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REPORT AND PRELIMINARY RESULTS OF VICTOR HENSEN CRUISE 96/1, BREMERHAVEN - BREMERHAVEN, 10.1. - 4.3.1996

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Contents

1. Preface	1
2. Narrative	2
3. Participants	3
4. Leg 1 and 5: Test mooring and water surface measurements	4
Introduction	4
Objectives	4
Results	5
Technical support	5
5. Leg 2: Bio-optics and biogeochemistry along 29°N transect	10
Introduction	10
Objectives and scientific questions	11
Methods	14
Preliminary results	17
Sampling of foraminifera	22
Sampling of coccolithophorids	23
6. Leg 3: Water column investigations at ESTOC and surrounding regions	25
Introduction	25
Methods	29
Preliminary results	33
7. Leg 4: Geological investigations along Moroccan shelf	37
Itinerary	37
Material and Methods	38
8. Appendices and list of abbreviations	41
Appendix I: Station list, Leg 2	42
Appendix II: Station list , Leg 3	47
Appendix III: CTD and fluorescence profiles, Leg 3	54
Appendix IV: Station list, Leg 4	74

1. Preface

During the five parts of RV VICTOR HENSEN cruise VH 96/1 to the Canary Islands, investigations related to several projects were carried out. Water column surveys for the European time-series project ESTOC were the main focus of Legs 2 and 3. The 'European Station for Time-series in the Ocean, Canary Islands' (or 'Estación Europea de Series Temporales del Oceano, Islas Canarias', ESTOC) is located 100 km north (upstream) of Gran Canaria in the eastern boundary flow of the subtropical North Atlantic gyre (at 29°10'N and 15°30'W). This Spanish-German project is carried out by four institutions, the ICCM (Instituto Canario de Ciencias Marinas) on Gran Canaria and the IEO (Instituto Español de Oceanografia) on Tenerife, which are responsible for the monthly sampling at the station, and the German groups at the IfM Kiel and the Geosciences in Bremen, who are responsible for current and water mass and particle flux studies, respectively. The main purpose of the station is to build a long-term oceanographic data base to be able to discern seasonal from long-term variability of hydrographic and biogeochemical parameters in this environmentally sensitive region of the Eastern Boundary Current of the North-Atlantic gyre. The region is also especially interesting because of its vicinity to the North African upwelling region and episodic dust depositions from the Sahara that likely influence productivity and particle formation.

ESTOC is also used as a reference station for the European project 'CANIGO' (Canary Islands Azores Gibraltar Observations), since 1. August 1996 funded by the European Commission within their MAST III (Marine Science and Technology) programme. The purpose of this interdisciplinary investigation carried out by numerous European scientists is to study the oceanography, particle flux and paleoceanography between the Canary Islands and Gibraltar, including the Moroccan coast. On VICTOR HENSEN Leg 4, pre-site studies were carried out for the paleoceanographical component within CANIGO along the coastal waters of Morocco. The results of this study helped in planning METEOR cruise 37/1 carried out in December of 1996 in the same region.

Instruments tests were conducted by the AWI group on Legs 1 and 5 (test mooring) and during Leg 4, a profiling CTD was tested by the GeoB group.

2. Narrative

VICTOR HENSEN departed on cruise VH 96/1 on 10 January 1996 from her home port in Bremerhaven and arrived on 19 January in the port of Santa Cruz, Tenerife. On this first leg, Klaus Ohm from the AWI in Bremerhaven deployed a test mooring at the ESTOC station. The second leg commenced on 23 January with a group from the University of Oldenburg led by Dr. Rainer Reuter. The main purpose was the sampling of bio-optical and biogeochemical parameters and organisms along a zonal transect along 29°N north of the Canary Islands. This transect is now integrated in a seasonal sampling schedule within the CANIGO (Canary Islands Azores Gibraltar Observations) project. On this leg, the European time-series station ESTOC was sampled twice as part of the regular monthly sampling schedule. On the following leg from 4 - 12 February, more work was conducted at and around the ESTOC station and around the islands of Fuerteventura and Lanzarote. This leg also included an extended set of parameters in addition to the routinely measured ones, and included rate measurements of production and export flux. The fourth leg from 13 - 22 February included geological work along the Moroccan coast and instrument testing. On the fifth and last leg which started on 24 February in Las Palmas, the test mooring at the ESTOC station was recovered. VICTOR HENSEN returned to the home port of Bremerhaven on 4 March.

Despite the restriction posed upon the work onboard ship due to rough weather, the cruise was very successful within the technical capabilities offered by the ship. An extensive data set was collected during this important time in the seasonal cycle of plankton communities in the Canary Islands region. This cruise offered the possibility to further the collaboration between the ESTOC groups and interested groups from other institutions, and helped foster the collaboration within the time-series project.

At this point, we would like to extend our sincere gratitude to Captain Klaassen and his crew for excellent help and collaboration, as well as the pleasant working atmosphere onboard, and to the AWI ships co-ordination to make this cruise possible. Octavio Llinas (ICCM Telde) provided valuable logistical support in Las Palmas. This research was partly funded by the Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie (FKZ 03F0108D).

3. Participants

Name	Institution
Leg 1	
Ohm, Klaus (chief scientist)	AWI
Loquay, Klaus	UOL
Pluggge, Rainer	AWI
Leg 2	
Reuter, Rainer Dr. (chief scientist)	UOL
Barth, Hans	UOL
Bollmann, Jörg Dr.	ETHZ
Cianca, Andrés	ICCM
Güss, Stephan	IfM Hamburg
Koy, Uwe	IfM Kiel
Loquay, Klaus	UOL
Spiedt, Andrea	GeoB
Leg 3	
Neuer, Susanne Dr. (chief scientist)	GeoB
Cianca Aguilar, Andrés	ICCM
Coca Saez de Albeniz, Josep	ULPGC
Eberwein, Astrid	GeoB
González-Davila, Melchor	ULPGC
Klein, Birgit Dr.	TracerB
Koy, Uwe	IfM Kiel
Lorenzen, Christiane	AWI
Luzardo Hernandez, Francis	ICCM
Leg 4	
Ruhland, Götz (chief scientist)	GeoB
Benabdeljelil, Abdelkader Dr.	UR
Bollmann, Jörg Dr.	ETHZ
Meinecke, Gerrit Dr.	GeoB
Snoussi, Maria Prof.	UR
Leg 5	
Ohm, Klaus (chief scientist)	AWI
Kopiske, Eberhard	UOL
Pluggge, Rainer	AWI

AWI	Alfred Wegener Institut für Polar und Meeresforschung
ETHZ	Eidgenössische Technische Hochschule, Zürich
GeoB	Geosciences department, Universtity of Bremen
ICCM	Instituto Canario de Ciencias Marinas, Telde, Gran Canaria
IfM	Institut für Meereskunde
Tracer B	Tracerozeanographie University of Bremen
UOL	University of Oldenburg
UR	University of Rabat, Morocco

4. Leg 1 and 5: Test mooring and water surface measurements

Introduction

The department Meeresphysik und Messwesen of Alfred-Wegener-Institut fuer Polar- und Meeresforschung is developing a self-profiling deep sea mooring for a project in the Greenland Sea. This mooring will sample one profile of conductivity, temperature and pressure per day between surface and a depth of 3600m for one year. The mooring includes a rope of a length of 3600m, attached to a ground weight and a subsurface top-buoy, a moving vehicle with a CTD and a control device. The vehicle consists of two parts, the self contained CTD and a buoyancy module and is adjusted to have a slightly lower density than sea water. The downward movement is achieved by putting a weight on the vehicle. This weight is released by the control device, which holds one weight per profile. When approaching the ocean bottom, the weight is released from the vehicle and the upward moving is initiated.

After already having tested the vehicle in polar regions with regard to its dynamic behaviour, a test of the complete system with special focus on the control device was necessary before the final displacement in the Greenland Sea. The ESTOC region offers appropriate depths for this test, and the mooring could be launched during the first leg and recovered during the last leg of the cruise. The buoyancy module had to be adjusted according to the temperature regime differing from the Greenland Sea conditions.

Objectives

As mentioned above, the main objective of the cruise was the test of the complete system. Particularly, the correct release of weights of the control device under field conditions was to be checked. A further aim was to gain experience in the handling of the mooring, since this system represents an unusual type of mooring.

Results

The mooring was deployed at 29°15'N, 15°51'W on Jan 18. Under the general conditions of moderate winds and strong swell, the deployment took approximately 3.5 hours. Only slight modifications of the design will be necessary. In general the handling proved sufficiently easy and should not cause any problems even with the complete load of 400 weights (approx. 300kg) stored in the control device.

The mooring was recovered within 2.5 hours on 25 Feb. at even better weather conditions. The evaluation of the CTD data showed only one downward track of the vehicle. The reason is presumably an incorrect buoyancy adjustment and high horizontal current speed in the ocean. This will not occur in the Greenland Sea.

Technical support

A COMED system was installed to provide other groups with data of surface temperature, salinity, chlorophyll fluorescence, and Mie backscattering olong the ship's track. The sensors are installed in the hydrographic well. These data provide online information and are logged by a PC. Some results for the vicinity of the ESTOC mooring are shown in Figure 2 to 4.

Reference: Axel Bochert, COMED - Continuously Measuring Device. Diplomarbeit AWI, Bremerhaven, 1990.

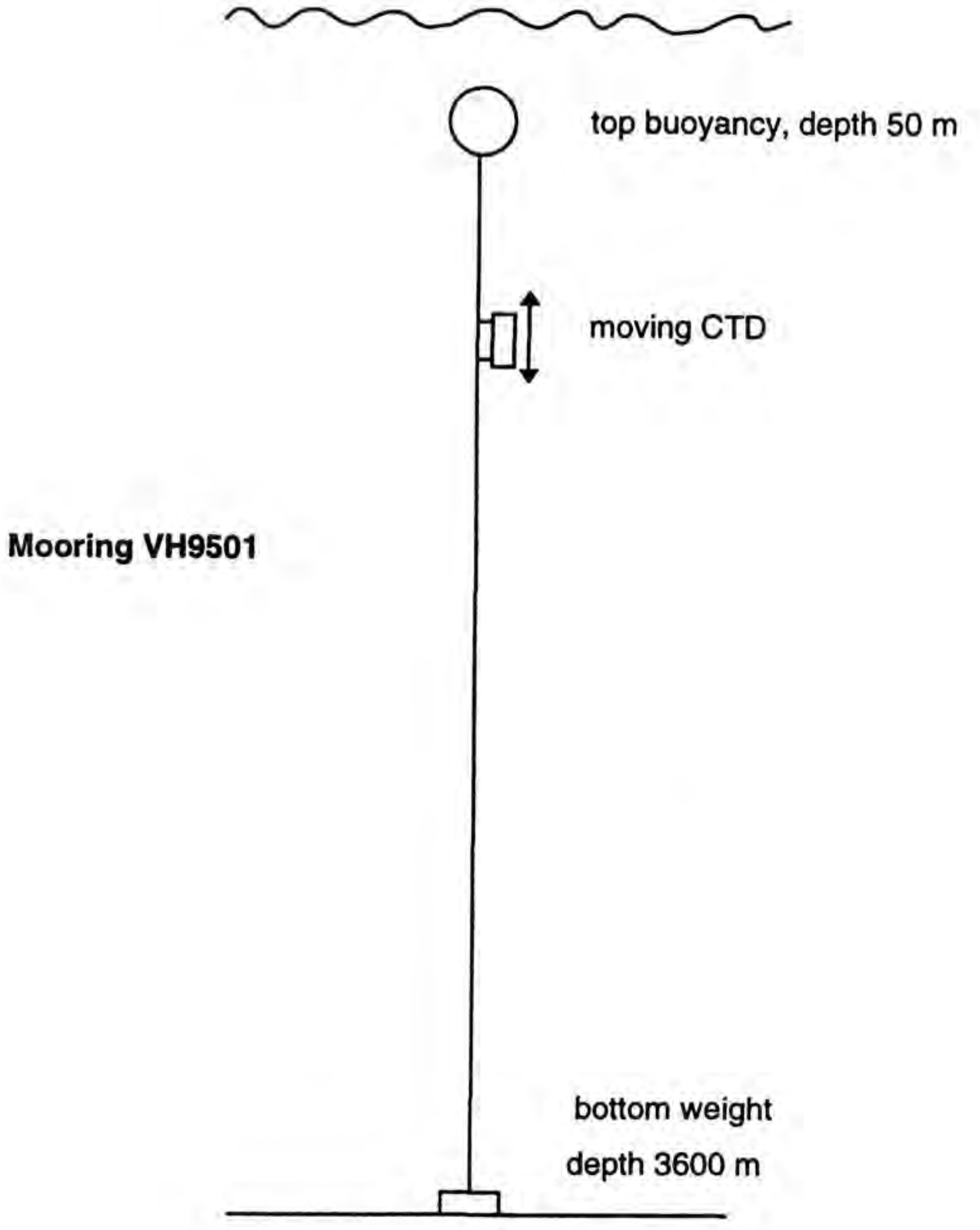


Fig. 1. Test mooring deployed on Leg. 1.

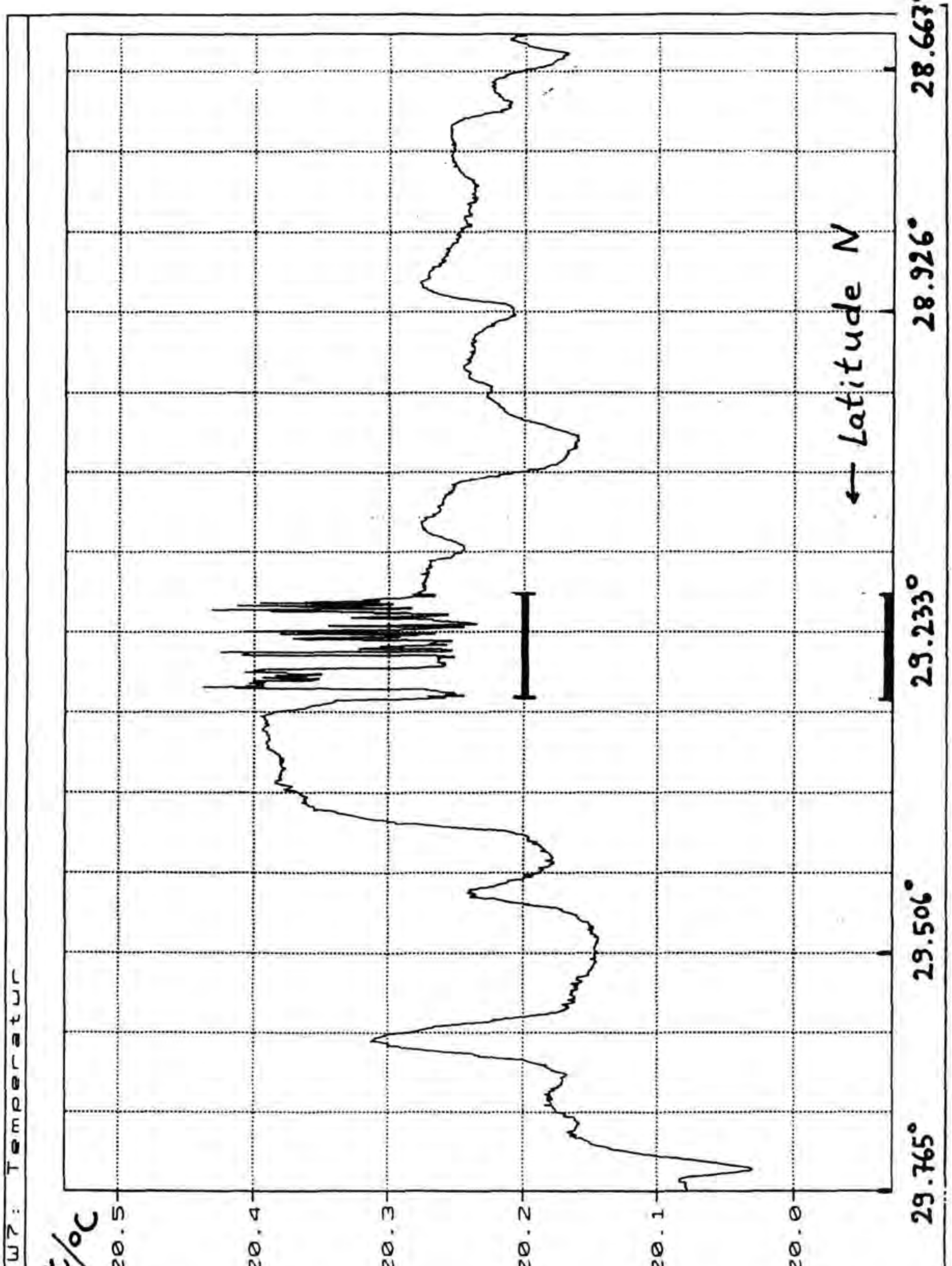


Fig. 2: Temperature measurements of the COMED system on a meridional transect on 18 Jan. The bar in the center of the plot represents the time spent on the mooring station.

