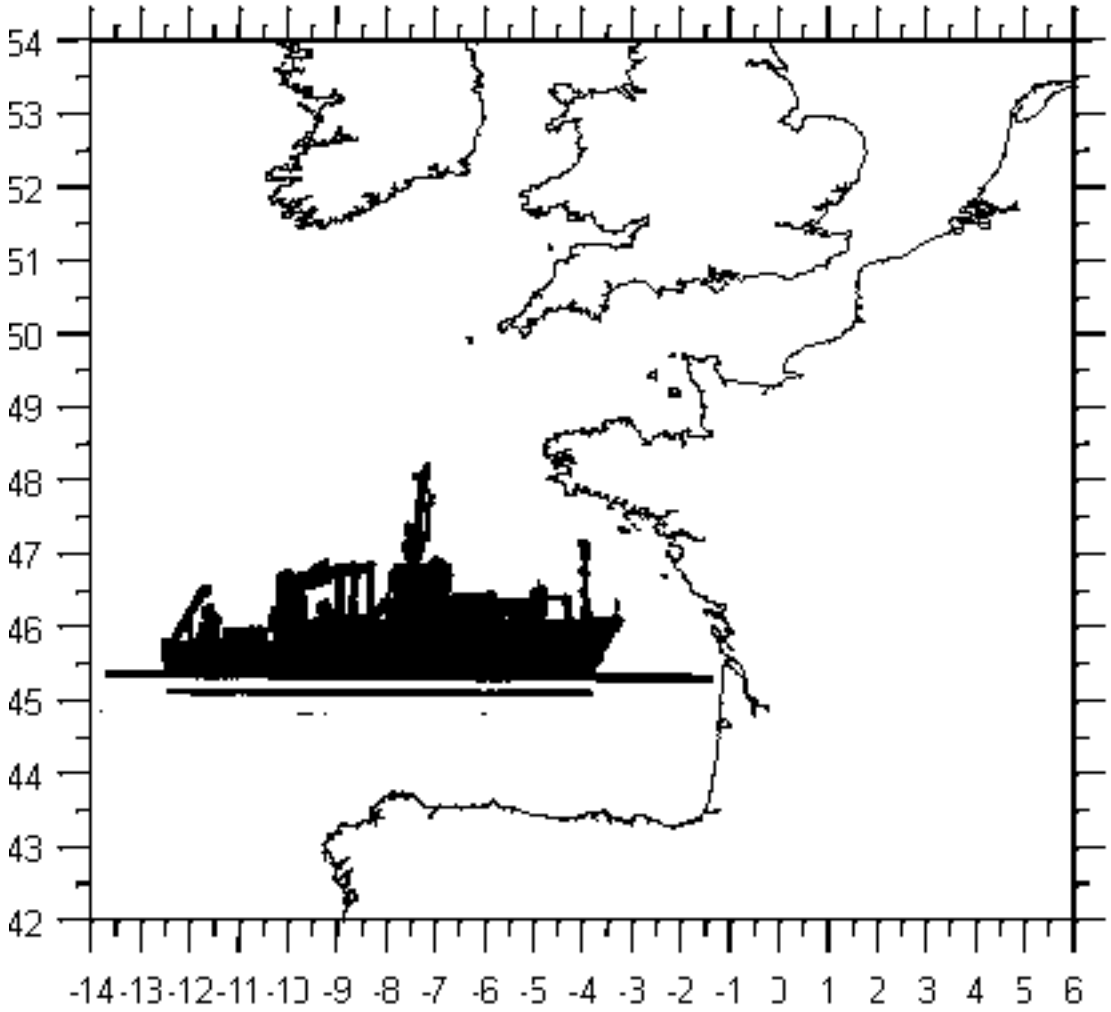
RV Pelagia Shipboard Report:

Cruise 64PE110, Project TripleB,

WHP repeat area AR12

H.M. van Aken
Chief Scientist



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1 Cruise Narrative

1.1 Highlights

a: WOCE Repeat Area AR12, RV Pelagia cruise PE110 in the Bay of Biscay

b: Expedition Designation (EXPOCODE): 64PE110

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d: Ship: RV Pelagia, Call Sign: PGRQ
length 66 m.
beam 12.8 m
draft 4 m
maximum speed 12.5 knots

e: Ports of Call: Texel (the Netherlands) to Texel (the Netherlands)

f: Cruise dates: August 8, 1997 to August 29, 1997

1.2 Cruise Summary Information

Summary

Early before noon of 8 August RV Pelagia left port in Texel, and headed for the Bay of Biscay. At 10 August a CTD test station was performed. We arrived at the Biscay continental slope near mooring BB13 late that day, and spent the night carrying out a echo sounder survey over the slope. The following day moorings BB17 to BB20 were recovered, and course was set to mooring BB10. On 12 August, after a nightly echo sounder survey, moorings BB10 to BB12 were recovered, and a CTD cast near mooring 12 was performed. On 13 and 14 August a CTD section from 46°N towards the continental slope near Gijón was surveyed (section A). On 15 August, after a nightly echo sounder survey, moorings BB21 to BB24 were deployed. Hereafter course was set to the Meriadzek Plateau, were on 17 August moorings BB17 to BB20 were deployed. Then RV Pelagia headed to the area west of Finisterre where late in the evening of 18 August the CTD survey of section B was started. After finishing section B, sections C, D, and E were surveyed in order to fill in geographical data gap in the surveys of the preceding years. Finally sections F and G across the French continental slope were surveyed; a re-survey of sections, from which hydrographic measurements were obtained in 1993, 1995, and 1996. During the hydrographic survey a total of 5 ARGOS surface drifters was deployed. At Tuesday 26 August the observations in the Bay of Biscay were ended, and RV Pelagia arrived back in Texel on Friday 29 August.

