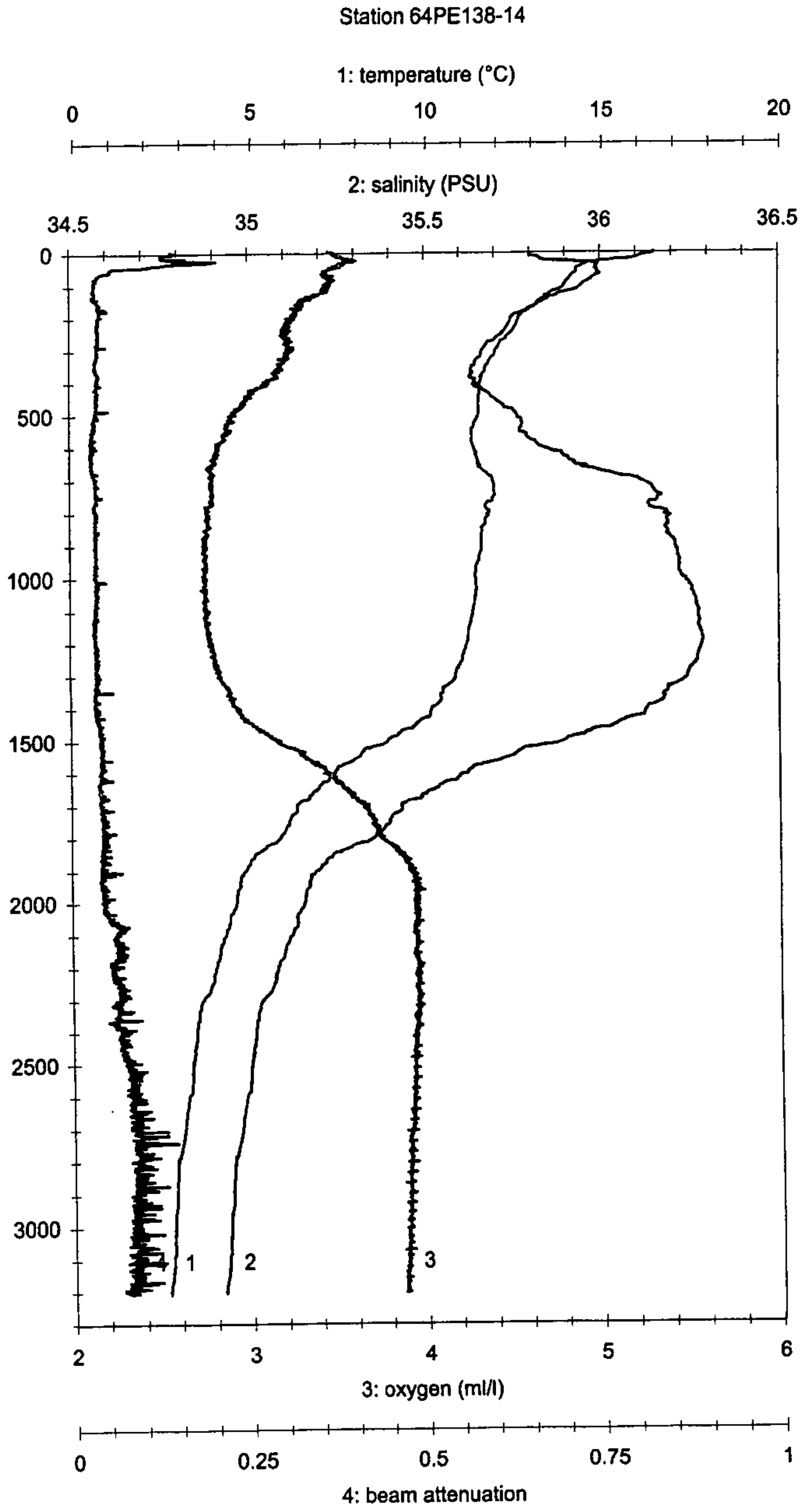

Station 64PE138-06
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
20
40
60
80
100
120
3
2
1
4
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation