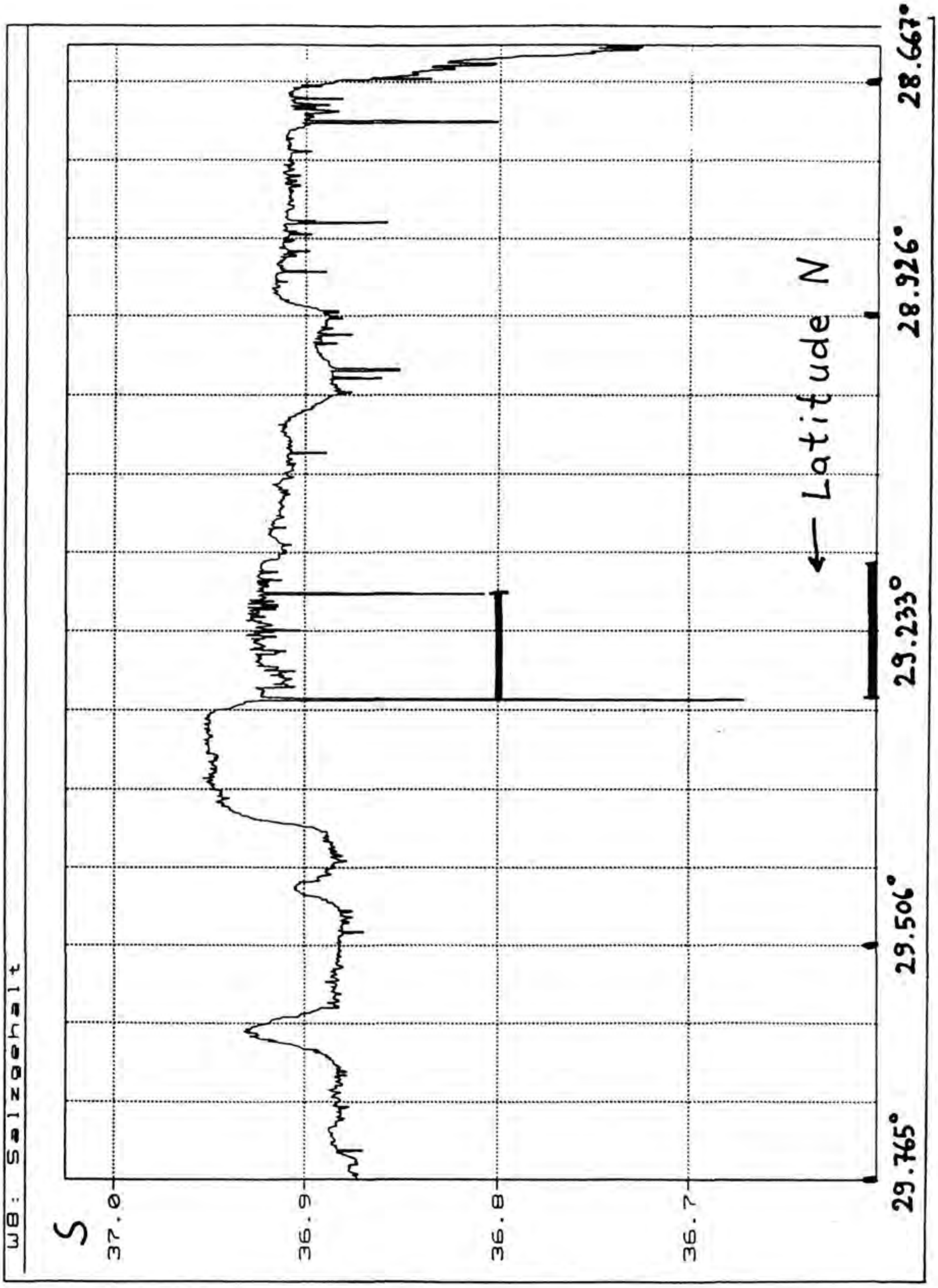


Fig.3: Same as Fig.2, but for salinity.

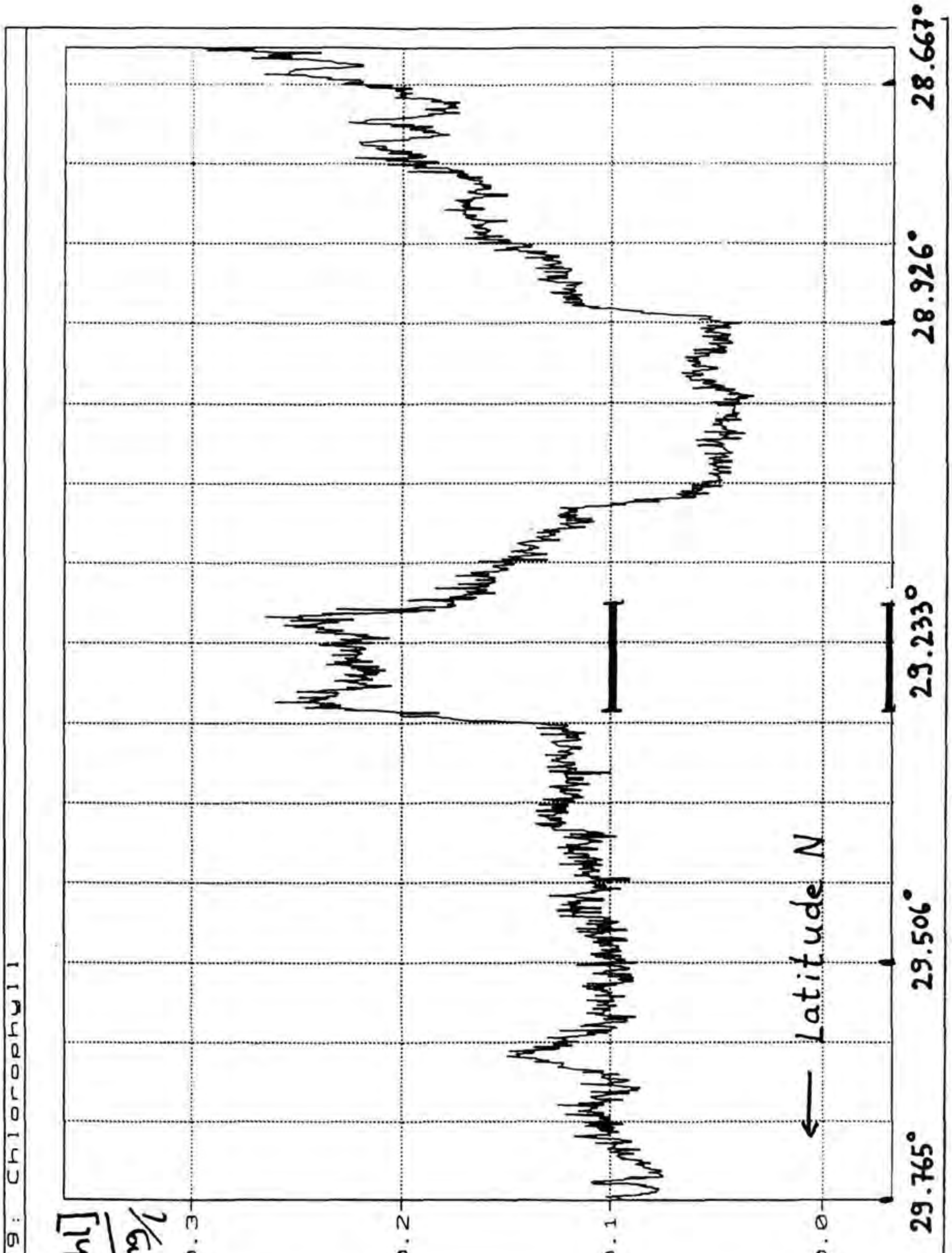


Fig.4: Same as Fig. 2, but for chlorophyll concentration.

5. Leg. 2: Bio-optics and biogeochemistry along 29°N transect

Introduction

Carbon represents the main element in the flow of dissolved and particulate organic matter, and living organisms. The most important sink for CO_2 is the ocean with its capability of binding this gas in biological systems. Calculations which include only chemical and physical properties for the exchange of carbon lead to wrong predictions, only the inclusion of biological activities fill this gap in understanding the carbon cycle. In the first two months of the year, the hydrographic conditions in the region of the Canary Islands are characterised by deep mixing, and an increase in phytoplankton biomass. One of the main objectives is to study the carbon assimilation and transport mechanisms by biological activities, to understand and quantify the amount of carbon which is transported to deep waters by mixing and sinking.

The following participants contributed to the investigations:

Andrea Spiedt	Univ. Bremen Multi net catches, foraminifera, stable isotopes, POC
Uwe Koy	IFM Kiel XCP
Andrés Cianca	ICCM, Telde CTD (SIS), O2, Chlorophyll, Nutrients
Stephan Güss	IFM Hamburg DOC
Dr. Jörg Bollmann	ETH Zürich HPLC, Coccolithophores
Klaus Loquay	C. v. O. Univ. Oldenburg Bio-Optik, Radiometer, CTD
Dr. Rainer Reuter	C. v. O. Univ. Oldenburg Bio-Optik, Radiometer, CTD
Hans Barth	C. v. O. Univ. Oldenburg Bio-Optik, Radiometer, CTD

Dissolved and particulate substances in seawater can be sensitively characterized by optical methods, without a preparation of the sample and therefore very fast. With fluorescence and attenuation sensors it is possible to draw conclusions about certain organic compounds that belong to the marine carbon cycle. With fluorescence methods yellow substances as a major compound of the marine DOM, chlorophyll and other phytoplankton pigments like phycoerythrin, fucoxanthin and fucocyanin, and the aromatic amino acid tryptophan can be measured. The attenuation coefficient is an optical parameter which depends sensitively on suspended and dissolved substances. Its measurement is of interest not only for an understanding of optical conditions in water, but it allows also a fast determination of absorbing and scattering matter in the form of depth profiles, which can hardly be obtained with other methods in realtime.

Objectives and Scientific Questions

During the second leg of R/V VICTOR HENSEN cruise VH96/1, water samples were taken with Niskin Samplers at 29 stations (Fig. 5) and fluorometrically investigated. Depth profiles were made with two CTDs and a newly developed polychromatic attenuation measurement probe. The scientific objectives were:

- Quantification of the carbon bound to phytoplankton, bacteria and DOM.
- Quantification of particulate and dissolved matter, to derive parameters for radiative transport calculations.
- Measurement of the algal and bacterial populations during the spring bloom in the Canary Island zone, with its high gradients to the upwelling area at the west coast of Africa. These measurements are useful to get parameters for modelling the population dynamic in the water column.
- The detection of chlorophyll in algae through its characteristic fluorescence in the red region of the spectrum is generally known and technically used *in-situ* sensors today. This fluorescence can be easily excited in the blue region of the spectrum because of the absorption band of chlorophyll. By a specific excitation of other pigments it is also possible to identify some classes of algae (YENTSCH and PHINNEY 1985).
- Another group of biogenic molecules which may be detected by fluorescence are the aromatic amino acids tyrosine and tryptophane, and, with a much lower fluorescence

quantum yield penylanaline bound to proteins in dissolved form or bound to particles. These molecules emit in the 280 to 350nm range when excited between 200nm and 280nm. The lower range for the detection of tryptophane and tyrosin under unbounded conditions reaches concentrations of about 1 µg/l.

- May the few data gained earlier about the distribution of fluorescing DOM in the water column be verified? Is it possible to deduce information on the flux of DOM from the depth profiles?
- Do connections exist between primary production in the euphotic zone and fluorescent DOM in the surface layer? Can allochthonous and autochthonous components be separated from the spectral shape?
- How can fluorescence signals be interpreted which can be attributed to aromatic amino acids? Do these signals originate from dissolved molecules or from particles, for example bacteria? May free or bound amino acids be distinguished through the spectral signature?

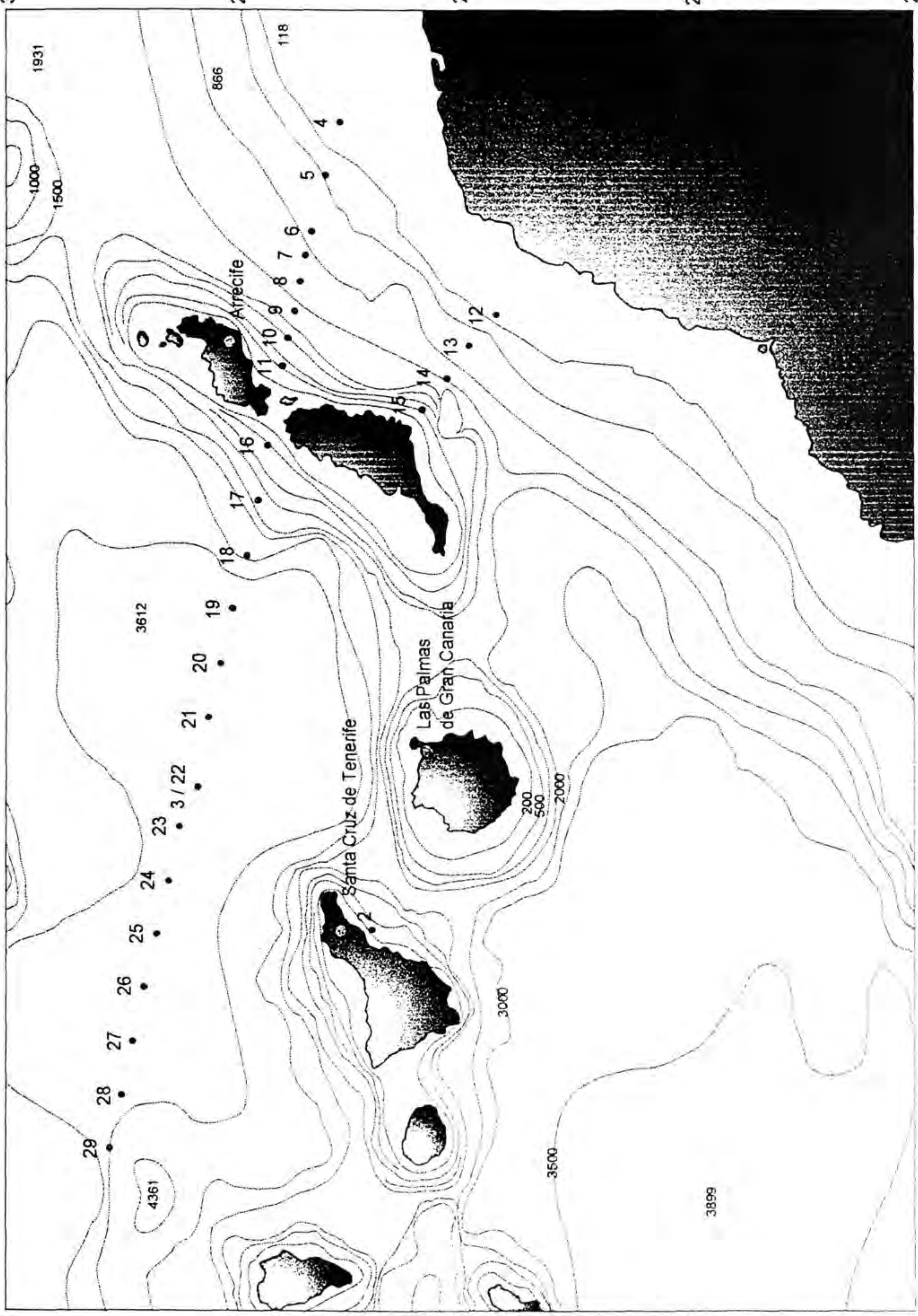


Fig. 5. Map of stations sampled on Leg 2.