Cruise Track

The cruise was carried out in the Bay of Biscay and west of NW Spain east of 12°30'W. The cruise track is shown in figure 1.

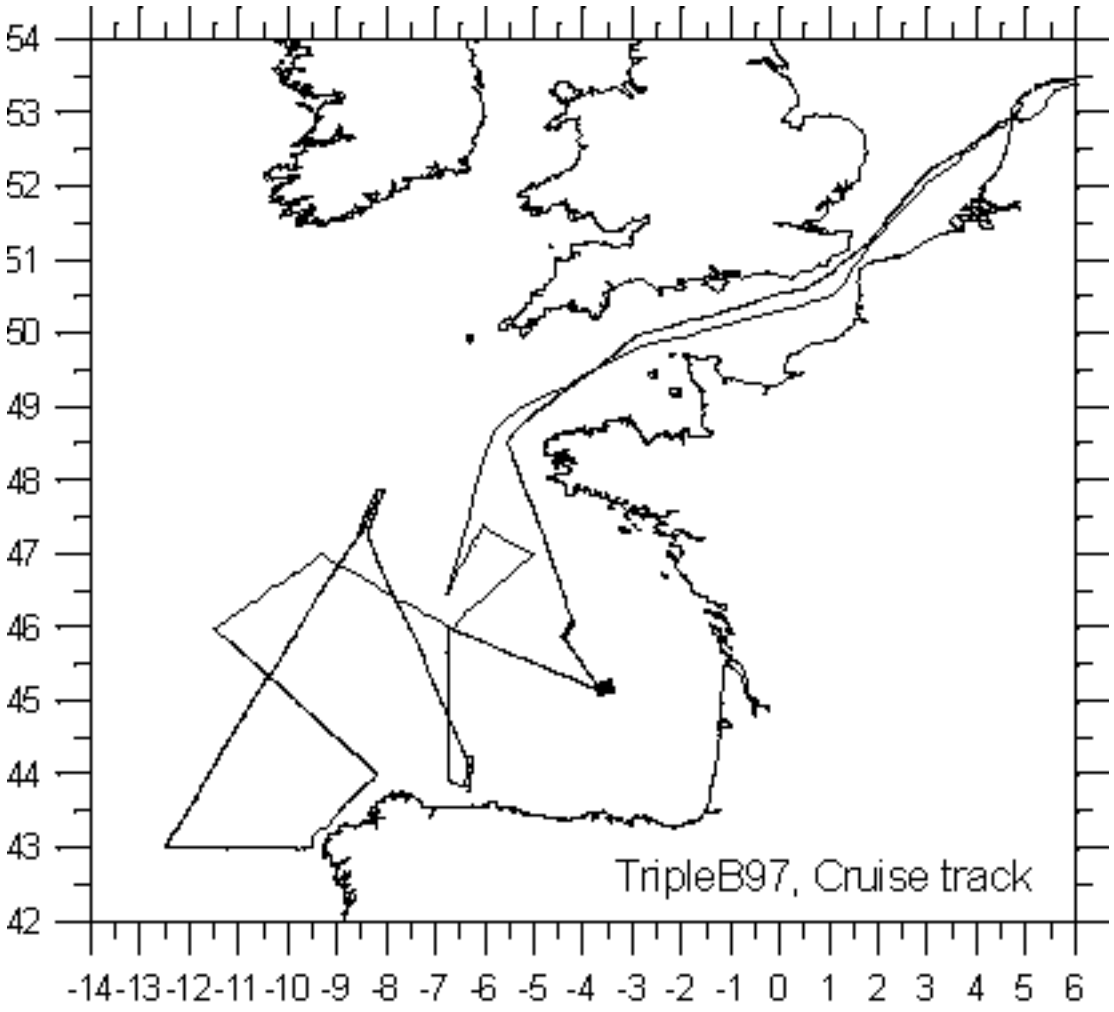


Figure 1. Cruise track of RV Pelagia cruise 64PE110

Number of Hydrographic Stations

A total of 64 CTD casts was recorded. On 55 of these casts, water samples were taken for the determinations of salinity and dissolved oxygen. Three water samplers in the rosette system were fitted with reversing electronic thermometers and pressure sensors. The positions of the hydrographic stations is indicated in figure 2.

At the hydrographic stations the SBE9/11+ CTD was lowered with a speed of about 1 m/s. Due to the use of a bottom indicator switch we were able to sample to within quite a short distance from the bottom (5 m).