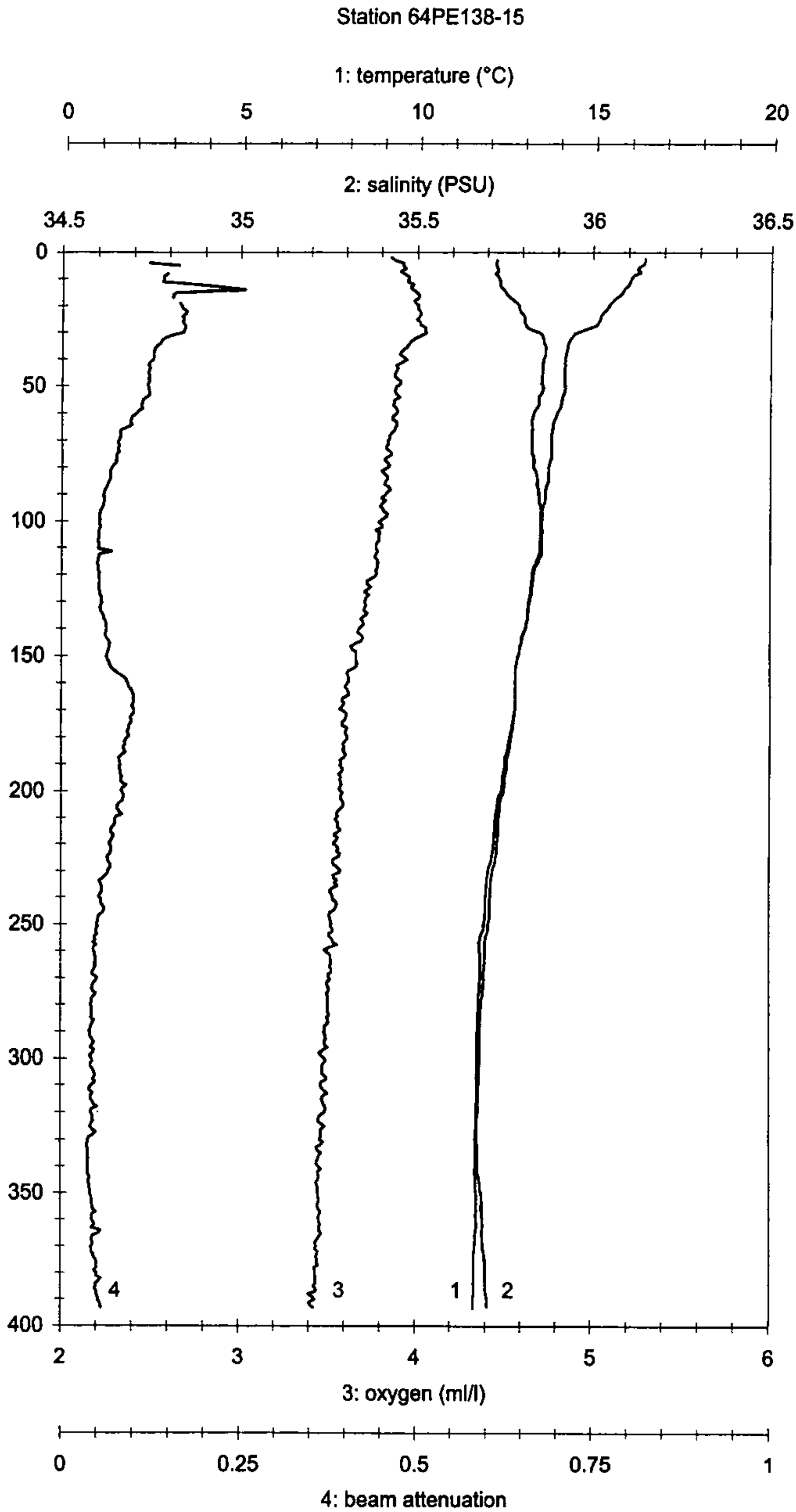

Station 64PE138-07
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
200
400
600
800
1000
1200
4
3
1
2
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation

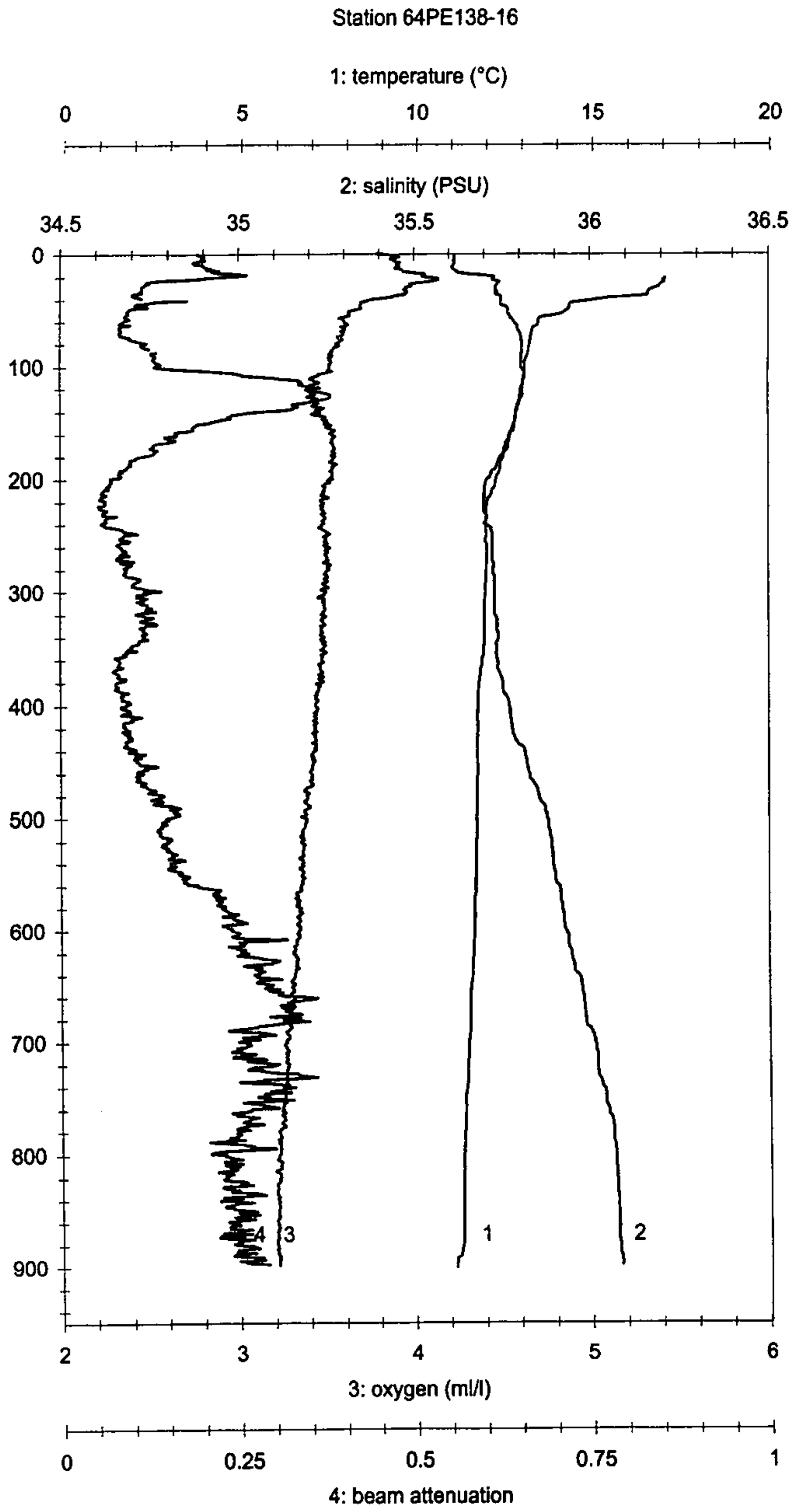

Station 64PE138-12
1: temperature (°C)
0 5 10 15 20
2: salinity (PSU)
34.5 35 35.5 36 36.5
0 50 100 150 200 250 300 350
4 3 1 2
2 3 4 5 6
3: oxygen (ml/l)
0 0.25 0.5 0.75 1
4: beam attenuation