Methods

CTD measurements

CTD measurements were performed with a Meerestechnik Elektronik CTD probe OTS 1500 for the 500 m profiles. For the 1000 m profiles a SIS probe is used.

Attenuation measurements

Attenuation measurements were done with a newly developed in situ probe. Using of a Xenon light source and two miniature spectrometers, attenuation spectra in the region between 370 and 730 nm were measured in 3 nm steps. The instrument measures values of the attenuation coefficient at optical path lengths which are variable up to 400 mm.

Fluorescence measurements

Fluorescence data were gained with a Perkin Elmer LS50 luminescence spectrometer using a flow-through cuvette which lowered the risk of sample contamination. Emission spectra were taken which are representative of chlorophyll, fucoxanthin, aromatic amino acids (thryptophan and tyrosine) or their derivates and also of fluorescent components of yellow substance. The variable spectral sensitivity of the fluorometer on the excitation and emission side was corrected by a calibration procedure as recommended by Perkin Elmer. The stability of the instrument could be improved by the water Raman scattering signal which is registered in all spectra: Any drift of the sensitivity is corrected by the method of normalisation of the fluorescence intensities to the Raman scatter signal. Preliminary results presenting here were obtained by the normalisation to the peak height of Raman scattering. However, the registered shape of the Raman scatter signal essentially depends on the chosen spectral resolution of the instrument, it is necessary to normalise on the integral of the Raman signal to receive quantitative and reproducible results (DETERMANN et al. 1993). This improved evaluation has not been completed by the time of this report. The in situ measurements of fluorescence were prevented by an electronic malfunction of the instrument at Station 02.

Table 1. :Ranges of fluorescing identifiable substances.

excitation/ nm	detection/ nm	identifiable substance:
530	550-750	fucoxanthin phycoerythrin phycocyanin
420	440-750	gelbstoff chl a phycoerythrin
400-670	680	div. pigments
385	400-720	gelbstoff chl a
308	320-450	gelbstoff
308	400-720	gelbstoff chl a
270	280-500	tryptophan gelbstoff
230	235-450	tyrosine tryptophan
220-325	340	tryptophan
230-425	440	gelbstoff

Radiometric measurements were performed with an in situ radiometer. The instrument measures the up- and downwelling irradiance at 67 wavelengths between 370 and 730 nm. Other parameters like PAR, vect. irradiance, etc. are calculated from these data.

Measurements with coupled sensors:

For a simultaneous operation of the in situ probes an underwater central unit has been developed. This unit combines three sensors, and sends the data as one package to the deck unit where the data acquisition is carried out (see Fig. 6 and 7). The parallel detection of these data is also required for correction calculations of the fluorescence data.

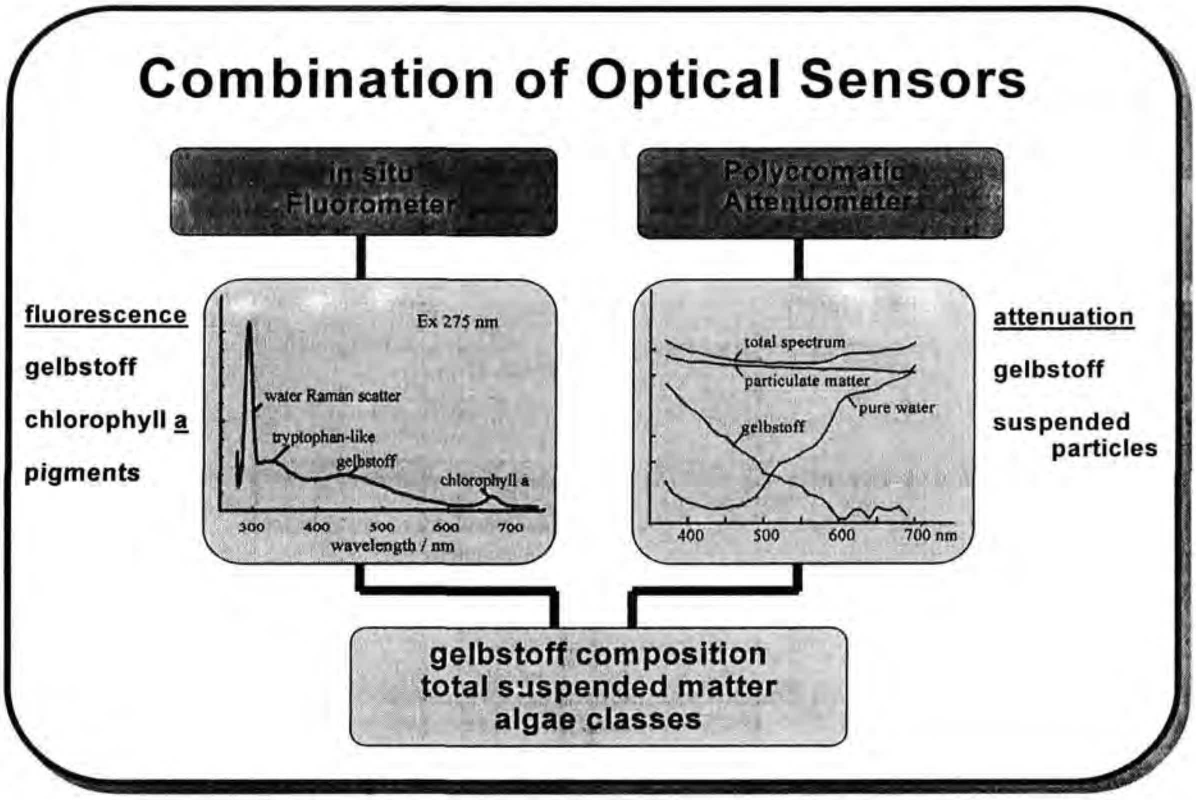


Fig. 6. Information which can be obtained by simultaneous measuring of optical parameters.

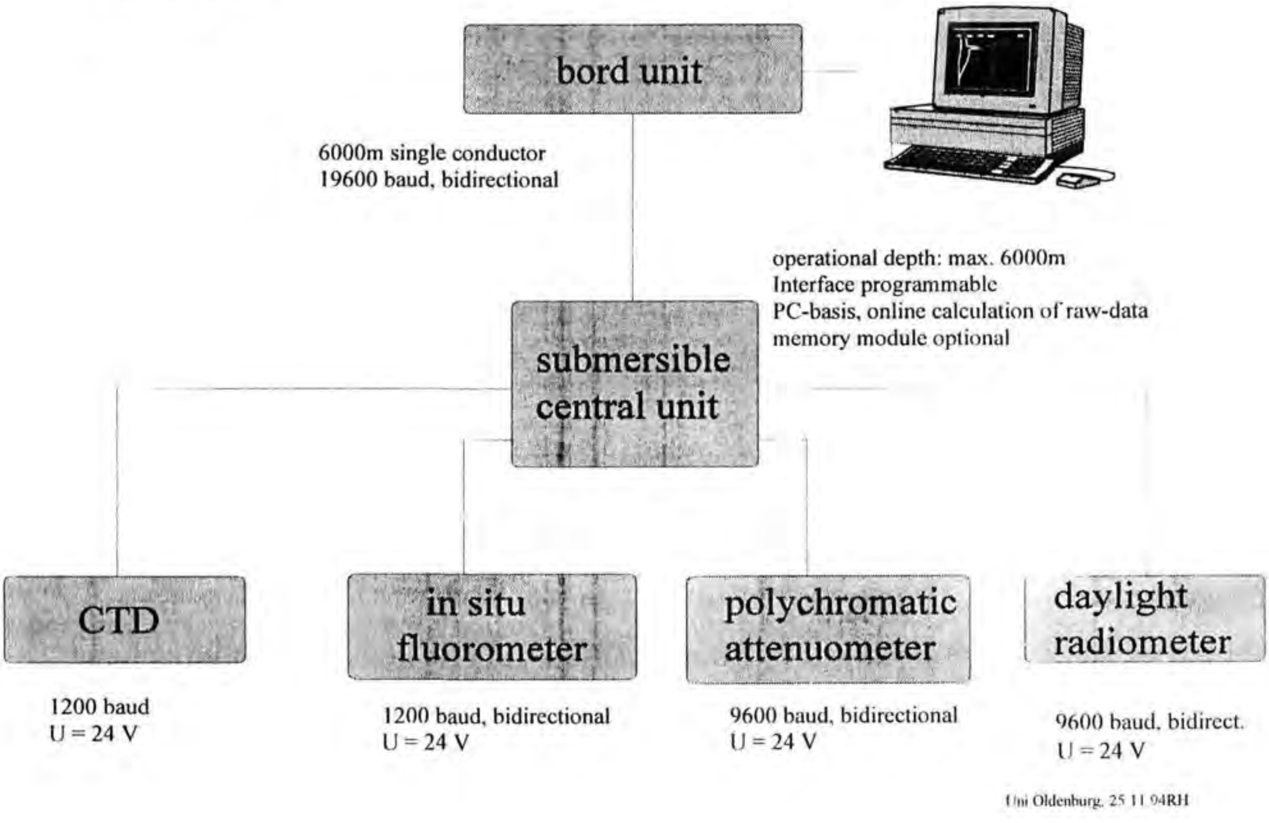


Fig.7. Technical scheme of the coupling of the optical sensors.

Sampling

Immediately after sampling the samples were stored in the dark at 5°C in glass bottles to keep changes of the sampling material as low as possible. Because the fluorescence measurements took 30 minutes for each sample, the work on the depth Stations proved to be very problematic due to the high number of samples.

Preliminary results

To illustrate the fluorescence data, four profiles (Stations 22 and 27) are shown in Fig. 8 and Fig.9. Station 22 is near the ESTOC time series station.

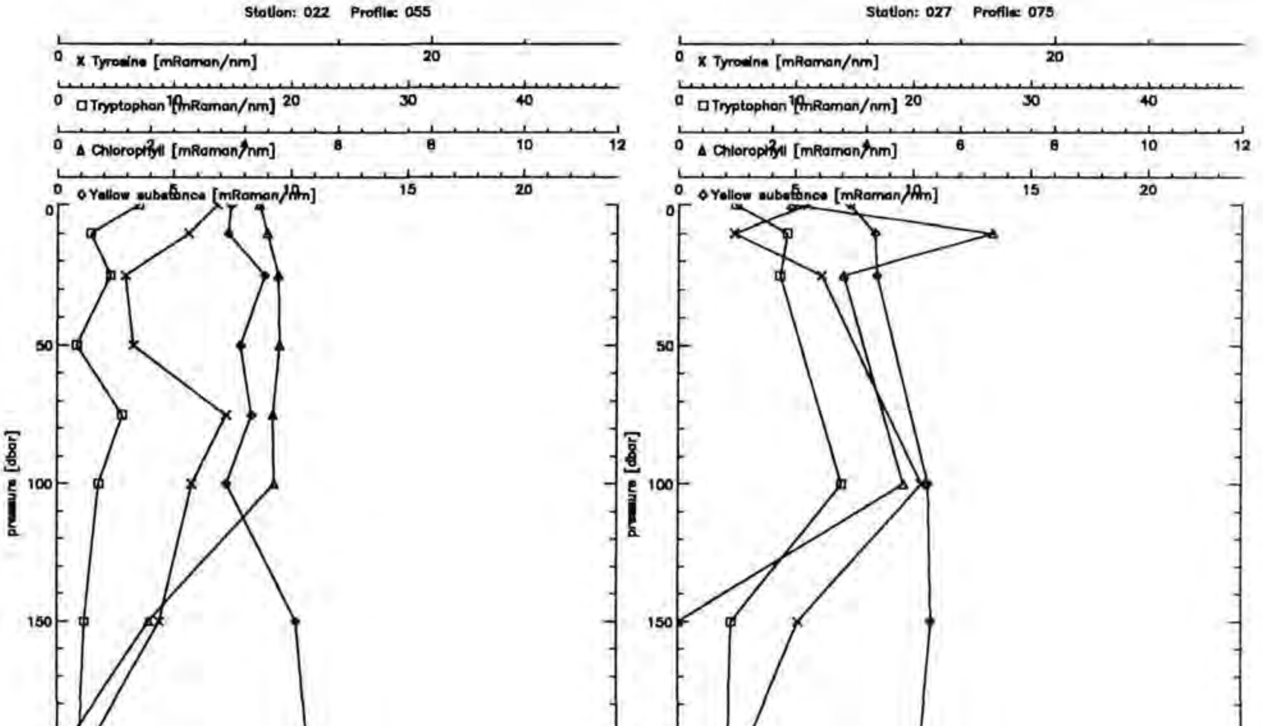


Fig. 8. Fluorescence profiles of chlorophyll, tryptophane, tyrosine and yellow substance of the first 200 m. Station 22 (profile 55 at 29°08.3 N, 15°34.0 W) and Station 27 (profile 75 at 29°25.2 N, 16°45.0 W).

The chlorophyll fluorescence profile shows a relative homogenous distribution down to a depth of 100 m. In some profiles this homogenous distribution is superimposed by two chlorophyll maxims one at the depth within the first 30 m and the second one at the depth of approximately 80 - 100 m. Below the deeper maximum, chlorophyll fluorescence decreased to 0 at 200 m depth.

Gelbstoff fluorescence showed only a slight decrease in the upper 100 m. This may be caused by bad weather so that photobleaching was low due to clouds during the period of investigation. Increased mixing of the upper layer caused by strong wind intensifies the effect of this relative high gelbstoff amount.