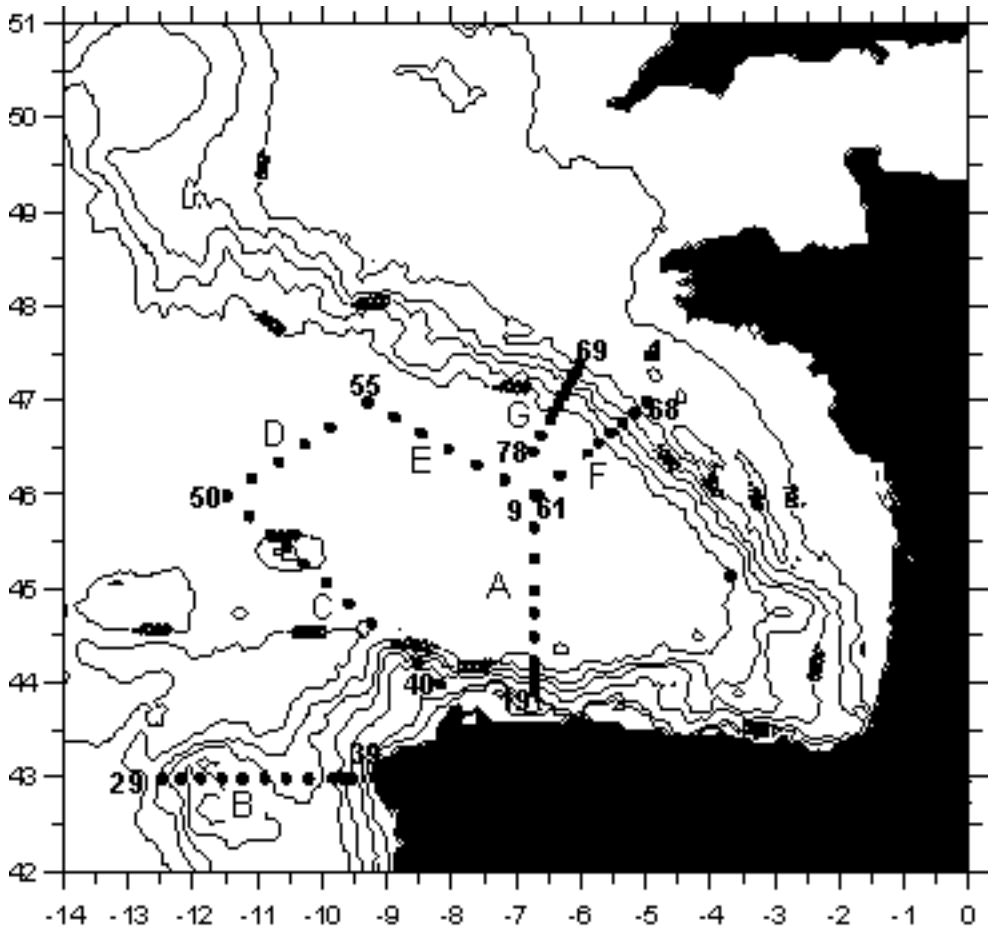


Figure 2. Distribution of hydrographic stations and sections.

Hydrographic Sampling

During the up-cast of each CTD/rosette station water up to 13 samples were taken at regular depth intervals. The samples were analysed for salinity. Only on sections B and F also the dissolved oxygen content of the samples was determined. Three water samplers were fitted with reversing electronic thermometers and pressure sensors.

The vertical distribution of the sampling locations is indicated in figure 3.

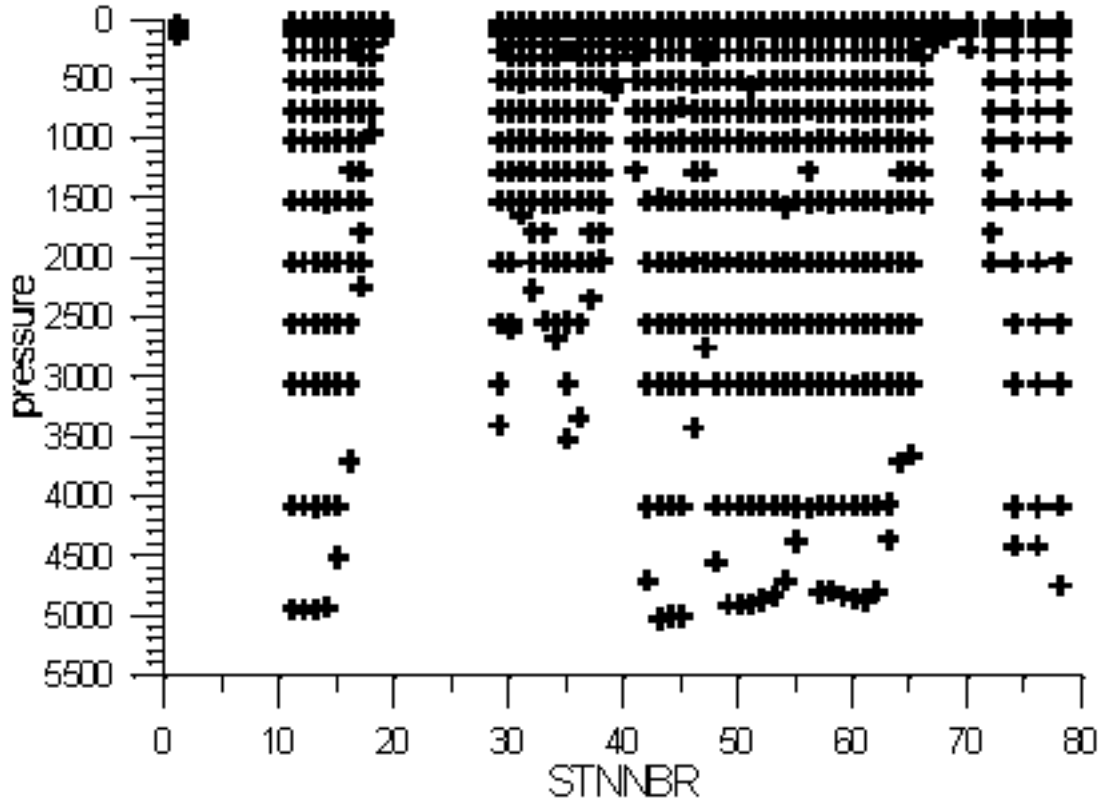


Figure 3. Vertical distribution of the water samples versus station number.