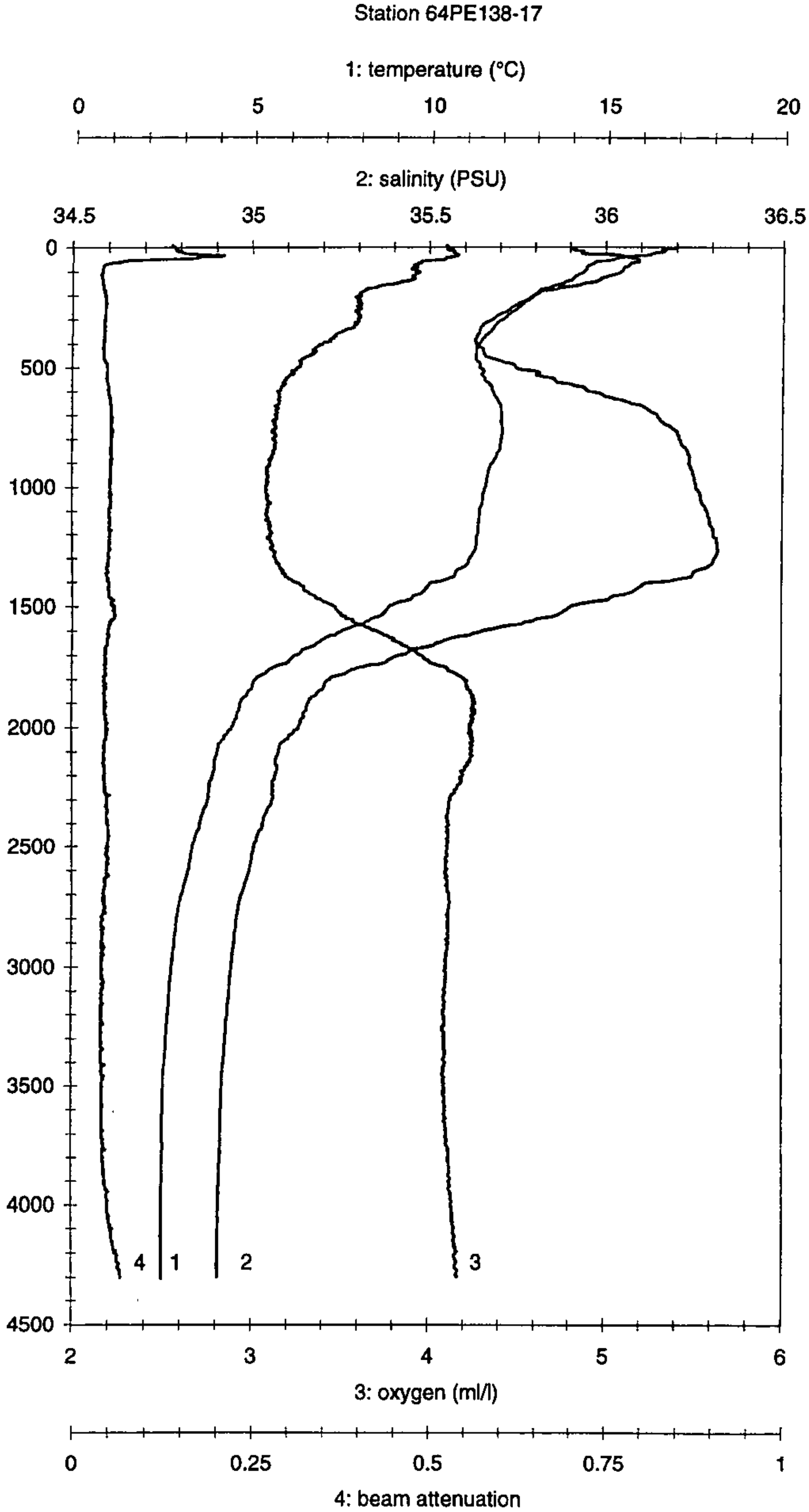
Station 64PE138-13
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
20
40
60
80
100
120
140
4
3
1
2
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation

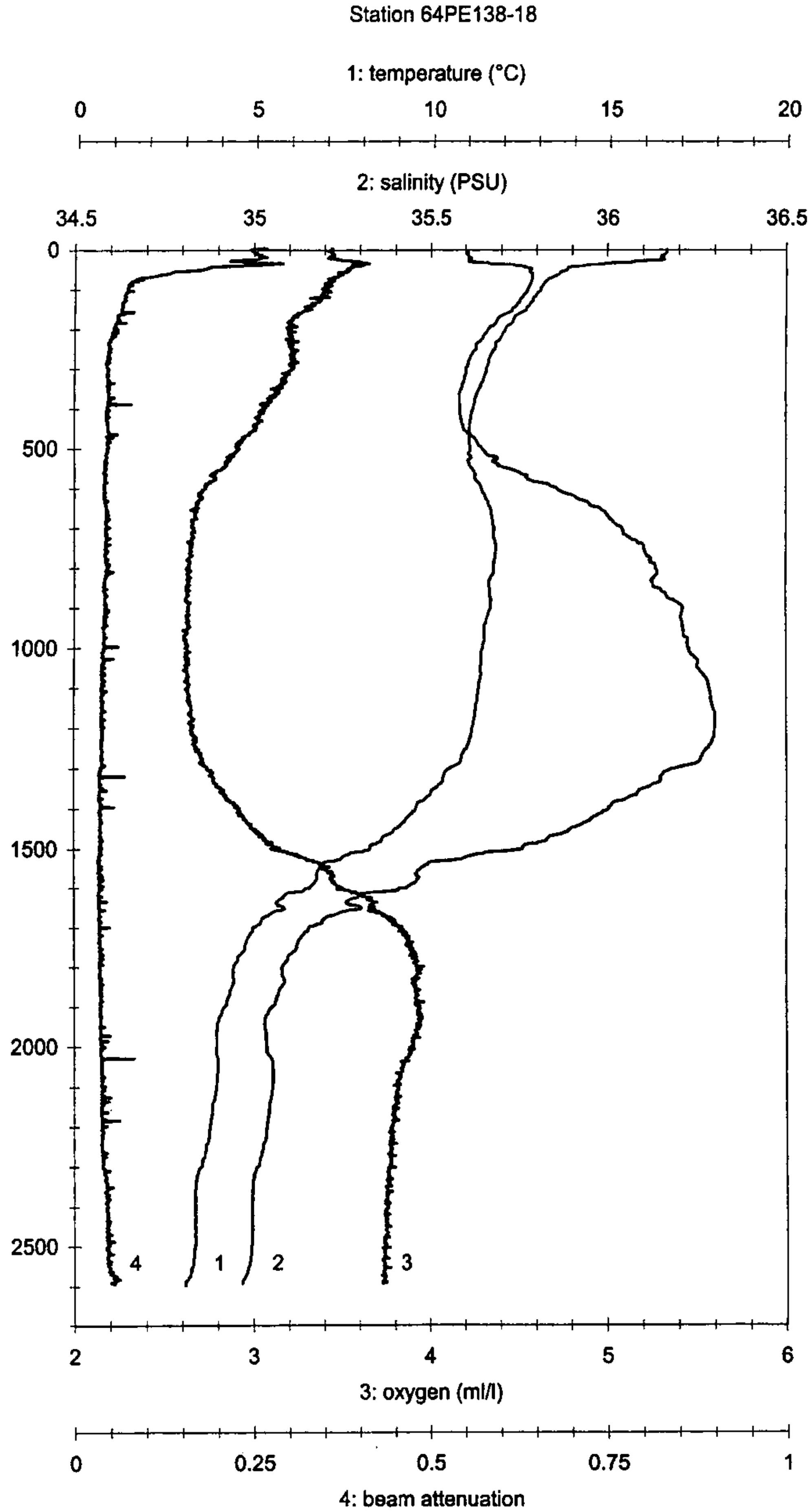

Station 64PE138-14
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
500
1000
1500
2000
2500
3000
1
2
3
4
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation


Station 64PE138-15
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
50
100
150
200
250
300
350
400
4
3
1
2
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation



Station 64PE138-16
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
100
200
300
400
500
600
700
800
900
4
3
1
2
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation