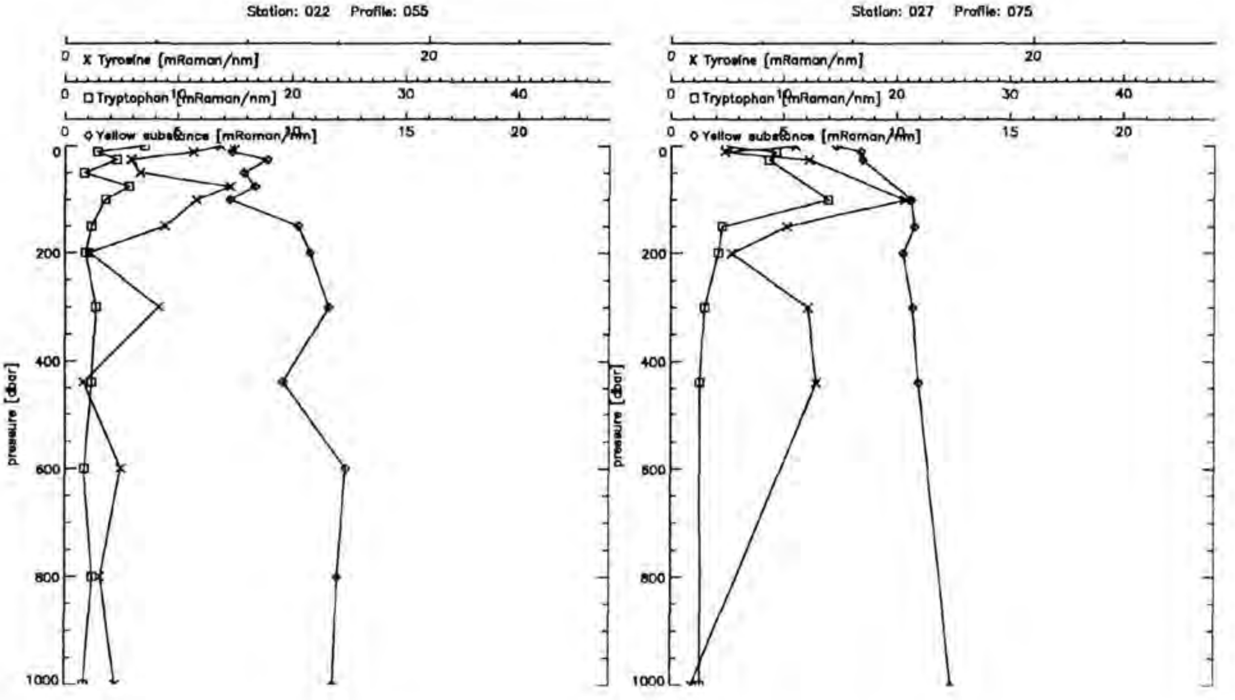


Fig. 9. Fluorescence profiles of tyrosine, tryptophane and yellow substance from 0 - 1000 m. Station 22 (Profile 55 at 29°08.3 N, 15°34.0 W) and Station 27 (Profile 75 at 29°25.2 N, 16°45.0 W).

The fluorescence of tryptophane and tyrosine is dominant in the upper 200 m, where phytoplankton and bacteria are present in large quantities.

CTD Measurements

The depth profiles of Station 22 (ESTOC) and Station 27 are shown in Fig. 10 and Fig.11. The profiles from 0 to 500 m are measured with the 'ME OTS 1500 probe', limited by the 500 m single conductor wire of VICTOR HENSEN. The profiles from 0 to 1000 m are measured with the automatically storing 'SIS 1000 probe'. These measurements were performed by A. Cienca from ICCM, Telde (Gran Canaria). Both data sets are calibrated by samples analyzed by U.Koy with a salinometer at the Inst. for Marine Research, Kiel.

Contour plots of salinity and temperature are shown in Fig. 12 and Fig. 13. On the right hand side, the plots begin at the coastal area of Marocco with Station 4. Between Station 10 and Station 16 the islands of Lanzarote and Fuerteventura split the isolines to two parts.

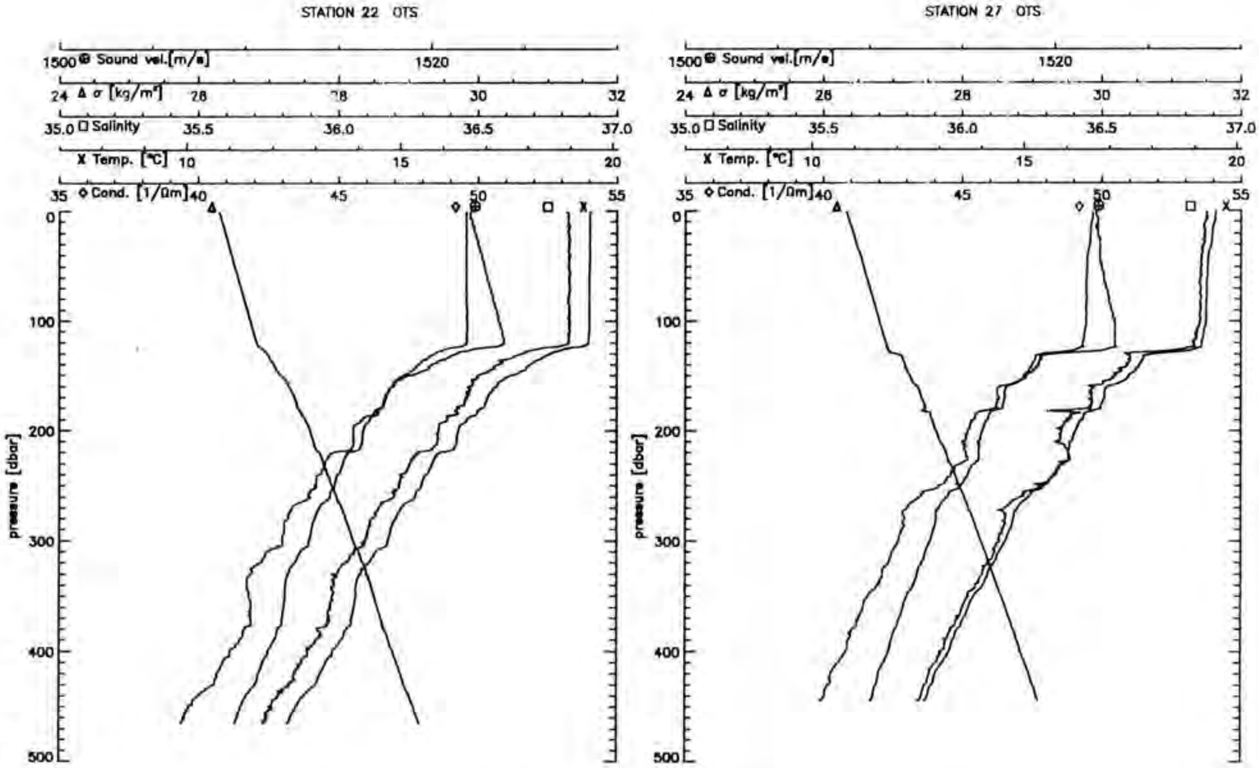


Fig. 10. Depth profiles of CTD at Stations 22 and 27 in the range of 0-500m.

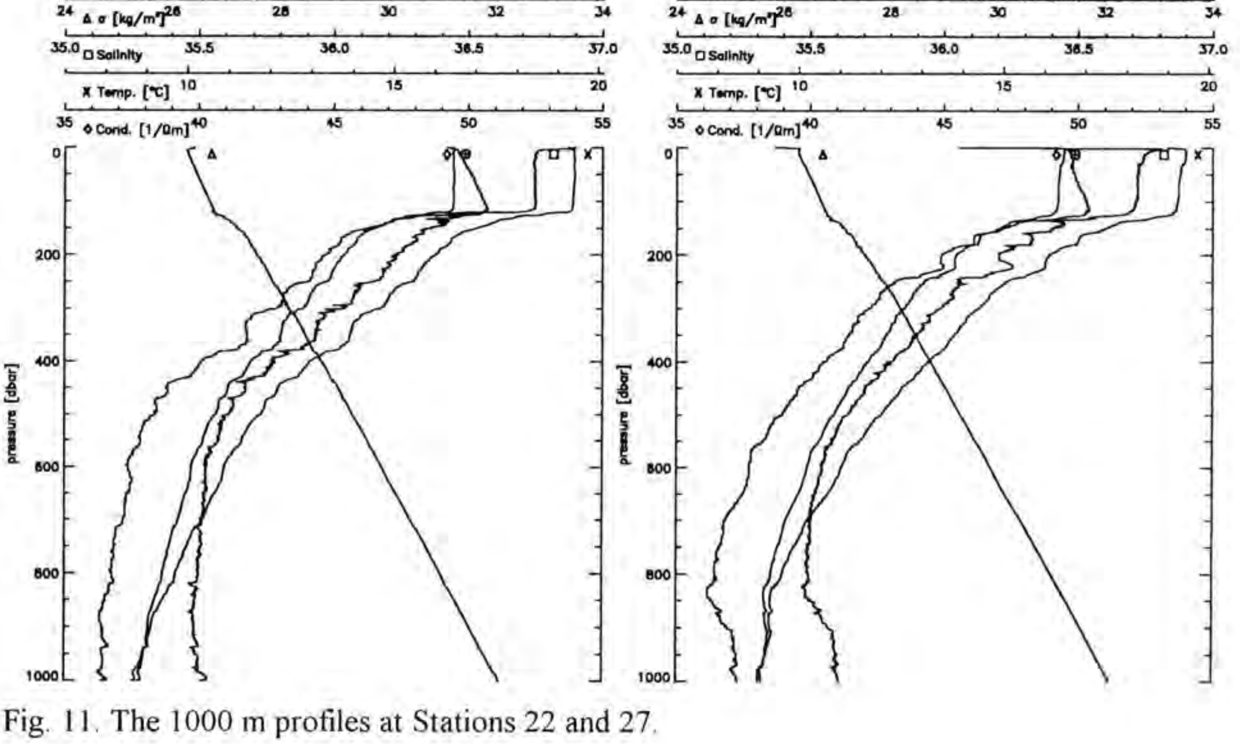


Fig. 11. The 1000 m profiles at Stations 22 and 27.

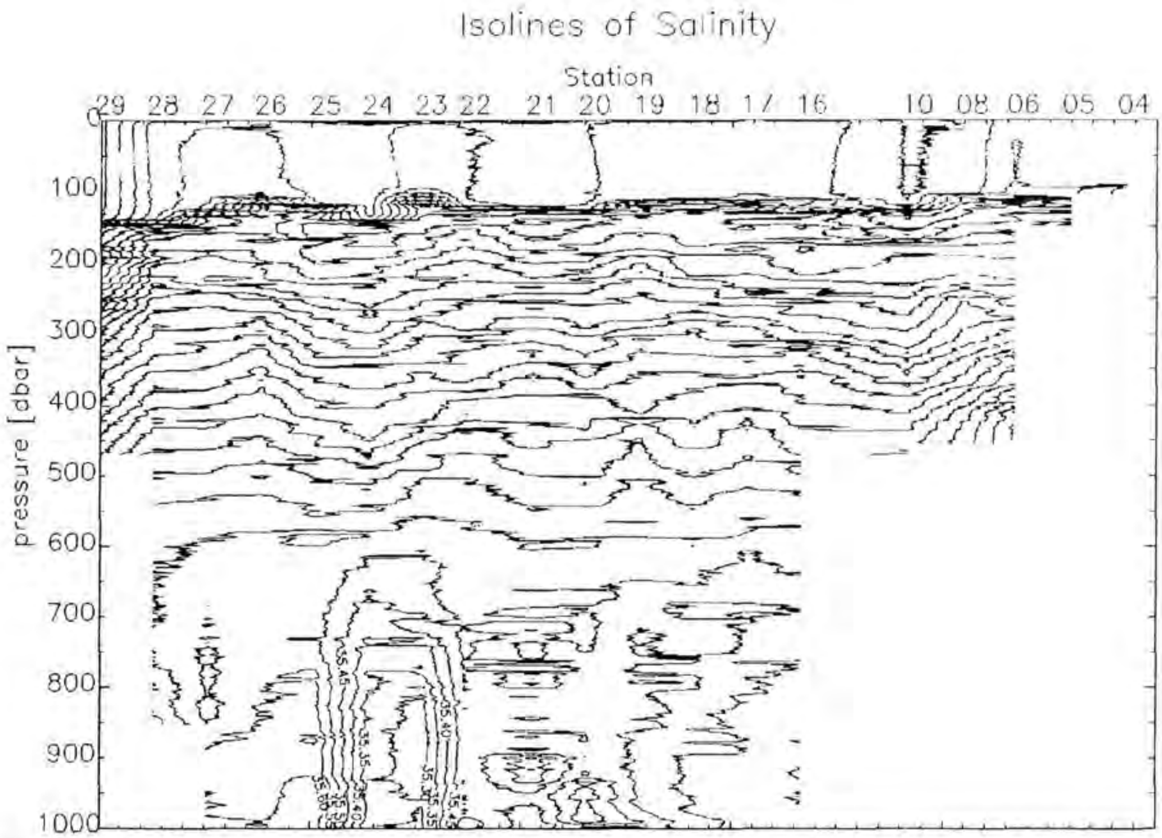


Fig. 12. Contour plot of salinity on the east-west transect.

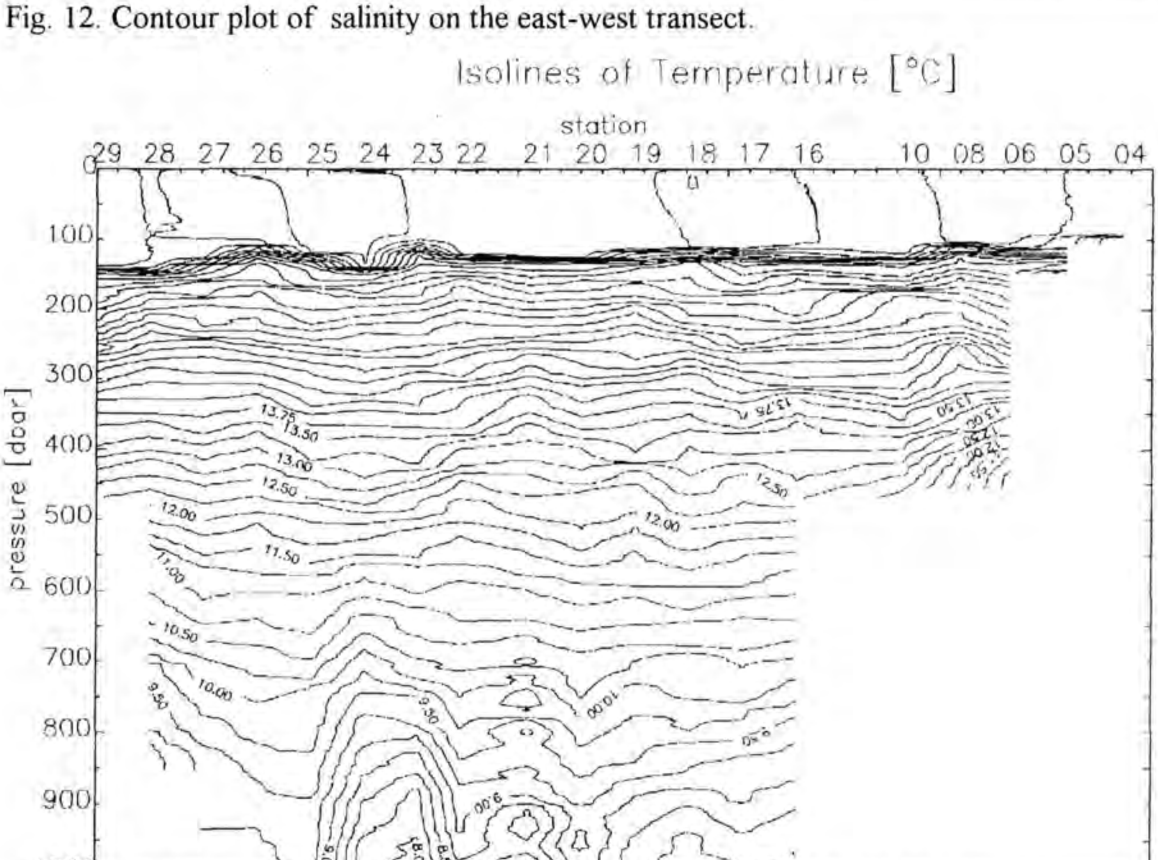


Fig. 13. Contour plot of temperature on the east-west transect.