Moorings

The moorings BB10 to BB16, deployed in 1996, were recovered without problems. Two Aanderaa RCM 8 current meters had leaked and contained only about a week of data. All other Aanderaa current meters contained at least over a year of data. The NBA current meters, as expected, all had encountered battery failure after about 6 months, which caused the data recording to stop. One NBA current meter showed a bit error in the direction. This effectively reduced the resolution of the current direction to 22 degrees.

After recovery of the current meters, their data were read and copied to the computer network of RV Pelagia. The data were pre-processed, and corrected for the magnetic variation. From the pre-processed data a low-pass data set, sub-sampled every 12 hours, as well as a high-pass data set, sub-sampled every hour were produced.

After servicing the current meters, moorings BB17 to BB24 were deployed, BB17 to BB20 over the continental slope near the Meriadzek Plateau, moorings BB21 to BB24 over the continental slope north-west of Gijón.

ARGOS drifters

During the cruise five ARGOS drifters were deployed. The drifters used were standard spherical WOCE/TOGA mixed layer drifters (diameter 30 cm), fitted with a holey sock drogue at 15 m. The drogues had a length of 7 m, and a diameter of 1 m. The ARGOS ptt numbers of the drifters are 12416 to 12420.

The positions of the drifter and mooring deployments are indicated in figure 4.

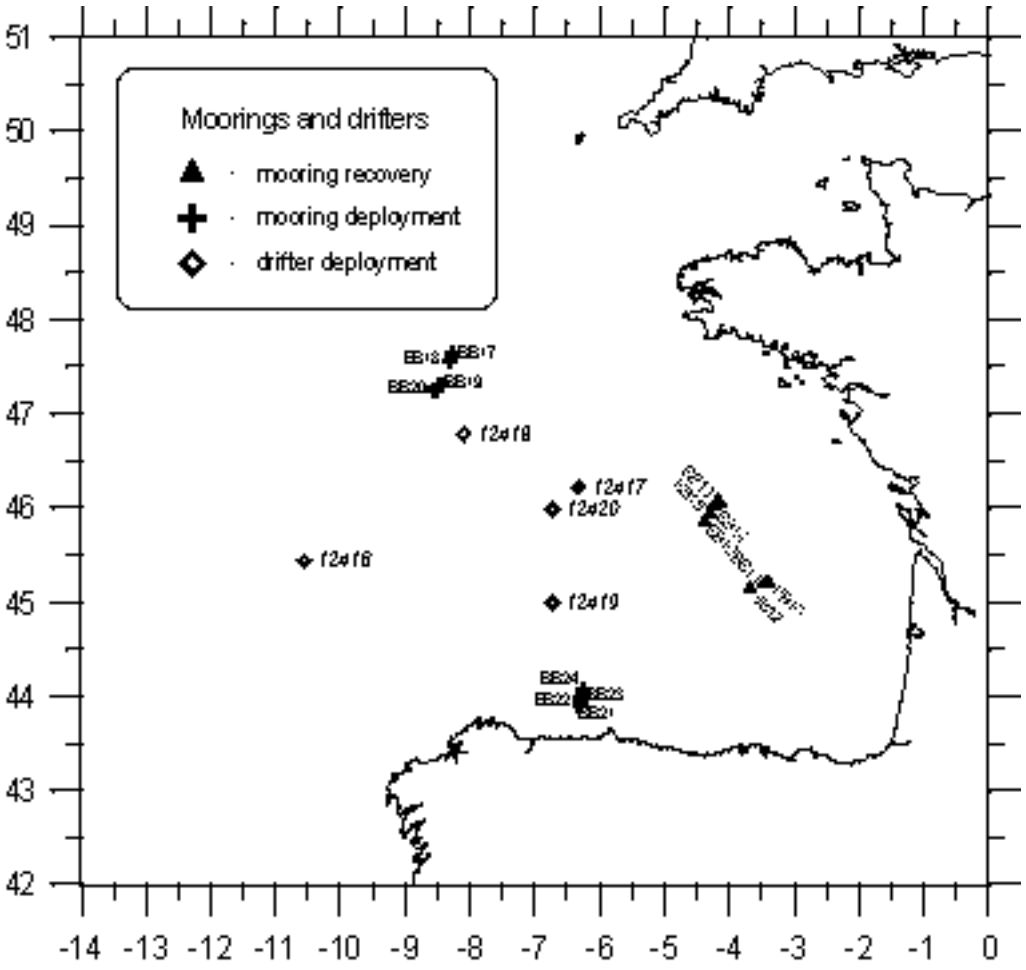


Figure 4. Positions of moorings and drifter deployments.

*.SUM file

The preliminary 64PE110.SUM file describing all stations has been submitted to WHPO.