Station 64PE138-17
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
500
1000
1500
2000
2500
3000
3500
4000
4500
4
1
2
3
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation


Station 64PE138-18
1: temperature (°C)
0
5
10
15
20
2: salinity (PSU)
34.5
35
35.5
36
36.5
0
500
1000
1500
2000
2500
4
1
2
3
2
3
4
5
6
3: oxygen (ml/l)
0
0.25
0.5
0.75
1
4: beam attenuation

APPENDIX F
CTD BOTTLE FILES (CALIBRATED)

Station name 64PE138-01
Cast name ROS1
Station/cast 001/01
Date 12 May 1999
Lat N 42°38.05
Long W 009°29.01
Depth (m) 213

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	220.5	12.133	35.686	12.104	27.103		212.9	0.67	0.09	0.02	10.86	4.5
2	219.3	12.180	35.689	12.150	27.096			0.67	0.06	0.01	10.82	4.5
3	218.9	12.179	35.689	12.150	27.096		213.2	0.66	0.09	0.01	10.85	4.5
4	219.1	12.164	35.688	12.135	27.098			0.66	0.11	0.02	10.82	4.5
5	219.3	12.170	35.689	12.141	27.098	35.688		0.66	0.10	0.03	10.74	4.5
6	218.9	12.187	35.690	12.157	27.095			0.66	0.14	0.03	10.75	4.4
7	218.4	12.168	35.689	12.139	27.098							
8	218.6	12.152	35.688	12.123	27.101							
9	217.4	12.179	35.690	12.150	27.096							
10	217.8	12.190	35.690	12.161	27.095							
11	181.3	12.331	35.699	12.307	27.073		213.6					
12	181.6	12.324	35.699	12.299	27.074							
13	181.2	12.330	35.699	12.306	27.073							
14	180.7	12.318	35.698	12.294	27.075							
15	182.0	12.309	35.698	12.285	27.076	35.697		0.63	0.11	0.01	10.20	4.6
16	99.7	12.718	35.721	12.704	27.012	35.719	224.5	0.44	0.11	0.02	7.32	2.8
17	99.6	12.719	35.721	12.705	27.011							
18	99.3	12.719	35.721	12.706	27.011							
19	99.7	12.721	35.721	12.707	27.011							
20	100.2	12.720	35.721	12.706	27.011							
21	99.4	12.719	35.721	12.705	27.011							
22	6.8	14.474	35.691	14.473	26.621	35.691	250.5	0.04	0.14	0.01	0.00	0.4

Station name 64PE138-02
Cast name ROS1
Station/cast 003/02
Date 13 May 1999
Lat N 42°38.18
Long W 009°59.95
Depth (m) 2164

CTD 03

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	2194.9	3.619	35.001	3.438	27.844			1.25	0.12	0.01	18.69	20.5
2	2195.1	3.619	35.001	3.438	27.844			1.26	0.12	0.01	18.59	20.5
3	2195.5	3.622	35.001	3.441	27.844			1.25	0.08	0.00	18.66	20.4
4	2195.3	3.623	35.001	3.442	27.844		249.2	1.24	0.15	0.01	18.57	20.3
5	2195.2	3.623	35.001	3.442	27.844							
6	2195.1	3.620	35.001	3.439	27.844							
7	2195.3	3.614	35.001	3.433	27.845	35.001	249.8	1.25	0.14	0.00	18.64	20.3
8	2027.1	3.748	35.011	3.581	27.838	35.011	249.8	1.23	0.15	0.00	18.45	18.7
9	1517.8	6.542	35.420	6.390	27.833			1.13	0.10	0.00	17.33	12.4
10	1362.9	8.472	35.759	8.318	27.822							
11	1012.1	11.147	36.108	11.015	27.637							
12	1012.4	11.148	36.108	11.016	27.637		178.6	0.94	0.11	0.01	15.29	8.4
13	759.3	11.327	35.923	11.228	27.453		182.3	0.92	0.13	0.00	14.85	7.4
14	504.7	10.957	35.568	10.894	27.238		207.1	0.84	0.13	0.01	13.46	5.5
15	353.4	11.407	35.580	11.362	27.161	35.577	221.4	0.71	0.13	0.00	11.56	4.4
16	298.2	11.632	35.611	11.594	27.142		220.6	0.67	0.13	0.01	10.97	3.9
17	203.7	12.066	35.659	12.039	27.094		223.0	0.59	0.12	0.02	9.67	3.2
18	103.1	12.876	35.761	12.862	27.011		244.2	0.31	0.19	0.02	4.98	1.6
19	102.9	12.877	35.761	12.863	27.011		243.4	0.31	0.05	0.00	4.95	1.6
20	51.4	13.367	35.815	13.360	26.952	35.819	242.6	0.25	0.12	0.03	4.09	1.4
21	26.1	13.512	35.796	13.509	26.906		247.8	0.18	0.82	0.27	1.81	0.9
22	4.8	14.196	35.709	14.195	26.694		255.1	0.03	0.15	0.02	0.00	0.8

Station name	64PE138-02
Cast name	ROS2
Station/cast	003/03
Date	13 May 1999
Lat N	42°38.02
Long W	009°59.99
Depth (m)	2170

C7504

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	2201.5	3.617	35.000	3.436	27.843							
2	2201.1	3.618	35.000	3.436	27.844							
3	2201.7	3.619	35.000	3.437	27.844							
4	2201.4	3.619	35.000	3.437	27.844							
5	2201.3	3.619	35.000	3.437	27.844							
6	2201.2	3.619	35.000	3.437	27.844							
7	1417.2	8.179	35.714	8.021	27.832							
8	1417.2	8.216	35.723	8.058	27.833							
9	1416.8	8.203	35.722	8.045	27.835							
10	1417.3	8.221	35.726	8.062	27.835							
11	1417.2	8.218	35.726	8.060	27.835							
12	1417.1	8.217	35.726	8.059	27.835							
13	1417.4	8.204	35.722	8.046	27.835							
14	1011.1	10.747	36.072	10.618	27.681							
15	1011.5	10.746	36.072	10.617	27.681							
16	1011.1	10.745	36.072	10.616	27.681							
17	1011.6	10.746	36.073	10.617	27.681							
18	1011.5	10.744	36.072	10.615	27.681							
19	1012.1	10.741	36.071	10.612	27.681							
20	484.1	10.994	35.548	10.933	27.215							
21	483.9	10.994	35.548	10.933	27.215							
21	479.6	10.994	35.537	3.511	0.035							

Station name 64PE138-03
Cast name ROS1
Station/cast 004/01
Date 13 May 1999
Lat N 42°37.99
Long W 010°22.05
Depth (m) 2939