During the time of measurements, no coastal upwelling took place. The isolines of salinity and temperature did not indicate that water with low temperature or high reached the surface. This is also confirmed by the chlorophyll fluorescence data, which do not show enhanced plankton in the coastal zone at the shelf of Africa.

Sampling of Foraminifera

Planktonic foraminifera are of central importance for the study of the modern and ancient marine ecosystems due to their widespread occurrence in the oceans, with rather clearly defined faunal provinces for many species, and the fact that they produce calcitic shells that contribute to the micro-fossil record. Foraminifera can be used for the reconstruction of paleoceanographic conditions by studying their species assemblages in the sedimentary record and by investigating the stable isotope composition of their shells. To be able to use foraminifera as proxies for the past oceanic environment, the species composition as well as the stable isotope ratios of the shells of recent organisms need to be studied as a function of oceanographic conditions.

The scientific objectives are:

-To determine the geographical and vertical species distribution of planktonic foraminifera along a WE-transect north of the Canary islands.

-To determine the relationships between environmental conditions and the occurrence of planktonic foraminifera as well as the stable isotope composition of their shells.

Methods

Foraminifera were collected with a multinet (mesh size 64µm) in five depth intervals (440-300, 300-150, 150-50, 50-25, 25-0m) at eleven stations along the transect including three stations at the ESTOC-position. The positions of the stations are shown in Fig. 5 and Appendix I. He multinet samples were fixed onboard with a saturated solution of $HgCl_2$ and stained with Bengalrosa. Samples for the $^{18}O/^{16}O$- and $^{13}C/^{12}C$-ratios of the water were taken from the base of each sampling interval from the water bottles. Samples for determining the $^{13}C/^{12}C$- ratio were also fixed with $HgCl_2$.

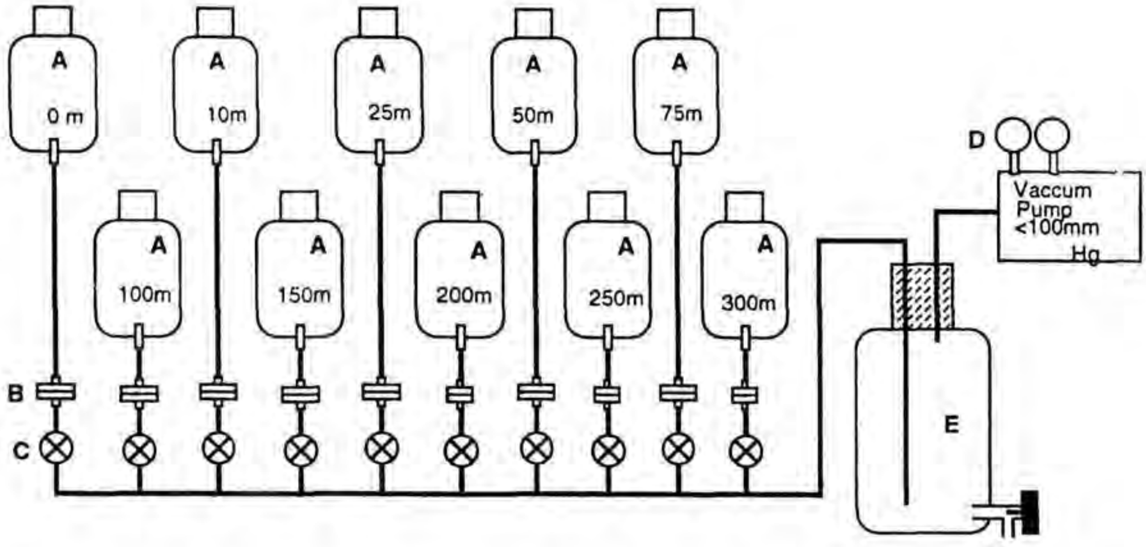
Coccolithophorids

The goal of the coccolithophore sampling is to obtain a better understanding of the seasonal and interannual interaction between coccolithophores and the physical environment, and to compare the water column composition and accumulation in the sedimentary archives. To achieve this goal, it is necessary to determine cell densities and the taxonomic composition in surface waters over at least two seasonal cycles, to determine the accumulation rate of coccoliths in the bioturbated sediment layer (see Leg 4), and to reconstruct the variability of accumulation rates of coccoliths as a function of paleoclimatic conditions during the last two climatic cycles. The results of this cruise will be used to develop a sampling strategy for future cruises in CANIGO.

Methods

Coccolithophorids were sampled along the WE transect from the African coast to the oligotrophic gyre (see Fig. 5, Appendix I). Water samples up to 10 l were taken in 9 depths (0, 25, 50, 75, 100, 150, 200, 300m) and filtered through Nucleopore filters (0.8μm, 47 mm diameter) using a low vacuum filtering set-up (Fig. 14). Filtration was terminated when the filter became clogged and the amount of remaining water was subtracted fromo the filtration volume. The filters were washed with 50 ml distilled water (pH 8.5 to prevent carbonate dissolution). Rinsed filters were dried in petri-dishes and stored in an refrigerator. Filters are counted with a Scanning Electron Microscope upon return to the laboratory.

In addition, samples for nutrients, chlorophyll, POC (particulate organic carbon) and DOC (dissolved organic carbon) were taken at the stations from other working groups (see Appendix I, for methods see Leg 3).



A 10 litre carboys (round or rectangular) with spigot (and 1/4-in. tubing adapter)
B 47mm in-line filter holders Gelman Nr. 1119 with 0.8µm MF-Millipore filter (Millipore Cat. no. AAWP 047 00)
C Stopcock valve (e.g. Cole-Parmer, Cat. no. L-06225-50)
D large water trapping carboy (total filtrate will be 110 liters!)
E vacuum pump, with gauge (to be set at <100mm Hg)

Fig. 14. Filtration set-up for coccolithophorid sampling.

References

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6. Leg 3: Water column investigations at ESTOC and surrounding regions

Introduction

Investigations of the temporal variability of water column processes and particle flux carried out so far at the time-series station ESTOC show a pronounced seasonality of hydrographical structure as well as plankton biomass. During January and February, plankton biomass reaches its highest values during the yearly cycle when the water column is highly mixed and nutrients are replete. Particle flux from the euphotic zone is also highest during winter, corresponding to the winter maximum of phytoplankton biomass. VICTOR HENSEN cruise VH 96/1 was scheduled to coincide with this period of high productivity. The aim of Leg 3 was to conduct the measurements at the ESTOC station in much closer intervals in order to be able to follow more closely changes of biogeochemical parameters at the station. In addition, studies in the vicinity of the station and along a transect north of the Canary islands were conducted to relate processes in the surrounding regions to the parameters determined at ESTOC.

The ESTOC time-series work encompasses a monthly sampling schedule at the ESTOC station. In addition, regional cruises are carried out to determine the variability and the representativeness of the station for the surrounding region. During this leg of VICTOR HENSEN cruise 96/1, we determined important biogeochemical parameters in addition to flux measurements in order to quantify short term changes at and the regional variability around ESTOC.

Biomass and species composition as well as the balance of production and loss rates decide about the quantity of particle flux from the mixed layer. High mineralisation rates in the euphotic zone of the water column often result in low sedimentation rates whereas bloom situations are often followed by high sedimentation rates of particulate organic matter. Particle trap studies at the ESTOC station have shown that particle flux rates are largest following the winter bloom. The balance of phytoplankton growth and loss rates such as grazing and sinking ultimately decide about loss rates of particulate matter from the mixed layer. One approach to investigate the relationship between production and loss rates in the ocean and particle flux is the deployment of surface tethered particle traps in conjunction with rate experiments carried out in the same water body.

Measurements of transient tracers, i.e. properties which are changing with time, have proven to be useful understanding ocean circulation and ventilation. The tracer measured by the tracer group in Bremen comprise tritium, the radioactive hydrogen isotope which decays to ^3He, helium isotopes and neon and the chlorofluorocarbons CFC-11, CFC-12, CFC-113 and $CCl4$. These substances are of anthropogenic origin. Tritium input into the ocean peaked in the mid-1960ies. Input of CFC-11 and CFC-12 started in the 1940s and increased monotonically but with somewhat different rates. Atmospheric concentrations of $CCl4$ have been increasing since 1920 while CFC-113 has been released to the atmosphere only since about 1970. These different input functions allow one to interpret concentration ratios of different tracers in terms of water "age" (time since the water mass had last been in contact with the surface layer), yielding rates of water mass formation and mixing. The quantification of these processes is necessary in understanding biogeochemical cycles in the ocean.

Aluminum distributions in Canary Islands (Central East Atlantic Waters) show a great variability. The area possesses major features that could affect the aluminum biogeochemical behavior, such as elevated aeolian (dust) inputs from the Sahara desert, proximity to areas of upwelling (150-200 Km) and mesoscale features induced by the effect islands on the course of the Canary Current. The aluminum distributions show a marked latitudinal gradient from East to West. The study of the Al variations along these gradients and at a fixed stations could give a better knowledge of the physical and biogeochemical processes controlling mesoscale distribution of aluminum in the area.

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

During this leg, we pursued the following objectives:

1. Sampling of time-series station ESTOC at close intervals during the late winter phytoplankton bloom: determination of phytoplankton development, nutrients, dissolved aluminum, hydrography and particle flux, tracers

2. Find relationship between phytoplankton growth and grazing rate in the water column and particle flux below the mixed layer by conducting rate experiments of phytoplankton growth/grazing (dilution experiments) and particle flux at ESTOC station

3. Determine biogeochemical gradients west of the islands of Lanzarote and Fuerteventura

Following parameters have been determined during this leg by the following participants:

Hydrography	Birgit Klein, Uwe Koy, Andrés Cianca*,FranciscoLuzardo*
O_2, Nutrients	Andrés Cianca*, Francisco Luzardo*
Aluminium	Josep Coca, Andrés Cianca for J. Hernández-Brito
Chlorophyll a	Andrés Cianca, Francisco Luzardo, Susanne Neuer
Trace metals	Birgit Klein
Alkalinity/pH	Melchor González-Davila
Protists	Christiane Lorenzen
HPLC (Pigments determined by High Pressure Liquid Cromatography), POC (Particulate Organic Carbon)	Susanne Neuer, Astrid Eberwein
Phytoplankton growth, microplankton grazing	Susanne Neuer, Christiane Lorenzen
Free-floating sediment trap	Susanne Neuer

*working group of Octavio Llinás (Instituto Canario de Ciencias Marinas, Telde, Gran Canaria)

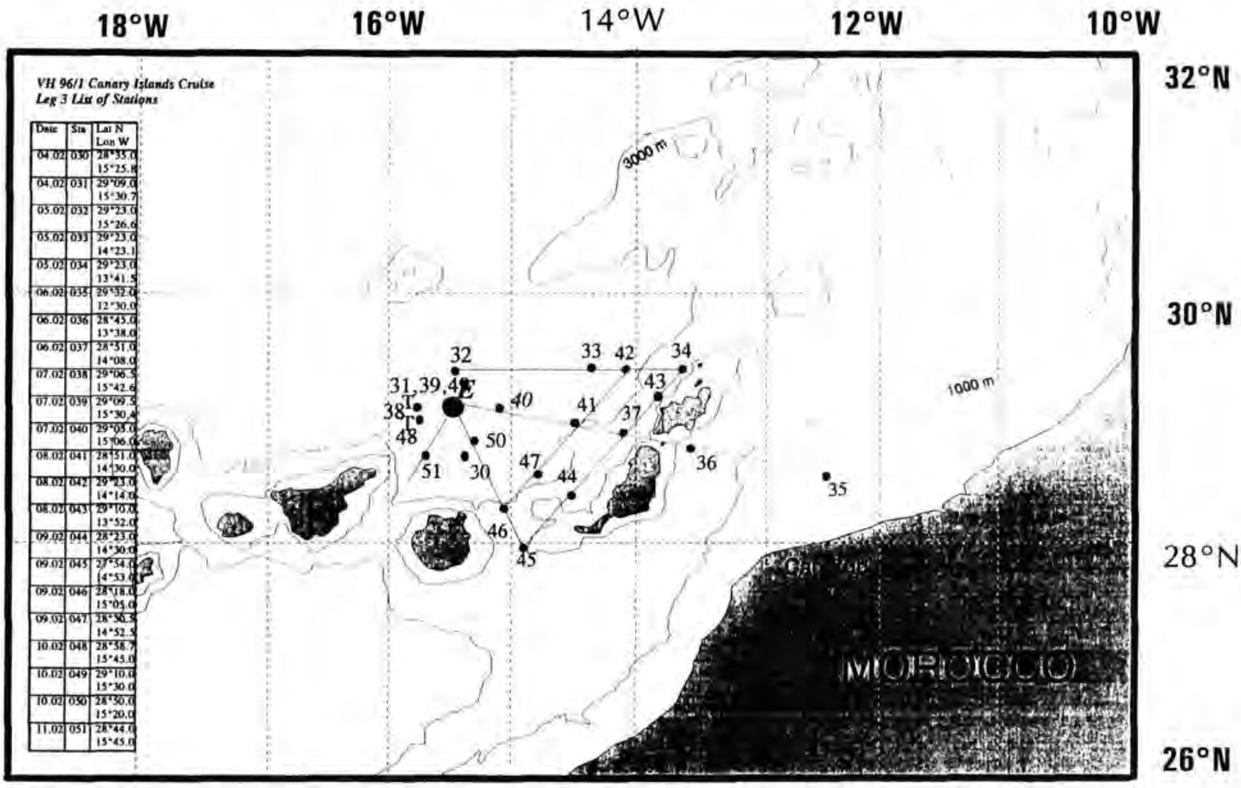


Fig. 15. Map of stations covered on Leg 3. The insert shows the station cooordinates.

On the 1996 VICTOR HENSEN cruise, we had the opportunity to analyse during 10 days both the ESTOC station and the surrounding area. The three ESTOC sampling data on 2, 7, and 10 Feb. will allow us to study short-term temporal variability. These data on the surrounding region will correlate with data from a previous Poseidon cruise in October 1995 with similar cruise tracks.

Itinerary

The Victor Hensen left port of Las Palmas on 4 Feb., two days late as was scheduled due to bad weather conditions. On board were four Spanish and five German scientists. We commenced with station work at ESTOC and deployed the surface tethered particle trap. We continued with an east-west section north of ESTOC and with a tangential section and parallel sections along Fuerteventura and Lanzarote (Fig. 15). We returned to ESTOC on two occasions, to conduct station work and to recover and re-deploy the particle trap. On 6 Feb. we needed to leave our colleague A. Coca onshore in Arrecife (Lanzarote) because of severe seasickness. We returned to port as scheduled in the morning of 12 February.

Methods

Hydrography and collection of water samples (see also Appendix II)

Temperature and salinity in the upper 400 m were determined using a NB 1 (Neil Brown) CTD in conjunction with a 12x2.5 l rosette on the 400 m long conducting wire all stations and a SIS selfrecording CTD on the serial wire down to 1000 m depth on some stations. In addition, reversing thermometers were used and water samples for salt determinations collected to calibrate the CTDs. Water samples were collected mainly with 10 l bottles attached to the 1000 m serial wire.