1.3 List of Principal Investigators

Name	Responsibility	Affiliation
Dr. H.M. van Aken	Ocean hydrography, ARGOS drifters	NIOZ/Texel
Ing. S. Ober	CTD & rosette-technology	NIOZ/Texel
Drs. C. Veth	Current measurements	NIOZ/Texel

1.4 Scientific Programme and Methods

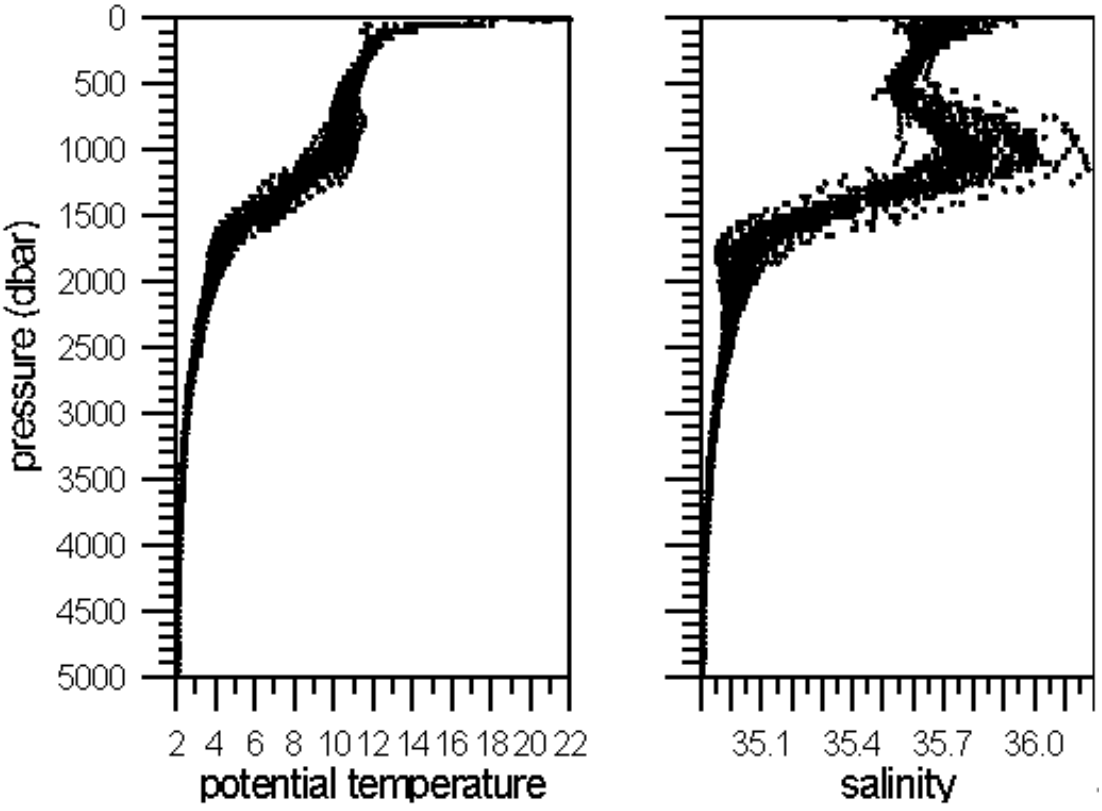
The goal of the research carried out during the cruise was to establish the structure, course and transport of the eastern boundary current in the Bay of Biscay, as well as the hydrographic structure of the Bay of Biscay and the nearby eastern North Atlantic, as it is affected by the eastern boundary current. For this purpose a hydrographic survey has been carried out in the Bay of Biscay up to 12_30'W, eight long term current meter moorings and five ARGOS surface drifters have been deployed. Seven long term current meter moorings, deployed in 1996, were recovered. The hydrographic survey covers part of the WOCE Hydrographic Research Programme repeat area AR12, and complements the hydrographic surveys, carried out in 1995 and 1996 in the Bay of Biscay in the TripleB programme.

The CTD-rosette frame was weighted in order to secure a fast enough falling rate. This package was lowered with a velocity of about 1 m/s, except in the lowest 100 m, where the veering velocity was reduced. Measurements during the down-cast went on to within 5 m from the bottom, until the bottom switch indicated the proximity of the bottom. During the up-cast water samples where taken at prescribed depths, when the CTD winch was stopped. After each cast the CTD/rosette frame was placed on deck. Subsequently water samples were drawn for the determination of dissolved oxygen and salinity, and the readings of the reversing electronic thermometers and pressure sensor were recorded.

A secondary goal in the programme was the testing of a multi-valve rosette system, developed at NIOZ, as well as the testing of newly acquired oxygen and transmissometer sensors, as well as newly acquired reversing electronic thermometers and pressure sensors.

Preliminary Results

At the end of the cruise the data are available in raw form, without final calibration and proper CTD processing. Oxygen is still in volumetric concentrations and should be transformed into densimetric concentrations and corrected for sea water blanks. However already from these raw data, presented in figures 5 to 7, some insight can be gained of the hydrographic situation in the Bay of Biscay during the cruise.



Fig**ure 5.** Vertical distribution of potential temperature and salinity from all CTD casts, sub-sampled every 50 dbar.