CTD05

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (μmol/kg)	PHSPHT (μmol/kg)	NH3 (μmol/kg)	NITRIT (μmol/kg)	NITRAT (μmol/kg)	SILCAT (μmol/kg)
1	2982.9	2.735	34.940	2.491	27.883		242.4	1.40	0.13	0.00	20.81	34.5
2	2982.2	2.735	34.940	2.492	27.883			1.39	0.13	0.00	20.85	34.5
3	2982.5	2.735	34.940	2.492	27.883			1.39	0.13	0.00	20.91	34.4
4	2982.2	2.735	34.940	2.492	27.883	34.939	242.7	1.40	0.13	0.00	20.83	34.5
5	2982.0	2.735	34.940	2.492	27.883			1.38	0.13	0.00	20.78	34.4
6	2535.8	3.162	34.972	2.956	27.867							
7	2026.6	3.783	35.005	3.616	27.830		253.2	1.22	0.13	0.00	18.39	17.4
8	1516.3	5.606	35.244	5.466	27.813		234.3	1.14	0.13	0.00	17.83	12.7
9	1366.5	7.521	35.579	7.376	27.822			1.07	0.12	0.01	17.30	11.6
10	1010.8	9.815	35.846	9.692	27.666			1.00	0.16	0.00	16.55	9.6
11	1011.0	9.816	35.845	9.694	27.665		186.3	1.01	0.15	0.00	16.69	9.6
12	756.2	10.561	35.794	10.467	27.491	35.793	184.3	0.97	0.12	0.01	16.04	8.3
13	505.0	10.989	35.626	10.925	27.278		200.6	0.86	0.09	0.02	14.23	6.1
14	302.7	11.600	35.627	11.561	27.160		218.4	0.68	0.16	0.01	11.43	4.2
15	201.8	12.177	35.683	12.150	27.091	35.680	224.3	0.56	0.14	0.01	9.34	3.3
16	99.5	12.898	35.719	12.884	26.974		244.7	0.28	0.14	0.02	4.52	1.3
17	99.8	12.898	35.720	12.884	26.975			0.28	0.14	0.05	4.42	1.3
18	50.8	13.270	35.713	13.263	26.892	35.713	245.5	0.17	0.37	0.66	1.54	1.0
19	25.0	14.094	35.687	14.091	26.700		250.9	0.06	0.56	0.08	0.10	0.9
20	4.2	14.450	35.673	14.449	26.612		256.4	0.03	0.16	0.00	0.04	0.9

Station name 64PE138-04
Cast name ROS1
Station/cast 014/01
Date 16 May 1999
Lat N 41°59.91
Long W 009°44.03
Depth (m) 2067

C7006

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	2088.3	3.985	35.061	3.809	27.855		246.8	1.22	0.10	0.00	18.85	19.8
2	2088.1	3.984	35.061	3.808	27.855							
3	2088.2	3.986	35.061	3.810	27.855			1.23	0.14	0.00	18.66	19.9
4	2087.6	3.987	35.061	3.810	27.855	35.062	247.4	1.24	0.17	0.00	18.75	19.9
5	2088.1	3.987	35.062	3.810	27.855			1.22	0.09	0.00	18.65	19.7
6	2025.8	3.931	35.043	3.761	27.846			1.17	0.12	0.00	18.13	17.2
7	1669.1	5.893	35.339	5.733	27.855			1.12	0.14	0.00	17.68	13.8
8	1518.9	7.375	35.584	7.214	27.849		214.8	1.08	0.12	0.00	17.12	12.1
9	1010.7	11.096	36.121	10.964	27.656			0.86	0.06	0.00	14.25	7.9
10	1011.0	11.092	36.121	10.960	27.657		180.1	0.94	0.10	0.01	15.33	8.8
11	757.3	11.331	35.966	11.233	27.486		182.8	0.91	0.12	0.00	15.12	7.8
12	505.1	10.952	35.588	10.888	27.254		205.0	0.85	0.11	0.01	14.12	6.0
13	303.2	11.652	35.612	11.612	27.139		227.3	0.64	0.12	0.00	10.62	3.8
14	200.0	12.348	35.694	12.322	27.066		226.7	0.54	0.11	0.00	8.95	3.1
15	102.7	12.944	35.763	12.929	26.999		242.9	0.33	0.07	0.01	5.14	1.5
16	50.5	13.504	35.812	13.497	26.921		243.1	0.22	0.14	0.04	3.42	1.3
17	25.4	15.038	35.760	15.034	26.551		249.8	0.04	0.14	0.15	0.24	0.8
18	25.9	15.056	35.761	15.052	26.548			0.06	0.20	0.19	0.40	0.8
19	6.0	15.147	35.757	15.146	26.524		250.3	0.03	0.12	0.00	0.03	0.8

Station name	64PE138-04
Cast name	ROS2
Station/cast	014/02
Date	16 May 1999
Lat N	41°59.97
Long W	009°43.92
Depth (m)	2067

C7D07

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	2090.7	3.954	35.057	3.778	27.855							
2	2091.1	3.955	35.057	3.778	27.855							
3	2091.6	3.953	35.057	3.777	27.855							
4	2092.0	3.951	35.057	3.775	27.855							
5	2091.8	3.952	35.056	3.775	27.855							
6	2088.9	3.946	35.056	3.770	27.855							
7	2088.9	3.946	35.056	3.770	27.855							
8	1668.6	6.032	35.360	5.870	27.854							
9	1669.7	6.012	35.356	5.850	27.853							
10	1669.7	6.003	35.354	5.841	27.853							
11	1670.5	5.997	35.353	5.835	27.853							
12	1670.6	5.982	35.350	5.821	27.853							
13	1670.2	5.981	35.350	5.819	27.852							
14	1009.6	11.079	36.118	10.948	27.657							
15	1010.1	11.085	36.119	10.954	27.656							
16	1010.0	11.094	36.118	10.963	27.654							
17	1010.3	11.096	36.119	10.964	27.654							
18	1010.0	11.098	36.119	10.966	27.654							
19	1010.2	11.101	36.119	10.969	27.653							
20	1010.4	11.104	36.119	10.973	27.653							
21	504.6	10.994	35.591	10.931	27.249							
22	504.8	10.990	35.591	10.927	27.250							

Station name 64PE138-05
Cast name ROS3
Station/cast 015/04
Date 17 May 1999
Lat N 42°00.02
Long W 010°28.72
Depth (m) 2847