Nutrients, O_2, Chlorophyll, HPLC, POC

Samples for nutrients were collected in plastic bottles and frozen immediately until analysis onshore. Samples for oxygen were taken and fixed and also analysed onshore.
To quantify the plankton community in the euphotic zone during the trap deployments, samples were taken for chlorophyll, taxonomically characteristic pigments (to be analysed with High Pressure Liquid Chromatography, HPLC) and POC (Particulate organic carbon). All of the water samples were filtered on GF/F filters. While chlorophyll a was analysed onboard ship as an acetone extract using a Turner AU 10 fluorometer (supplied by O. Llinas, ICCM, Telde), POC and HPLC samples were kept frozen until analysis onshore.

Particle Flux

To study particle flux below the euphotic zone, two surface-tethered particle interceptor traps (PIT) were deployed below the mixed layer at 200 and 220 m (Fig. 16) during two mooring periods. The first mooring period lasted from 4-7 Feb., the second mooring period from 7-10 Feb.. The traps were attached to a surface buoy with an ARGOS transmitter and a Radar reflector. The main buoyancy was located at about 30 m depth to avoid the wind-induced EKMAN layer.

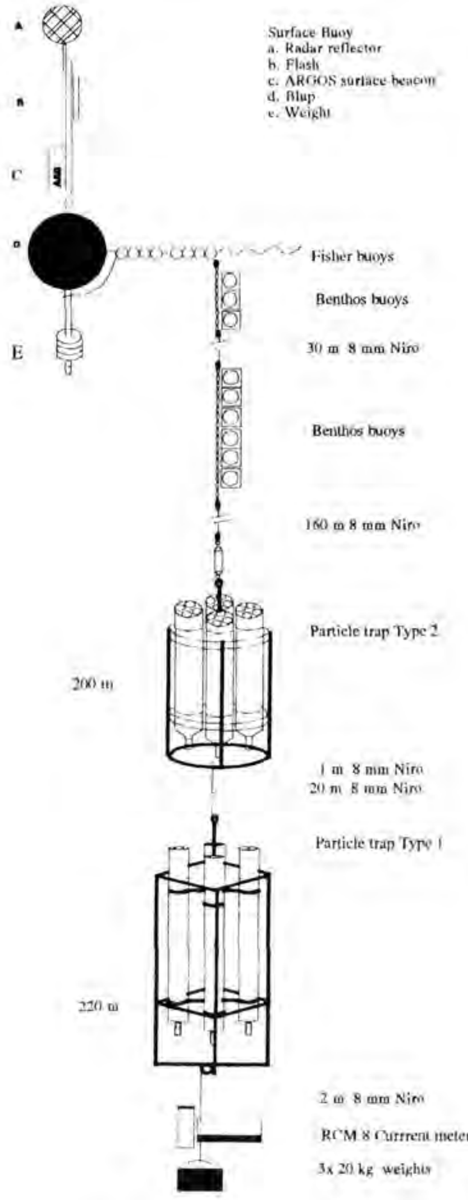


Fig. 16. Free-floating trap-array deployed during Leg 3.

Dilution experiments

During the deployment of the particle trap, dilution experiments were conducted to determine phytoplankton growth and microzooplankton grazing rates under close to in-situ conditions. Dilution experiments were carried out with water from 10 or 30 m depth collected at the beginning of the deployment period of the particle trap. The incubations were carried out in an on-deck incubator. Due to the bad weather conditions and high wave impact on the incubator, the incubation bags ruptured and no result from these experiments could be drawn.

Tracers

Measurements of transient tracers were conducted only at ESTOC station proper. The station was sampled three times during VH96/1at stations 31, 39 and 49. Each tracer profil consists of up to 9 depth levels covering the upper 1000m. A total of 24 tritium samples, 29 helium samples and 27 CFC samples have been collected during this cruise. The CFC samples were sealed off in glas ampoules and will be measured by means of ECD capillary gas chromatography as soon as the gas chromotograph returns from another expedition. Chromatograph and column are commercial units, connected to a non-commercial sample preparation part. The latter is used to prepare gas aliquots for calibration, and to transfer the gas from water samples (30 cm3 volume) into the column by a purge-and-trap procedure. The trap is cooled by means of liquid CO2 to -52 °C, and the trapped gases are released to the chromatographic column by heating to 110 °C. Measurement is by an electron capture detector (ECD). Detection sensitivity is approximately 0.01 pmol/kg, and precision for surface samples about 1 %. Helium samples were placed into clamped-off copper tubes, and tritium samples into 1-liter glass bottles, to be analyzed in the laboratory at Bremen after the cruise. Helium and tritium samples have been extracted immediately after the cruise. The next step in the procedure is helium isotope mass spectrometry (precision 0.2 % in ^3He, 0.4 % in He isotope and Ne concentrations). Tritium is measured by determining 3He grown in from tritium decay (typical ingrowth period 6 months). Helium isotope measurements will begin soon.

Alkalinity

Water samples for pH, titration alkalinity and total carbon dioxide collected from surface to 1000 m were analysed on board within four hour of collection with a termostatized (25°C ± 0.1) 200 ml titration cell with ROSS glass pH electrode and an Orion double junction Ag, AgCl reference electrode. The electrode system was evaluated by determining the pH_{sw}, TA and TCO_2 of Certified Reference Material for Oceanic CO_2 measurements (batch 25) provided by Dickson. The results of these measurements indicate that high-precision measurements of TA (±2.5 μmol kg^{-1}), TCO_2 (± 2.8 μmol kg^{-1}) and pH (± 0.008) can be obtained. The titration values of TCO_2 were very close (± 1.8 μmol kg^{-1}) to the certified value of 2127.2 μmol kg^{-1}.

Alumnium

The water sampling was carried out using Niskin bottles provided with silicone rubber. Samples were taken and manipulated wearing plastic gloves to avoid metal contamination. Water was stored at 250 ml polyethylene bottles an immediately frozen until the analysis at the land-based laboratory. Every container has been previously cleaned using conventional procedures in the trace metal assay. The HPACSV (High Performance Adsorptive Cathodic Stripping Voltammtry) method [Hernández-Brito et al, 1994] will be used to measure dissolved aluminum in seawater. Samples are prepared in teflon cups of polarographic cell, containing 10 ml of water, 2·10-6 M DASA and 0.01 M BES. The adsorption potential (-0.9 V) is applied to the working electrode, while the solution was stirred. After 40 s accumulation time, the stirring is stopped and 5 s was allowed for the solution to became quiescent. The scanning was started at -0.9 V and terminated at -1.4 V. The scan is made using staircase modulation with a scan rate of 30 V/s and a pulse height of 5 mV. The DASA-Al peak appears at ca. -1.25 V. When the analysis is carried out in the presence of oxygen a background correction is carried out. The blank voltammogram is made using 2 seconds deposition and 2 seconds quiescence time. A standard addition procedure is used to quantify the aluminum concentration of the sample.

Plankton sampling

Several sample strategies were followed in order to both collect the small as well as the larger forms of the heterotrophic and autotrophic plankton. On 15 stations, water samples were collected in different depths using the rosette (10 x2.5 l) or the 10 L water bottles and sampling depths were determined according to the fluorescence and the CTD plots. Samples were filled directly into brown glass bottels and fixed immediately with Formalin (20%, buffered with Hexamin) or with Lugol's solution (10 ml to 100 ml sample).

Small forms (cells in the nano, 2-20 μm, and pico, 0.2 - 2 μm, size range were collected on 25 mm Nucleopore filters and fixed with 1 ml Glutardialdehyde and stained with DAPI (1μg / 30 ml sample). DAPI staines the nucleic material and aides in identification of organisms. The filters were embedded in a drop of immersion oil on a slide and frozen at -20 °C.

On nine stations, plankton was concentrated using inverse filtration. Filter holders with 2 µm Nucleopore filters (diameter 47 mm) were placed in a vessel and 3-5 l of seawater from 3 depths were concentrated to 300 ml by carefully pumping the seawater off through the filter holders. The samples were transferred to 100 ml bottles and fixed with 10 ml Lugol and 250 ml bottles which were fixed with 10 ml Formalin.

At the ESTOC Station, the Multinet was deployed twice. The depth ranges were set according to the hydrography. The content of the sampling cups was decanted to about 150 ml and fixed with 20 ml Formalin (1-2% final conc.).

Preliminary results

Hydrography

The water column during Leg 3 was well mixed and the mixed layer depths reached generally down to 150 m depth with surface temperatures around 19 °C. The fluorescence profiles show that phytoplankton biomass was evenly distributed in the mixed layer and did not exhibit consistent maxima in the water column, nor were there signs of phytoplantkon biomass in the thermocline itself. In the time-course of the mesaurements conducted at ESTOC (4 Feb., 7 Feb. and 10 Feb.) the water column shoaled on 7 Feb. to approximately 120 m, while on 10 Feb., the water column was again 150 m deep. On 10 Feb., phytoplankton biomass was reduced in the upper 50 m, possibly indicating the end of the winter bloom and the beginning formation of a deep accumulation of phytoplankton which is typical of the non-bloom situations in this region.

At Station 35, the closest on the shelf to the coast of Morocco, the mixed layer depth reached to the sea floor (around 100 m depth) and phytoplankton biomass was much higher (in arbitrary fluorescence units 0.08 to 1 as compared to around 0.04 in the open sea).

Alkalinity

In this time of the year the surface mixed layer at ESTOC and surrounding area was around 150 m deep while in comparison to October 1995, it was only 75-100 m deep. As can be seen in Figure 17, an important change in the TCO_2 vertical distribution can be observed. By using the CTD data to determine the carbon parameters in the water column, it can be concluded that the distribution in the first 200 m reflects the uptake of CO_2 by phytoplankton for photosynthesis. The structure of the TCO_2 profile resembles that of a typical nutrient type profile, with a surface depletion in the mixed layer which increased sharply with depth to about the 1000 m studied. This decrease is due to the oxidation of organic debris in this zone. However, future calculations and property to property relationships are going to be carried out in order to correlate the data obtained.

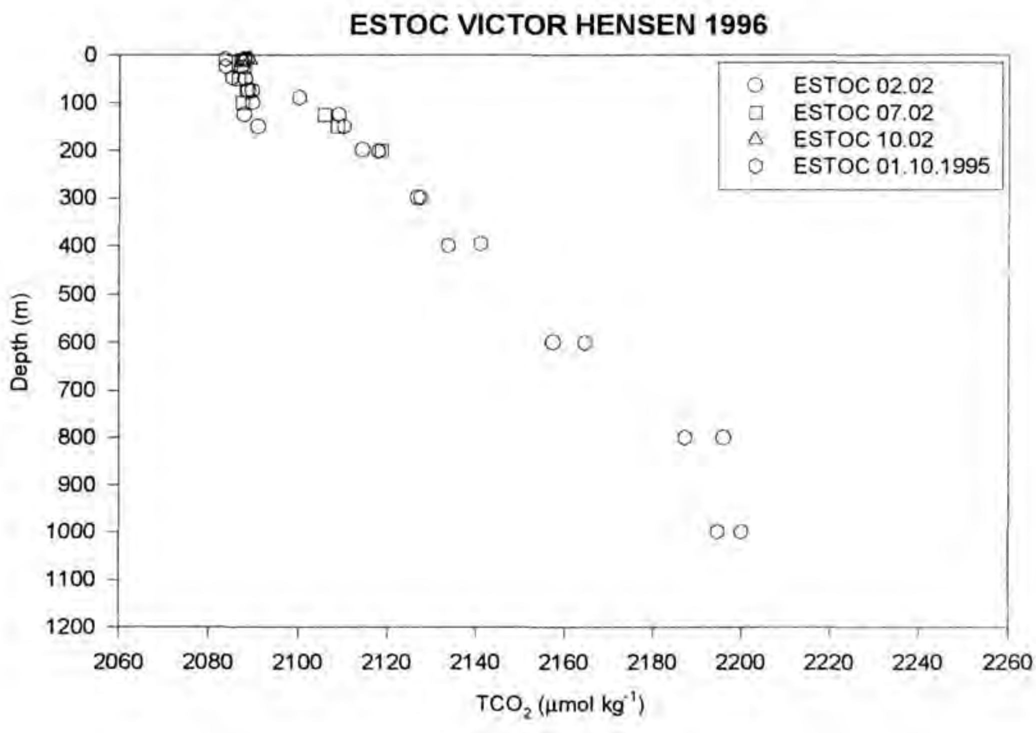


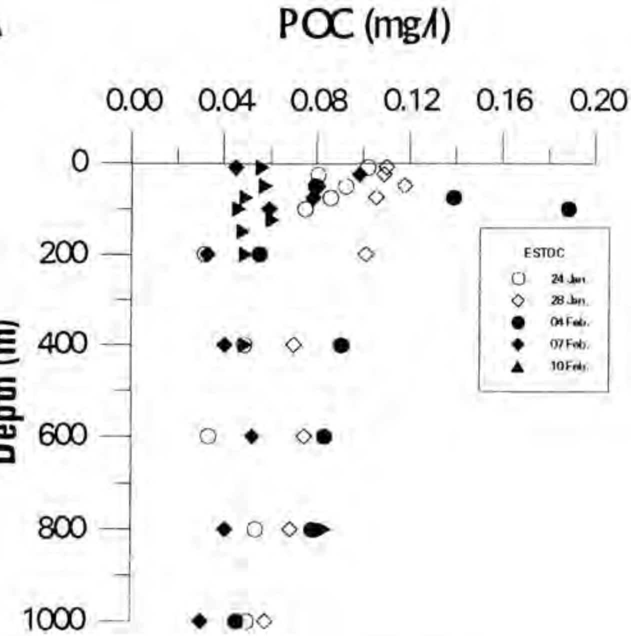
Fig. 17. Depth profiles of total CO_2 determined on different ESTOC stations on this cruise and on RV Poseidon cruise POS 212/3 (October 1995).

Particulate organic carbon

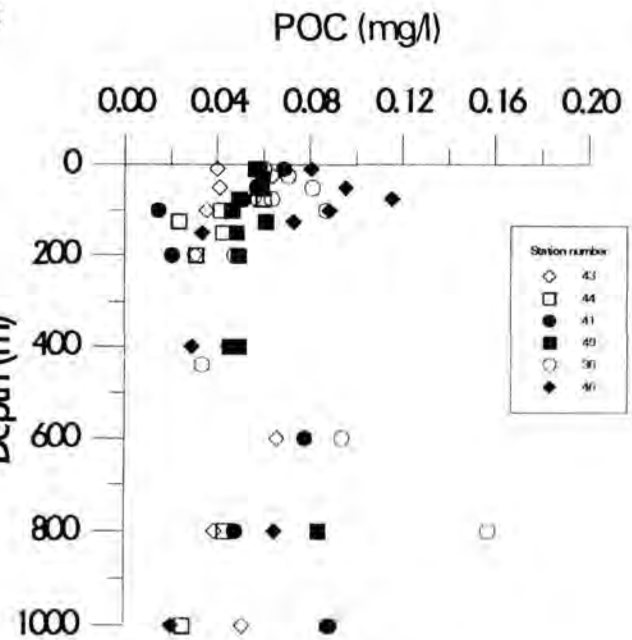
From the end of January until 10 of February, a decline of particulate carbon could be measured at the ESTOC station, from surface values of around 0.1 mg/l to 0.05 mg/l. In addition, on 4 Feb., a subsurface peak could be observed.

The POC profiles taken at the other stations in the ESTOC region indicate that local variability is strongest close to the islands: Station 46 is located close to Gran Canaria and has the highest surface POC values in addition to exhibiting a strong subsurface peak. Station 36 is located east of the islands Fuerteventura and Lanzarote and exhibits a peak at 800 m depths probably correlated to the Mediterranean outflow water. The stations in the vicinity of Lanzarote and Fuerteventura did not show POC concentrations above the range of values measured at the other stations, indicating that biomass was not oncreased due to upwelling or island related processes. Station 49 is ESTOC station of 10 Feb..