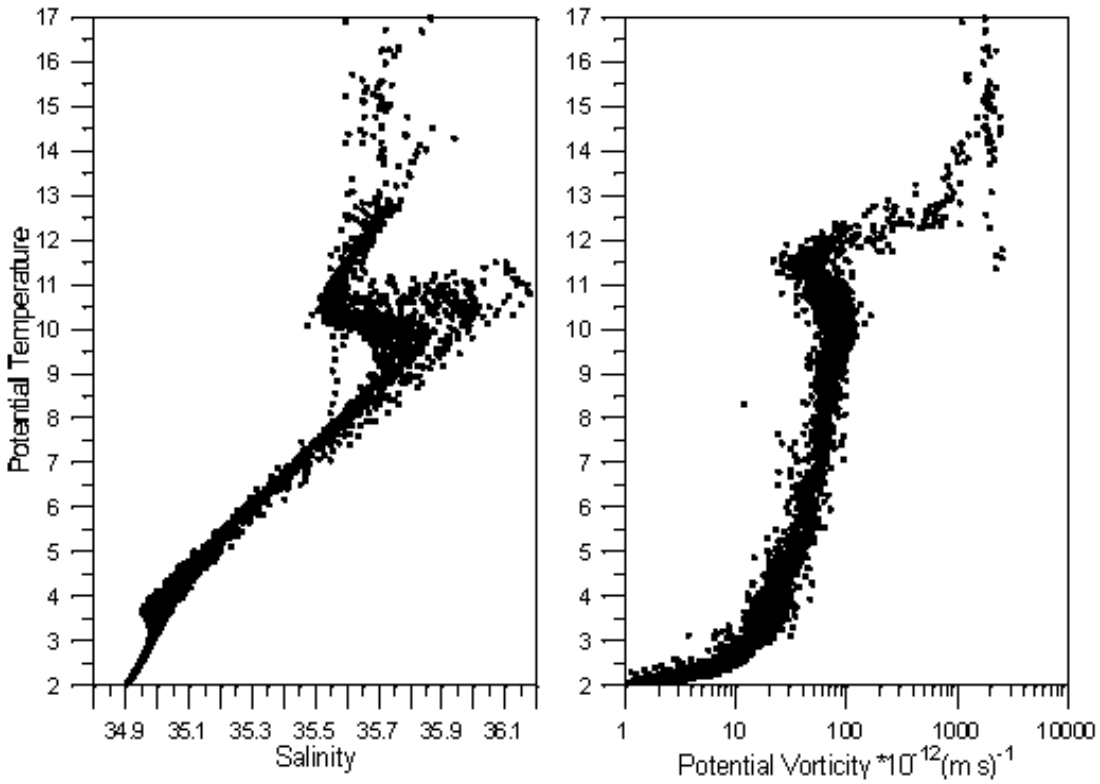


Figure 6. Diagrams of salinity and potential vorticity versus potential temperature. The data are from all CTD casts, sub-sampled every 50 dbar.

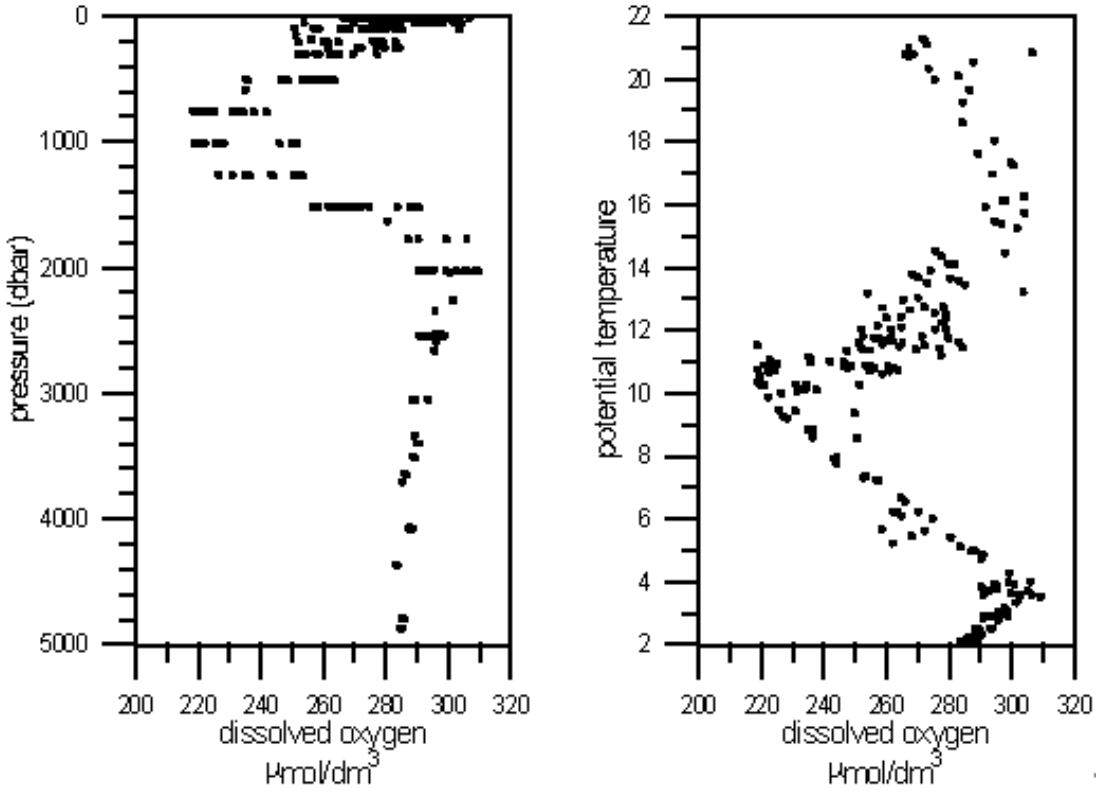


Figure 7. Plots of the dissolved oxygen concentration versus the pressure, and versus the potential temperature.