CTD 10

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	2893.3	2.860	34.953	2.623	27.882	34.954	241.2	1.40	0.13	0.00	20.82	33.6
2	2891.6	2.859	34.953	2.623	27.882		241.5	1.40	0.14	0.00	20.80	33.5
3	2891.5	2.859	34.953	2.623	27.882			1.38	0.17	0.00	20.53	33.2
4	2890.9	2.859	34.953	2.623	27.882							
5	2890.3	2.859	34.953	2.623	27.882							
6	2889.9	2.859	34.953	2.622	27.882							
7	2890.6	2.859	34.953	2.622	27.882							
8	2533.8	3.235	34.989	3.027	27.874	34.989	244.9	1.32	0.13	0.00	19.88	27.4
9	2026.4	3.940	35.044	3.770	27.845		248.9	1.21	0.06	0.00	18.51	18.2
10	1519.0	6.540	35.419	6.389	27.833		223.3	1.11	0.11	0.00	17.52	12.2
11	1011.9	11.238	36.169	11.105	27.668		179.7	0.91	0.15	0.00	15.05	8.4
12	1012.4	11.283	36.183	11.150	27.670			0.91	0.16	0.00	15.15	8.4
13	755.6	11.336	35.944	11.237	27.467		183.0	0.92	0.18	0.00	14.98	7.4
14	506.6	11.091	35.578	11.026	27.221		208.4	0.83	0.15	0.00	13.69	5.3
15	506.1	11.091	35.578	11.027	27.221			0.81	0.16	0.00	13.54	5.3
16	303.5	11.846	35.634	11.807	27.119		223.7	0.62	0.10	0.00	10.51	3.6
17	202.7	12.618	35.725	12.590	27.037		225.3	0.51	0.15	0.00	8.52	2.8
18	152.6	13.425	35.845	13.404	26.966			0.32	0.16	0.00	5.14	1.7
19	101.5	13.874	35.895	13.859	26.909		238.3	0.20	0.15	0.02	3.29	1.2
20	50.7	15.008	35.865	15.000	26.640		247.3	0.05	0.14	0.19	0.49	0.9
21	25.3	15.262	35.853	15.258	26.573		248.3	0.01	0.14	0.01	0.01	0.8
22	4.8	15.258	35.854	15.257	26.574		248.0	0.02	0.14	0.00	0.04	0.7

Station name 64PE138-06
Cast name ROS1
Station/cast 018/01
Date 18 May 1999
Lat N 41°52.03
Long W 009°03.95
Depth (m) 113

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	107.7	12.531	35.709	12.517	27.040		210.0	0.60	0.12	0.04	9.56	4.4
2	107.5	12.532	35.709	12.518	27.040	35.710	210.2	0.59	0.13	0.04	9.57	4.3
3	107.6	12.533	35.709	12.518	27.040							
4	107.9	12.533	35.709	12.518	27.040							
5	107.8	12.533	35.709	12.519	27.040							
6	107.9	12.533	35.709	12.518	27.040							
7	108.1	12.533	35.709	12.518	27.040							
8	96.8	12.533	35.710	12.519	27.040							
9	96.7	12.532	35.710	12.519	27.040							
10	96.7	12.531	35.709	12.518	27.040							
11	96.8	12.532	35.709	12.519	27.040							
12	97.1	12.531	35.709	12.518	27.040							
13	79.2	12.730	35.727	12.719	27.014							
14	78.8	12.736	35.728	12.725	27.013							
15	79.5	12.731	35.728	12.720	27.014							
16	79.3	12.733	35.728	12.722	27.014							
17	79.1	12.736	35.729	12.725	27.014							
18	78.8	12.738	35.729	12.727	27.013							
19	49.7	13.159	35.654	13.152	26.869		239.2	0.29	0.16	0.03	4.81	1.7
20	25.1	15.038	35.499	15.034	26.350		251.2	0.04	0.13	0.05	0.18	0.9
21	15.0	15.066	35.460	15.063	26.313							
22	14.9	15.064	35.462	15.062	26.316		256.6	0.04	0.15	0.01	0.13	0.8

Station name 64PE138-07
Cast name ROS1
Station/cast 021/01
Date 19 May 1999
Lat N 41°59.98
Long W 009°28.13
Depth (m) 1298

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	1259.6	10.412	36.109	10.252	27.775		188.2	0.97	0.08	0.00	15.85	9.5
2	1259.4	10.408	36.108	10.249	27.775							
3	1259.4	10.411	36.109	10.252	27.775							
4	1259.8	10.423	36.111	10.264	27.774							
5	1260.1	10.453	36.117	10.293	27.774							
6	1260.7	10.493	36.123	10.332	27.771							
7	1260.3	10.473	36.120	10.313	27.773							
8	1012.3	11.285	36.168	11.152	27.658			0.91	0.14	0.00	15.35	8.4
9	1012.6	11.286	36.169	11.153	27.658							
10	1012.5	11.286	36.169	11.153	27.658							
11	1012.1	11.287	36.169	11.154	27.658							
12	1012.2	11.288	36.169	11.155	27.658	36.169	181.4	0.91	0.10	0.00	15.32	8.4
13	759.3	11.547	36.060	11.447	27.519		182.9	0.90	0.11	0.01	14.90	7.5
14	574.6	11.293	35.785	11.219	27.347							
15	575.2	11.288	35.782	11.214	27.346							
16	575.7	11.288	35.782	11.214	27.346			0.90	0.08	0.00	14.92	6.7
17	575.5	11.284	35.779	11.210	27.344							
18	575.3	11.283	35.778	11.209	27.344		191.9	0.89	0.11	0.00	14.94	6.6
19	575.7	11.283	35.778	11.209	27.344							
20	301.8	11.610	35.617	11.571	27.150		221.8	0.69	0.15	0.01	11.71	4.1
21	200.8	11.987	35.660	11.961	27.110		219.4	0.64	0.09	0.00	10.83	3.7
22	101.6	12.870	35.739	12.856	26.995		234.0	0.39	0.11	0.01	6.50	2.0

Station name 64PE138-12
Cast name ROS1
Station/cast 028/01
Date 22 May 1999
Lat N 39°38.84
Long W 009°14.69
Depth (m) 344

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	342.2	12.274	35.812	12.228	27.176	35.811	206.1	0.71	0.07	0.03	11.53	5.5
2	342.6	12.275	35.812	12.229	27.176			0.70	0.10	0.03	11.36	5.4
3	342.2	12.277	35.811	12.231	27.175							
4	342.3	12.276	35.812	12.230	27.176							
5	343.5	12.251	35.814	12.205	27.182							
6	343.0	12.250	35.813	12.204	27.182							
7	343.4	12.247	35.813	12.201	27.183							
8	302.5	12.368	35.804	12.327	27.151	35.805	207.2	0.69	0.11	0.02	11.24	5.2
9	201.3	12.656	35.805	12.628	27.092							
10	201.9	12.657	35.806	12.630	27.092		209.7	0.63	0.10	0.03	10.33	4.7
11	201.9	12.659	35.806	12.631	27.092							
12	201.7	12.659	35.806	12.631	27.092							
13	201.9	12.660	35.806	12.632	27.092							
14	100.4	13.133	35.816	13.119	27.002		216.5	0.50	0.05	0.02	8.36	3.2
15	50.7	13.557	35.821	13.550	26.917							
16	50.3	13.562	35.820	13.554	26.916		222.3	0.40	0.09	0.09	6.36	2.2
17	50.9	13.558	35.822	13.550	26.917							
18	50.8	13.563	35.820	13.556	26.915							
19	50.7	13.563	35.820	13.556	26.915							
20	50.9	13.563	35.820	13.556	26.915							
21	25.0	14.731	35.739	14.727	26.602		240.8	0.17	0.24	0.14	2.36	1.2
22	5.6	16.255	35.626	16.254	26.172		254.4	0.02	0.12	0.00	0.07	0.6