A



B



Drifting Particle trap

During the two deployment periods, the particle trap drifted south west, in the path of the Canary current (Fig. 19). During the first deployment, the trap drifted almost 20 km with a speed of 8.54 cm/s. During the second deployment, the trap drifted almost 31 km with a speed of 11.8 cm/s. These velocities are typical of mesoscale velocities measured in this region.

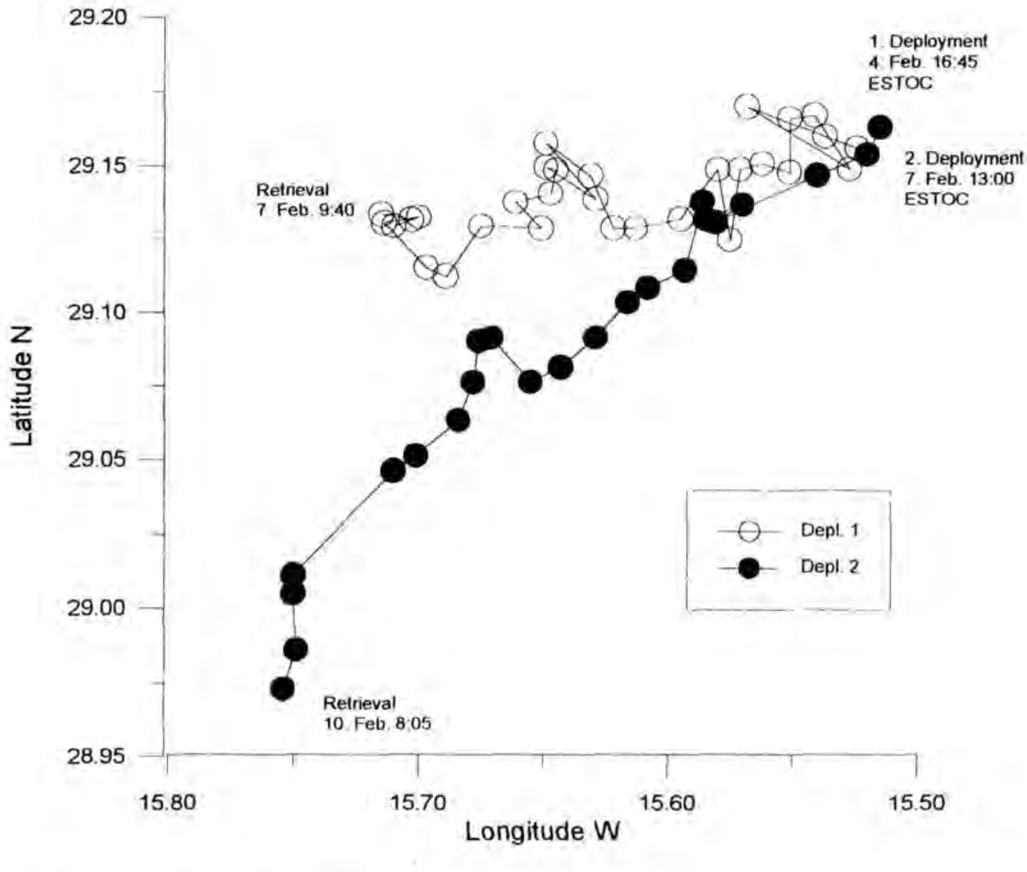


Fig. 19. Drift course of the free-drifting particle trap during the two deployment periods.

Fig. 18. Vertical profiles of particulate organic carbon. A. Profiles determined at the ESTOC station during VICTOR HENSEN cruise VH 96/1. B. Profiles determined at different stations in the surrounding area (lower graph, see Fig. 14 for station locations).

7. Leg 4: Geological investigations along Moroccan shelf

Itinerary

Leg 4 began on 13 February 1996 at Las Palmas, Gran Canaria. At 16:00h Victor Hensen left Las Palmas for a cruise of ten days heading to the coast of Morrocco. On board were four German and two Moroccan scientists. The scientific program started the next morning with a transect off the Moroccan shelf to the north-west. During the next eight days, six transects between the Canary Islands and Morocco were sampled with CTD, grabber and box corer. On the last day, a one-day station was carried out close to the northern coast of Fuerteventura, where CTD profiles were taken and a new profiler system was tested. The cruise ended in Las Palmas on 22 February 1996.

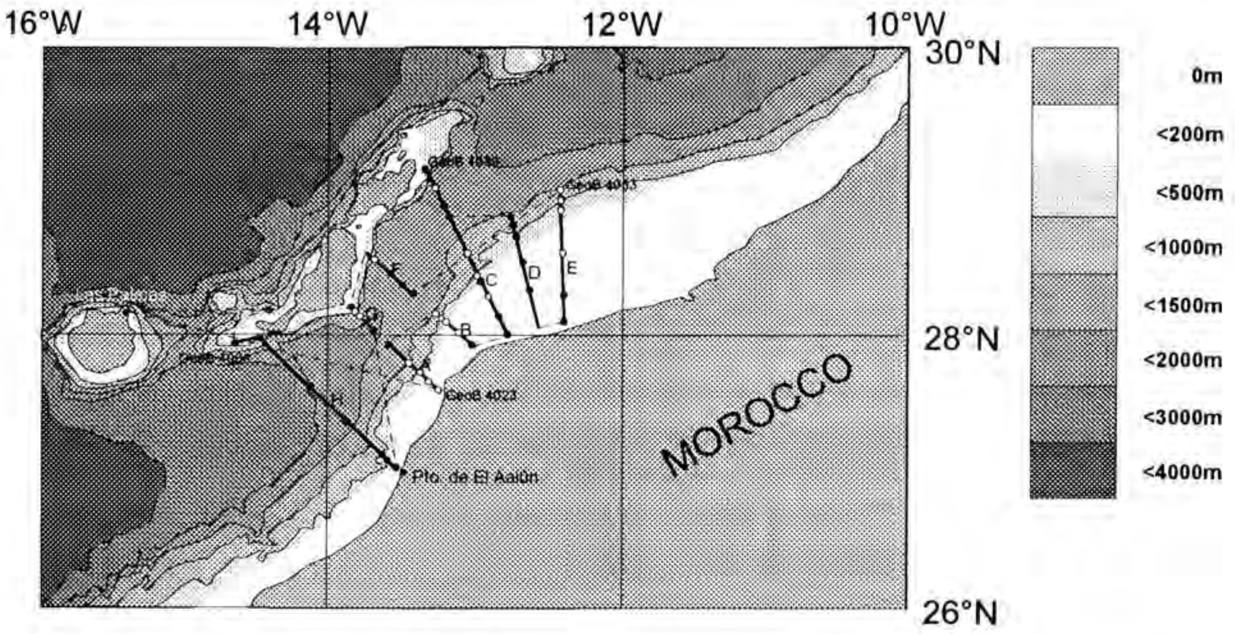


Fig. 20: Cruise track of the Victor Hensen Leg 4. Positions of stations with sediment samples and CTD casts are marked with white dots, positions with additional CTD casts with black dots..

Material and Methods

CTD-casts

The analyses of salinity, temperature, and oxygen was carried out online with a Neill Brown CTD sensors (CTD). Additionally, the CTD was equipped with a fluorescense sensor and a O_2 (relative) sensor. The measurements were restricted to the upper 465m due to the length of cable. On shallower stations, the CTD was lowered to 10-20m above the bottom. In total, 53 CTD casts were taken on 46 stations.

The measurements were made in order to characterize the oceanographic conditions between the Moroccan coast and the eastern Canary Islands and also to provide data for the subsequent correlation of plankton and sediment analysis. Fig. 21 shows the transects A and G (Fig. 20) at the narrowest distance between Morocco and the Canary Islands as example for the shallowing of the mixed layer thickness from about 140m in the northwest to 60m close to the Moroccan coast. Close to the coast, the mixed layer was situated close to the bottom.
On the last day, eight CTD casts were taken close to the south-west of Fuerteventura from 08:00h to 21:30h at one position to characterize the daily variation of coccolithophorid cell densities and community composition.

Plankton sampling for coccolithophorids

Together with the CTD, a rosette with twelve Niskin bottles (2.5 l) was used to get samples from different water depths. At the lower depth levels (150, 200, 300 m) the content of two bottles were combined to obtain sufficient water for the filtration procedure. These samples were filtered over 0.8 µm Nucleopore filters with 47 mm diameter using a low vacuum filtration. Filtration was terminated if the filter became clogged and the amount of remaining water was measured. Afterwards the filters were rinsed with 50 ml of distilled water to eliminate the sea salt. 1-2 drops of NH_4OH per litre were added to obtain a pH value of 8.5 to prevent carbonate dissolution. The samples has been dried at 50°C and stored in a refrigerator. Plankton samples were taken at stations GeoB 4024 to GeoB 4028, GeoB 4030 to GeoB 4032, GeoB 4035, and at station GeoB 4069 northwest of Fuerteventura (Appendix IV).

Surface sediments

The boxcorer which was used at most stations had a sampling area of 50 x 50 cm.

Usually it was subsampled by taking two archive cores of 12.5 cm diameter of the complete length. Additionally, two surface samples for planktonic and benthic studies (0-1 cm) and organic material (0-1 cm) were taken. If possible, syringe samples of the sedimentary sequence were taken every 2 cm. Two samples from surface and from 15-20 cm were taken for sedimentary studies to be conducted by the Moroccanian scientists onboard.

When it was not possible to get samples with a boxcorer due to coarse sediments, a grabber was employed to obtain a surface sample.

Surface sediment distribution

The sediments on the shelf down to 400 m water depth were reddish to light brown and coarse with a great amount of mollusc and pteropod fragments. Down to 1000 m water depth, the sediments became finer grained and the color changed to grey green. In the deeper parts (>700m), carbonatic ooze was widely distributed. Often sorted layers of coarse sediment could be found in the sediment series, indicative of turbiditic sequences.

Profiler test

On the last station, a newly developed CTD profiler was successfully tested. The system was linked to a small wire and could change its depth using a user defined program while measuring temperature, pressure, and salinity. The system can transmit the measured data via a UHF radio connection to the ship.

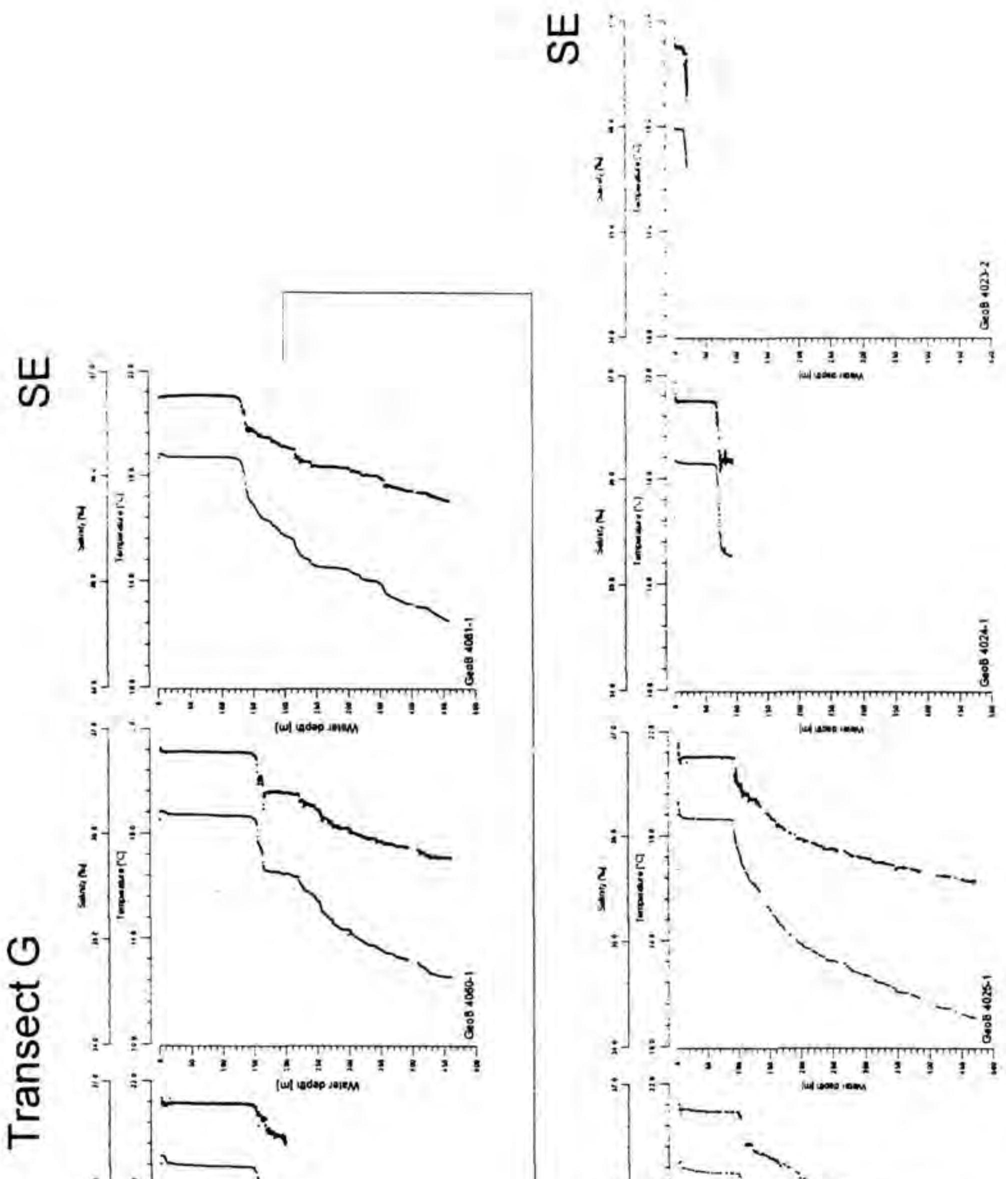


Fig. 21. CTD profiles taken along transects A and G (see Fig. 20).