1.5 Major Problems Encountered during the Cruise

The newly developed multi-valve rosette system was tested on stations 1, 8, 9 and 10. Initially the system functioned quite well, but at pressures over 2000 dbar at station 8 the closing of the samplers failed, whereas at stations 9 and 10 the closing of the samplers was a complete failure. Thereupon it was decided to switch the CTD to the G.O. rosette rack. On later stations the multi-valve was also mounted in that rack in order to perform tests to find out what caused the problems. Slight modifications were made in the multi-valve, and at the end of the cruise the performance of the system was considered to be satisfactory.

Both the newly acquired oxygen sensor and transmissometer gave erroneous values. Contacts will be established with the manufactures in order to improve the sensors.

After recovery of moorings BB10 to BB16 it appeared that five of the radio beacons and flashlights, mounted on the beacon float had leaked. Only one could be repaired. It was decided to switch spare parts from the faulty flashlight to the faulty radio beacons, so that all moorings BB17 to BB24 could be fitted with at least a radio beacon.

During the deployment of mooring BB17 the ARGOS SMM transmitter in the frame on top of the ADCP was torn loose, and lost into the sea.

Halfway the cruise the shipboard computer TRITON had a disk crash. This computer acted as e-mail server, and because of its failure further e-mail contacts with the shore was inhibited. Also, because of this computer failure, direct access to the data from the continuous logging system was denied. Only after return to Texel, these data will be available.

The ITI temperature sensor in the ABC underway logging system showed erroneous values in is in need of repair. The meteorological sensors for air temperature, humidity and air pressure gave completely unreliable values and should be replaced.

1.6 Lists of Cruise Participants

Scientific crew

Person	Responsibility	Institute
H.M. van Aken	Chief Scientist, ARGOS drifters, Data Management	NIOZ
J.P.J.. Berkhout	Hydro Watch, Oxygen Determination	IMAU
J. Blom	Mooring Operations, Technical Assistance	NIOZ
R.L. Groenewegen	Computer Network, Acoustic Releases, Electronics	NIOZ
M. Hiehle	Hydro-Watch, Salinity Determination, Data Management	NIOZ
M.T.J. Hillebrand	Current meters, Hydro Watch	NIOZ
M. Manuels	Oxygen Determination, Current Meters	NIOZ
S. Ober	CTD system, Thermometry, ADCP	NIOZ
W. Polman	Mooring Operations, Technical Assistance	NIOZ
L. de Streur	Hydro-Watch, Salinity Determination	IMAU
G.M. Terra	Hydro-Watch, Salinity Determination	IMAU
E. Tuenter	Hydro-Watch, current meters	IMAU
C. Veth	Current Meters, Hydro Watch	NIOZ
M. Walgreen	Hydro-Watch, Salinity Determination	IMAU

NIOZ: Netherlands Institute for Sea Research, Texel

IMAU: Institute for Marine and Atmospheric Research, Utrecht University

Ships crew

J. Groot	captain
M.D. van Duijn	first mate
P. van Erve	second mate
J. Seepma	first engineer
J. Kalf	second engineer
G. Steenhuizen	cook
P.-W. Saalmink	ships technician
R. van der Heide	ships technician
S. Kuiper	ships technician

2 Underway Measurements

2.1 Navigation

RV Pelagia has several different navigational systems. We used the Differential GPS receiver for the determination of the position. The data from this receiver were recorded every ten seconds in the ABC data logging system. After removal of a few spikes these data were sub-sampled every minute.

2.2 Echo Sounding

The 3.5 kHz echo sounder as well as the navigational Furuno echo sounder were used on board to determine the water depth. The uncorrected depths from these echo sounders were recorded in the ABC data logging system. Over the steepest parts of the continental slope the depth digitizer of the 3.5 KC echo sounder was occasionally not able to find a reliable depth. The maximum range of the Furuno echo sounder to obtain reliable results was about 800 m.

Near the positions of the recovered current meter moorings on the continental slope additional echo sounder surveys were carried out to determine the topography of the deployment locations. Preceding the deployment of the current meter moorings one 2 to 5 lines were surveyed to determine the deployment sites, which were bound to pre-determined depth ranges.

2.3 Thermo-Salinograph Measurements

The Sea Surface Temperature, Salinity, and dissolved Oxygen concentration were measured continuously with an AQUAFLOW thermo-salinograph with the water intake at a depth of about 3 m. The primary temperature sensor, mounted near the water inlet, showed an increasing unreliable behaviour during the cruise. From data from the first five days however it appeared that the secondary thermometer in the AQUAFLOW system gave

temperatures within 0.1°C of the temperature from the primary sensor. For the calibration of the salinity sensor and the oxygen sensor, water samples were taken three times per day.