Station name 64PE138-13
Cast name ROS1
Station/cast 029/01 C7014
Date 22 May 1999
Lat N 39°38.52
Long W 009°20.07
Depth (m) 138

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	130.9	12.809	35.804	12.791	27.059		208.9	0.62	0.15	0.06	10.06	4.3
2	131.0	12.814	35.805	12.796	27.058	35.804		0.61	0.12	0.05	10.05	4.3
3	131.0	12.815	35.805	12.797	27.058							
4	131.2	12.799	35.804	12.781	27.061							
5	131.4	12.799	35.804	12.781	27.061							
6	131.5	12.783	35.804	12.765	27.064							
7	130.8	12.789	35.804	12.771	27.063							
8	114.6	12.855	35.809	12.840	27.053		207.7	0.62	0.10	0.04	10.00	4.5
9	114.7	12.853	35.808	12.838	27.053							
10	114.8	12.890	35.809	12.874	27.046							
11	114.4	12.876	35.810	12.860	27.049							
12	102.0	13.043	35.817	13.029	27.021		207.7	0.58	0.10	0.03	9.62	4.3
13	52.1	13.565	35.782	13.558	26.885							
14	51.7	13.563	35.782	13.555	26.886		221.0	0.41	0.15	0.08	6.52	1.7
15	51.9	13.585	35.780	13.577	26.880							
16	52.1	13.591	35.781	13.584	26.879							
17	51.7	13.603	35.780	13.596	26.876							
18	52.0	13.610	35.780	13.603	26.874							
19	25.2	16.401	35.654	16.397	26.159		248.7	0.03	0.22	0.01	0.30	0.3
20	6.4	16.767	35.639	16.766	26.062		248.3	0.01	0.16	0.00	0.11	0.2

Station name 64PE138-14
Cast name ROS1
Station/cast 035/01
Date 25 May 1999
Lat N 39°30.75
Long W 009°50.03
Depth (m) 3128

CTD 17

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	3197.9	2.647	34.932	2.384	27.885							
2	3198.0	2.647	34.932	2.383	27.885							
3	3197.7	2.647	34.932	2.383	27.885		242.9	1.43	0.09	0.00	21.25	38.4
4	3197.6	2.647	34.932	2.383	27.885			1.42	0.10	0.00	21.32	38.2
5	3197.9	2.647	34.932	2.383	27.885							
6	3197.5	2.647	34.932	2.383	27.885							
7	3197.5	2.647	34.932	2.383	27.885							
8	3197.2	2.646	34.932	2.382	27.885							
9	3043.9	2.763	34.945	2.513	27.885							
10	2534.4	3.318	35.009	3.109	27.882		238.7	1.29	0.10	0.01	19.60	26.8
11	2019.5	4.499	35.154	4.322	27.875		240.9	1.21	0.13	0.00	18.53	19.1
12	1516.5	8.519	35.834	8.346	27.876		203.9	1.01	0.10	0.00	16.34	11.9
13	1007.6	11.466	36.235	11.332	27.677							
14	1007.7	11.470	36.233	11.336	27.674			0.87	0.12	0.00	14.66	8.3
15	753.2	11.975	36.173	11.874	27.526		184.3	0.80	0.09	0.00	13.69	7.0
16	497.2	11.506	35.783	11.442	27.304		189.5	0.86	0.08	0.00	14.51	6.4
17	302.1	12.025	35.673	11.985	27.116		211.9	0.68	0.03	0.01	11.52	4.1
18	201.4	12.759	35.760	12.731	27.037		215.1	0.56	0.06	0.01	9.65	3.3
19	201.5	12.776	35.762	12.748	27.035			0.55	0.14	0.01	9.45	3.2
20	101.4	14.034	35.961	14.019	26.927		232.9	0.25	0.09	0.01	4.20	1.6
21	51.7	14.597	35.999	14.589	26.833		238.4	0.11	0.12	0.03	1.77	1.2
22	25.0	15.921	35.854	15.917	26.425		247.2	0.02	0.12	0.00	0.04	0.8

Station name 64PE138-15
Cast name ROS1
Station/cast 033/01
Date 24 May 1999
Lat N 39°34.99
Long W 009°36.43
Depth (m) 390

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	390.2	11.657	35.715	11.606	27.221	35.715	199.8	0.82	0.10	0.00	13.67	5.5
2	390.0	11.656	35.716	11.605	27.221		199.8	0.82	0.10	0.00	13.68	5.5
3	390.1	11.655	35.716	11.604	27.222							
4	390.0	11.655	35.716	11.604	27.222							
5	391.0	11.655	35.716	11.604	27.222							
6	391.8	11.654	35.717	11.603	27.222							
7	391.8	11.655	35.716	11.604	27.222							
8	303.2	11.817	35.687	11.777	27.166	35.686	202.5	0.78	0.10	0.00	13.16	5.0
9	303.3	11.817	35.687	11.777	27.166							
10	303.7	11.817	35.687	11.778	27.166							
11	304.5	11.820	35.687	11.780	27.166							
12	304.7	11.822	35.687	11.782	27.165							
13	201.6	12.445	35.746	12.418	27.088		210.0	0.66	0.09	0.00	11.05	4.1
14	167.8	12.866	35.796	12.843	27.042							
15	168.2	12.867	35.797	12.844	27.042		214.3	0.56	0.08	0.01	9.25	3.6
16	167.9	12.869	35.797	12.846	27.042							
17	168.5	12.872	35.797	12.848	27.042							
18	168.4	12.873	35.797	12.850	27.042							
19	168.3	12.873	35.797	12.850	27.042							
20	100.7	13.662	35.862	13.647	26.928		229.5	0.34	0.10	0.01	5.57	1.9
21	52.8	14.212	35.850	14.205	26.802		238.7	0.18	0.07	0.07	2.86	1.2
22	25.1	15.293	35.802	15.289	26.527		249.5	0.05	0.12	0.03	0.51	

Station name 64PE138-16
Cast name ROS1
Station/cast 034/01
Date 24 May 1999
Lat N 39°35.73
Long W 009°24.24
Depth (m) 893

CTD 16

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	895.3	11.134	36.093	11.018	27.624	36.092	189.9	0.88	0.18	0.01	14.50	9.1
2	894.9	11.138	36.093	11.021	27.623		189.1	0.86	0.18	0.02	14.49	9.1
3	894.9	11.135	36.093	11.019	27.624							
4	895.3	11.135	36.093	11.019	27.624							
5	895.9	11.136	36.093	11.019	27.624							
6	895.5	11.134	36.093	11.018	27.624							
7	896.0	11.132	36.093	11.015	27.625							
8	757.2	11.416	36.059	11.317	27.542		190.8	0.84	0.15	0.02	14.03	8.4
9	504.1	11.771	35.887	11.704	27.336		199.3	0.77	0.15	0.01	12.81	6.7
10	320.4	11.988	35.747	11.946	27.181	35.748	205.7	0.73	0.13	0.02	12.26	5.3
11	320.2	11.987	35.748	11.944	27.181							
12	320.2	11.989	35.747	11.946	27.181							
13	320.5	11.983	35.747	11.940	27.182							
14	319.8	11.991	35.747	11.948	27.180							
15	201.9	12.079	35.711	12.053	27.132							
16	202.1	12.081	35.711	12.055	27.132							
17	202.4	12.081	35.711	12.054	27.132		202.3	0.71	0.19	0.01	12.17	4.7
18	129.0	12.771	35.800	12.753	27.063							
19	99.4	13.088	35.819	13.074	27.013		208.1	0.57	0.13	0.03	9.26	4.6
20	51.0	13.346	35.770	13.339	26.921			0.43	0.15	0.05	7.19	2.2
21	25.8	15.067	35.720	15.063	26.514		244.9	0.11	0.12	0.08	1.66	0.9
22	6.2	17.053	35.624	17.052	25.982		250.3	0.02	0.17	0.01	0.03	0.4

Station name 64PE138-17
Cast name ROS1
Station/cast 040/01
Date 26 May 1999
Lat N 39°34.76
Long W 010°12.45
Depth (m) 4195

GT018

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	4299.1	2.495	34.904	2.112	27.886							
2	4297.8	2.494	34.905	2.111	27.886	34.904	241.8	1.48	0.16	0.00	22.14	43.4
3	4297.9	2.494	34.905	2.111	27.886		243.3	1.49	0.17	0.01	22.10	43.5
4	4298.0	2.494	34.905	2.111	27.886			1.50	0.09	0.01	22.07	43.5
5	4297.7	2.494	34.905	2.111	27.886							
6	4297.8	2.494	34.905	2.111	27.886							
7	4297.7	2.495	34.905	2.112	27.886							
8	4069.9	2.486	34.907	2.130	27.886			1.48	0.06	0.00	22.06	43.1
9	3554.3	2.534	34.917	2.234	27.886	34.918	245.1	1.45	0.12	0.00	21.75	40.6
10	3045.2	2.756	34.943	2.506	27.884							
11	2535.4	3.330	35.007	3.120	27.880		245.0	1.33	0.12	0.01	20.02	27.6
12	2026.1	4.340	35.121	4.164	27.865		244.7	1.21	0.09	0.00	18.62	18.1
13	1519.0	9.113	35.942	8.933	27.867		200.3	1.00	0.07	0.00	16.25	11.2
14	1009.5	11.551	36.270	11.416	27.688		182.3	0.84	0.14	0.01	14.24	7.9
15	755.3	12.063	36.217	11.960	27.543							
16	756.6	12.072	36.216	11.970	27.540			0.80	0.11	0.00	13.46	6.8
17	502.8	11.549	35.807	11.484	27.315		191.9	0.85	0.10	0.00	14.31	6.2
18	301.0	12.009	35.663	11.969	27.111							
19	300.1	12.018	35.665	11.978	27.110			0.69	0.13	0.01	11.79	4.0
20	204.8	13.046	35.801	13.017	27.011		211.1	0.57	0.10	0.01	9.59	3.1
21	101.5	14.492	36.053	14.477	26.899		231.4	0.24	0.10	0.00	3.97	1.4
22	50.6	15.184	36.093	15.176	26.776		242.4	0.06	0.13	0.04	0.78	0.9

Station name 64PE138-18
Cast name ROS2
Station/cast 043/02
Date 27 May 1999
Lat N 40°59.99
Long W 009°44.97
Depth (m) 2530

BTLNBR (#)	CTDPRS (dbar)	CTDTMP (its-90)	CTDSAL (pss-78)	THETA (its-90)	GAMMA (kg/m^3)	SALINITY (pss-78)	OXYGEN (µmol/kg)	PHSPHT (µmol/kg)	NH3 (µmol/kg)	NITRIT (µmol/kg)	NITRAT (µmol/kg)	SILCAT (µmol/kg)
1	2591.5	3.110	34.981	2.898	27.879	34.981	246.6	1.35	0.12	0.01	20.31	30.2
2	2591.4	3.107	34.980	2.896	27.879			1.35	0.13	0.00	20.36	30.2
3	2590.2	3.101	34.980	2.890	27.879							
4	2499.8	3.339	35.004	3.132	27.876	35.007	247.4	1.31	0.13	0.01	19.86	27.3
5	2500.4	3.339	35.004	3.132	27.876		247.3	1.32	0.13	0.00	19.86	27.2
6	2501.1	3.343	35.004	3.136	27.876							
7	1999.4	3.968	35.050	3.801	27.846		252.5	1.21	0.13	0.00	18.48	18.3
8	1999.7	3.969	35.049	3.801	27.846		252.5	1.20	0.10	0.00	18.44	18.3
9	1999.7	3.968	35.049	3.801	27.846							
10	1401.1	9.593	36.016	9.423	27.844		197.2	0.97	0.09	0.01	16.03	10.5
11	1401.3	9.592	36.016	9.421	27.845		197.2	0.97	0.13	0.00	15.96	10.5
12	1401.4	9.614	36.021	9.443	27.845			0.97	0.10	0.00	15.95	10.5
13	1100.4	11.389	36.295	11.243	27.740		183.2	0.87	0.08	0.00	14.79	8.6
14	1100.8	11.398	36.293	11.252	27.737		183.1	0.88	0.09	0.01	14.74	8.6
15	1101.0	11.399	36.293	11.253	27.737			0.88	0.06	0.00	14.81	8.5
16	451.3	11.119	35.634	11.062	27.258		203.2	0.85	0.09	0.00	14.28	6.0
17	451.1	11.119	35.634	11.062	27.259			0.85	0.08	0.00	14.27	6.0
18	451.3	11.119	35.634	11.062	27.259		203.6	0.84	0.09	0.01	14.05	5.9
19	59.6	13.830	35.786	13.821	26.833		249.0	0.14	0.09	0.09	1.80	1.0
20	50.3	13.878	35.785	13.870	26.822		250.0	0.12	0.11	0.10	1.46	1.0
21	50.4	13.927	35.781	13.920	26.809		250.2	0.11	0.12	0.09	1.42	1.0
22	50.2	13.923	35.782	13.916	26.810			0.12	0.12	0.10	1.39	1.1