3 Hydrographic measurements - Descriptions, Techniques, and Calibrations

3.1 Rosette Sampler and Sampler Bottles

A General Oceanics 24 position rosette sampler was used, fitted with 10 litre NOEX sampler bottles. On most stations only 13 sampler bottles were placed in the rosette. Their general behaviour was good, but the samplers fitted with reversing electronic thermometers and pressure sensors (2, 4, and 6) quite often showed unreliable salinities. This occurred probably because of too early closing due to the vibrations of the thermometer cases, which caused the valves of the closing system to open prematurely. No errors in the functioning of the rosette sampler itself could be detected. The samplers from which oxygen samples were drawn were mostly fitted with silicon rubber lids. Oxygen samples from these bottles have to be corrected according to the algorithm determined during cruise 64PE95N/1, but such corrections are small, less than 1 _mol/kg. For test purposes, during a number of stations also sampler were taken with samplers, closed by means of the multi-valve unit. These samples are included in the present version of the *.SUM file, but later inspection of the data may lead to the omission of these samples in further reports.

3.2 Temperature Measurements

On sampler bottles 2, 4, and 6 thermometer racks were mounted, fitted with SIS reversing electronic thermometers with a numerical resolution of 1 mK. After the cruise calibrations of the SIS sensors at the water triple point as well as at a number of other temperatures in the intermediate and deep water temperature range will be carried out.

Also mounted on the CTD was a secondary SBE temperature sensor, but not connected to the sensor flushing system, as well as a high precision SBE35 temperature sensor. Preliminary results of comparison of the primary CTD temperature sensor with the secondary temperature sensor as well as with the SIS sensors and the SBE35 sensor indicate that the temperatures, measured with the different sensors, showed a strong agreement. For the samples with a temperature below 3.0°C the difference between the temperature measured with the SBE35 and with the primary CTD sensor had an average of -0.1 mK and a standard deviation of 0.9 mK (N=47).

3.3 Pressure Measurements

In the thermometer racks, mounted on sampler bottles, also SIS reversing electronic pressure sensors were placed. Before the cruise these sensors were calibrated by the manufacturer. Also readings of the deck pressure was performed with the SIS sensors to determine the zero offset. Previous experience has shown that such offset readings before and after each CTD cast give identical results.

3.4 Salinity Measurements

Water was drawn from the samplers into a 0.5 litre glass sample bottle for the salinity determination after 3 times rinsing. The sample bottles had a massive rubber stopper as well as a screw lid. Salinity of water samples (SALNTY) was determined by means of an Guildline Autosal 8400A salinometer. The salinometer was used in a laboratory container, fitted with an air conditioning system. This kept the surrounding air temperature constant within 1°C. The readings of the instrument were performed by computer, giving the average and statistics of 10 consecutive readings. For each sample 3 salinity determinations were carried out. The standard water used was from batch P131 with a K_{15} ratio of 0.99986 (S=34.994), prepared at 10 October 1996.

From each deep CTD/rosette cast an extra duplicate sample was drawn. Salinity determinations from the duplicate samples obtained from independent runs were used to determine the reproducibility of the salinity determination. The RMS value of the difference between duplicate water samples amounted to 0.0005 salinity units.

The results from the water sample salinities will be used to determine the calibration of the CTD conductivity sensor. It was known beforehand that the conductivity sensor hat a slight calibration offset because of some fouling. A preliminary analysis of the difference between the water sample salinity and the CTD salinity sampled below 1000 dbar gives a mean value of -0.0041 and a standard deviation of 0.0013 (N=216).

3.5 Oxygen Measurements

For the oxygen determination water samples were drawn in volume calibrated 120 ml pyrex glass bottles. Before drawing the sample each bottle was flushed with at least 3 times its volume. When the samples were drawn the temperature of the sample was determined. The determination of the volumetric dissolved oxygen concentration of water samples was carried out by means of a high precision automated oxygen Winkler titration system, based on an optical end point determination. The stock solution of KJO_3 used in the analysis was prepared and calibrated in the laboratory by using gravimetric methods. The stock solutions were stored at low temperature (~4°C). Final calibration of the 0.2 Mol $Na_2S_2O_3$ titrant on board took place by tritration of at least 6 samples of stock solution samples of 3 different concentration levels with the 0.2 Mol titrant.

At each cast where samples for the oxygen determination were drawn, duplicate samples and samples for the determination of the sea water blank value were drawn from the deepest water sampler, and occasionnally from the shallowest sampler too. The resulting RMS of the difference between samples drawn from the same sampler amounted to 0.3 _mol/dm ^{3}.

3.6 CTD Data Collection and Processing

For the data collection the Seasave software, produced by SBE, was used. The CTD data were recorded with a frequency of 24 data cycles per second. After each CTD cast the data were copied to a hard disk of the ship's computer network, and a daily back-up copy was made on tape. Back on Texel these data are downloaded into the NIOZ computer network, via the network connection in the harbour.

On board the up-cast data files were sub-sampled to produce files with CTD data corresponding to each water sample, taken with the rosette sampler. On board the CTD data were processed with the preliminary calibration data, and reduced to 1 dbar average ASCII files, which were used for the preliminary analysis of the data. Full re-calibration and data processing will be carried out at NIOZ, Texel.

4 Acknowledgements

The research reported here was funded by the Foundation for Geological, Oceanographic and Atmospheric Research (GOA), subsidiary of the Netherlands Organisation for Scientific Research (NWO), contract no. 750.197.01 .

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