8. Appendices and list of abbreviations

Appendix I	**Station list of Leg 2**
Appendix II	**Station list of Leg 3**
Appendix III	**CTD and fluorescence profiles of Leg 3**
Appendix IV	**Station list of Leg 4**

Abbreviations used

Alk	Alkalinity
BG	Grab sampler
CFC	Chlorofluorocarbons
Chl	Chlorophyll a
coc	Coccolithophorids
CTD	Conductivity, Temperature, Depth sensors
Dil-Exp.	Dilution experiment
doc	Dissolved organic carbon
flu	Fluorescence
for	Foraminifera
GKG	Giant box corer
He/3H	Helium/Tritium
HPLC	High pressure liquid chromatography
lat	Latitude
lon	Longitude
Nut	Nutrients
poc	Particulate organic carbon
Prof	Profile
Stat	Station
XCP	Expendable Current Profiler

Appendix: station protocol

Canary Islands cruise 22.1.-1.2.96

Date	Stat	Prof	lat N	lon W	depth /m	time start/end	ctd me	ctd sis	profile depth	sampling depths /m	sampl time	xcp	for	coc	Chl HPLC	Chl std	flu	O_2	Nut	doc	poc	Isotopes
23.1.	002	test	28°25.0	16°15.0	1500	13:50 15:05																
	002	001				15:25 16:43		#		25-50-150-300-500							#					
	002	002				20:04 ??:??		#									#					
24.1.	003	003	29°08.3	15°34.0		08:20-08:45		#	0-200	0-10-25-50-75-100-150-200	08:35			#			#			#		#
	003	004	29°08.3	15°34.0		09:40-10:05		#	0-200	0-10-25-50-75-100-150-200	09:55				#	#	#	#	#		# not 150	
	003	005	29°08.3	15°34.0		11:05-12:55		#	0-1000	200-300-400-500-600-700-800-900-1000	11:40			300	200		#	#	#	# 300-500-800-1000	100-600-800-1000	3[illegible] 400-500-600-1000
	003		29°08.3	15°34.0		13:15-13:50					13:36		#									
	003	006	29°08.3	15°34.0		14:30-14:50			0-450													
25.1.	004	007	28°32.0	12°30.0	104	06:30-06:40	#		0-104													
	004	008	28°32.0	12°30.0	104	06:51-07:10		#	0-104	0-10-25-50-75-103	07:00			# not 0		#	#		#	#		
	005	009	28°35.0	12°45.4	150	8:55-9:10	#		0-153													
	005	010	28°35.0	12°45.4		9:20-9:40		#	0-150	0-10-25-50-75-100-150	9:30						#					
	006	011	28:38.5	13.00.7	560	11:15-11:35	#		0-455													
	006		28:38.6	13.00.9	560	11:47-???			0-440		12:05		#									
	006	012	28:38.6	13:00.9	560	12:50-13:30		# no data	0-550	0-10-25-50-75-100-150-200-300-440-550	13:05			300		#			#	#		2[illegible] 50-150-300-440
	006	013	28:38.6	13:00.9	560	13:38-????		#	0-550													
	006	014	28°38.5	13°00.5		14:04						# 1										
	007	015	28°40.1	13°07.3		14:46						# 2										
	008	016	28°41.5	13°14.8	1080	15:40	#											#				

Canary Islands cruise 22.1.-1.2.96: station protocol

Date	Stat	Prof	lat N	lon W	depth /m	time start/end	ctd me	ctd sis	profile depth	sampling depths /m	sampl time	xcp	for	coc	Chl HPLC	Chl std	flu	O_2	Nut	doc	poc	Isotopes	radiomet
25.1.	008	017	28°41.5	13°14.8	1080	16:00-17:10		#	0-1000	0-10-25-50-75-100-150-200-300-500-800-1000	16:33						#						
		018	28°41.5	13°14.8								# 3 def											
		019	28°41.5	13°14.8								# 4											
	009	020	28°43.1	13°22.5							18:12	# 5											
	010	021	28°44.7	13°30.3	1300	19:10-19:36	#		0-450														
	010		28°44.7	13°30.3	1300	19:40					20:15		#										
	010	022	28°44.7	13°30.3	1300	20:55-????		#	0-1000	0-10-25-50-75-100-150-200-300-440-800-1000	21:30			# 300		#	#		#	#		440 300 150 50 25	
		023	28°44.7	13°30.3	1300	23:05						# 6											
26.1.	011	024	28°46.4	13°37.9		00:15						# 7											
	012	025	27°49.9	13°23.6	105	08:10-08:20	#		0-105														
	012	026	27°49.9	13°23.6	105	08:42-08:58		#	0-90	0-10-25-50-75-90	08:50			#, not 0			# 10 - 90						
	013	027	27°56.5	13°32.4	1960	10:07-10:30	#		0-450														
			27°56.5	13°32.4	1960	10:30-11:15					10:45		#										
	013	028	27°56.5	13°32.4	1960	11:28-12:55		#	0-1000	0-10-25-50-75-100-150-200-300-440-800-1000	12:15			# 300			#			#		440 300 150 50 25	
	013	029	28°02.8	13°41.3		13:00-13:15				0 - 36 (2), 0													#
	014	030	28°02.8	13°41.3																			
	014	031	28°02.8	13°41.3		15:00-15:50				10-50-120-440-1000	15:22			# 10-50-120	# 10-50-120		#						
	014	032				16:00-16:10				0-36 (3) - 0													#

Canary Islands cruise 22.1.-1.2.96: station protocol

Date	Stat	Prof	lat N	lon W	depth /m	time start/end	ctd mc	ctd sis	profile depth	sampling depths /m	sampl time	for	coc	Chl HPLC	Chl std	flu	O_2	Nut	doc	poc	Isotopes	radiomet	mst
26.1.	015	033	28°09.0	13°49.9	750	17:13-17:40	#																
	015	034	28°09.0	13°49.9		17:40-17:55				0 - 33 (3) , 0												#	
			28°09.0	13°49.9		18:00-18:45					18:22	#											
	015	035	28°09.0	13°49.9		~18:50-				0-10-25-50-75-100-150-200-300-440-650	19:25		# 300						#		440 300 150 50 25		
27.1.	016	036	28°49.9	13°59.9	1500	08:14-08:43	#		0-470				# 0										
	016	037	28°49.9	13°59.9		~9:17-9:40		#	0-1000	0-440-1000													
	017	038	28°52.4	14°14.9	2620	12:05-12:28	#		0-470														
	017		28°52.4	14°14.9		12:35-13.15					12:50	#											
		039	28°52.4	14°14.9		13:20-14:35		#	0-1000	0-10-25-50-75-100-150-200-300-440-800-1000	13:50		# 300	#			#		#		440 300 150 50 25		
	017	040	"	"	"	14:45-15:25		#	0-460														#
	018	041	28°55.3	14°30.0	3000	~17:08-17:19		#	0-460														#
	018	042	28°55.3	14°30.0		•17:28-~17:50	#																
	018	043	28°55.3	14°30.0		17:55-18:57		#	0-1000	0-440-1000	18:22		# 0			#							
	019	044	28°58.9	14°44.9	3515	20:45-21:07	#		0-470														
	019	045	28°58.9	14°44.9		21:30-21:50		#															#
	019	046	28°58.9	14°44.9		22:07--11:35		#	0-1000	0-50-100-440-1000	10:40		# 100			#		#					
28.1.	020	047	29°02.2	15°00.0	3580	06:07-06:29	#		0-470														
	020		29°02.2	15°00.0		06:32-7:15					6:50	#											
	020	048	29°02.2	15°00.0		07:20-8.43		#	0-1000	0-10-25-50-75-100-150-200-300-440-800-1000	08:00		# 300	#		#	#	#	#		440-300-150-50-25		
	020	049	29°02.2	15°00.0		9.03-9.23		#															#

Canary Islands cruise 22.1.-1.2.96: station protocol

Date	Stat	Prof	lat N	lon W	depth /m	time start/end	ctd me	ctd sis	profile depth	sampling depths /m	sampl time	for	coc	Chl HPLC	Chl std	flu	O_2	Nut	doc	poc	Isotopes	radiomet	mst
	021	050	29°05.4	15°14.7	3580	11:06-11:25		#	0-470														#
		051				11:28-?	#		0-470														
		052				?-12:55		#	0-1000	0-50-100-440-1000	12:15		# 0-50-100			#		#					
	022	053	29°08.3	15°34.0	3710	15:21-15:40	#		0-470														
		054				15:45-16:05		#															#
						16:10-16:55					16:30	#											
		055				16:55-17:30		#	0-200	0-10-25-50-75-100-150-200	17:16					#	0-50-100-200	#	#	# not 0-150	#		
		056				18:12-18:45		#	0-200	0-10-25-50-75-100-150-200	18:25		#	#	#								
		057				19:10-20:30		#	0-1000	300-440-600-800-1000	19:40		# 300			#	440-1000		# not 600	# not 300	#		
						20:30-21:15					20:53	#											
	023	058	29°12.8	15°45.2	3640	22:40-23:00	#		0-470														
		059	29°12.8	15°45.2		23:02-00:10		#	0-1000	0-50-100-440-1000	23:30		# 0-50-100			#		#					
29.1.		060	29°12.8	15°45.2		00:30-00:45		#	0-470														#
	024	061	29°16.1	16°00.1	3650	08:07-08:23	#																
		062	29°16.1	16°00.1		08:27-09:33		#		0-50-100-440-1000	08:52		# 0-50-100			#		#					
		063	29°16.1	16°00.1		09:45-10:05		#															#
		064				10.:10-10:22				0-33(3)												#	
	025	065	29°19.2	16°15.0	3700	11:47-12:08		#															#
			29°19.2	16°15.0		12:15-13:00					12:36	#											

Canary Islands cruise 22.1.-1.2.96: station protocol

Date	Stat	Prof	lat N	lon W	depth /m	time start/end	ctd me	ctd sis	profile depth	sampling depths /m	sampl time	for	coc	Chl HPLC	Chl std	flu	O_2	Nut	doc	poc	Isotopes	radio met	mst
29.1.		066	29°19.2	16°15.0		13:05-14:20		#	0-1000	0-10-25-50-75-100-150-200-300-440-800-1000[1]	13:38		# 300	#		#		#	#			440-300-150-50-25	
		067	29°19.2	16°15.0		14:25-14:40	#		0-470														
		068				14:40-14:56				0-33(3)												#	
	026	069	29°22.2	16°30.0	3700	16:24-16:43	#		0-470														
		070	29°22.2	16°30.0		16:50				clouds: rejected												#	
		071	29°22.2	16°30.0		17:00-18:10		#	0-1000	0-50-100-440-1000	17:23		# 0-50-100					#					
		072	29°22.2	16°30.0		18:30-18:50		#	0-470														#
	027	073	29°25.2	16°45.0	3840	20:22-		#															#
		074	29°25.2	16°45.0		22:45-21:05																	
			29°25.2	16°45.0		21:05-21:55					21:32	#											
		075	29°25.2	16°45.0		22:00-23:40				0-10-25-50-100-150-200-300-440-1000	22:52		0-25-50-100		# not 300-1000	#		#			440-300-150-50-25		
30.1.	028	076	29°28.5	17°00.0	3930	08:10-08:25	#																
		077	29°28.5	17°00.0		08:31-09:30		#		0-50-120-440-1000	08:55		# 0-50-120					#					
		078	29°28.5	17°00.0		09:42-10:03		#[2]															#
	029	079	29°31.5	17°15.0	4050	11:57-????	#																
		080	29°31.5	17°15.0		12:25-13:30		#		0-50-100-200-440-1000	12:55		# 0-50-100-200					#	#				
		081	29°31.5	17°15.0		13:53-14:15		#															#

[1] The depth was not 1000 m , because the temperature of the unprotectet termometer was to high.

[2] no data

Canary Islands cruise 02.02-12.02.1996: station protocol

Date	Sta	Prof	Lat N Lon W	Wea-ther	depth /m	time start	ctd nbl	ctd sis	profile depth	sampling depth /m	He /H_3	CFC	O_2	Alk/ pH	Chl std	Nut	Trace metal	POC	Iso-topes	HPLC	Protis-ten	Dil-Exp	Trap depth
04.02	030	001	28°35.0 15°25.8	NE: 4	3650	11:25			500	500-530													$H_2$0 NaCl
		002				12:24	#		465	465													
04.02	031	000	29°09.0 15°30.7	NE: 4	3660	16:45																	into water 200-220m
		001				17:30		#	1000	1000, 800, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25, 10			#	#	#	#	#						
		002				19:17	#			150, 90, 75, 25											#		
		003				20:10		#	1000	1000, 800, 600, 400, 200, 100, 75, 50, 25, 10								#		#			
		004				21:37			30	30, 28, 26, 24												#	
		005				21:50			1000	1000, 600, 400, 200, 150, 100, 50, 25, 10	#	#											
		006				23:20			80	80, 78, 76, 74												#	
						23:40			XBT-T5,# 01	1800 m													

Date	Sta	Prof	Lat N Lon W	Wea-ther	depth /m	time start	ctd nb 1	ctd sis	profile depth	sampling depth /m	He /H3	CF C	O_2	Alk/ pH	Chl std	Nut	Trace metal	POC	Iso-topes	HPLC	Protis-ten	Dil-Exp	Trap depth
05.02	032	001	29°23.0 15°26.6	NNE: 5/6	3700	08:05		#	1000	1000, 800, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25				#	#	#	#						
		002				09:30	#		465	200, 150, 100, 50, 10				#	#	#	#				#		
						18:24			[1] XBT-T5,#02														
05.02	033	001	29°23.0 14°23.1	NNE: 5-6	3450	16:15			1000	1000, 800, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25, 10				#	#	#	#				#		
		002				17:22	#		465	200, 100, 75, 50, 25, 10										#			
05.02	034	001	29°23.0 13°41.5	NNE: 5-6	1840	23:20				1000, 800 600, 400, 300, 200, 150, 125, 100, 75, 50, 25			#	#	#	#	#						
		002				00:42	#			10			#	#	#	#	#						
06.02	035	001	28°32.0 12°30.0	N: 5-6	100	09:25	#		100	90, 75, 50, 25, 10			#	#	#	#	#				#		
		002				10:20			100	90, 75, 50, 25, 10					#			#		#			

[1] XBT hat nicht funktioniert

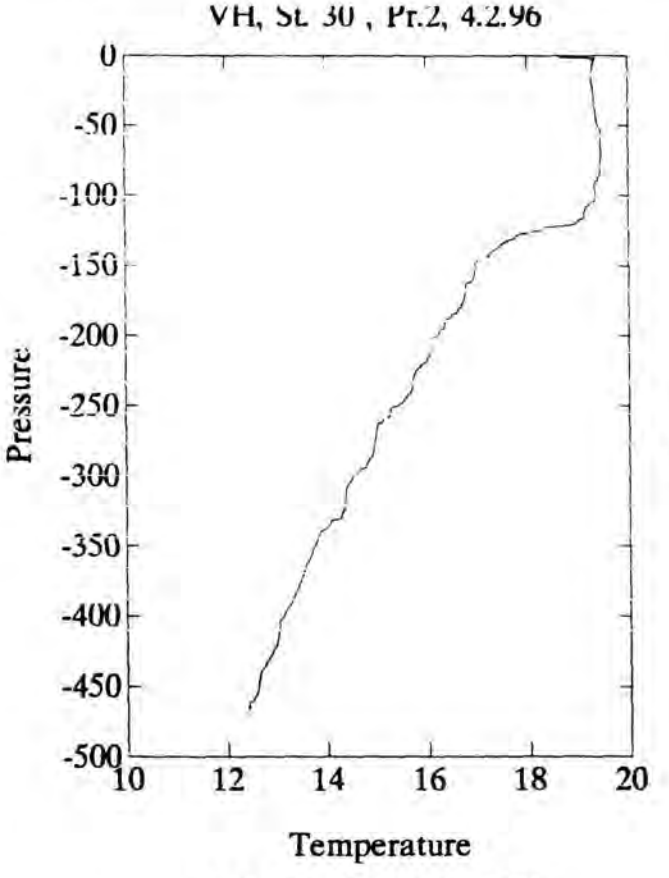
Date	Sta	Prof	Lat N Lon W	Wea-ther	depth /m	time start	ctd nb 1	ctd sis	profile depth	sampling depth /m	He /H_3	CFC	O_2	Alk/ pH	Chl std	Nut	Trace metal	POC	Iso-topes	HPLC	Protis-ten	Dil-Exp	Trap depth
06.02	036	001	28°45.0 13°38.0	NNE: 5	1140	17:45			1000	1000, 800, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25				#		#	#						
		002			1140	19:16	#		465	100, 75, 25, 10				#		#	#				#		
		003			1140	19:56			1000	1000, 800, 600, 400, 200, 100, 75, 50, 25, 10								#		#			
06.02	037	001	28°51.0 14°08.0	NNE: 5-6	2000	23:55			1000	1000, 800, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25			#	#	#	#	#						
07.02	037	002			2000	01:16	#		465	100, 75, 50, 25, 10			#	#	#	#	#				#		
07.02	038	000	29°06.5 15°42.6	N: 5	3630	09:40			500	500-530													out of water
		001			3630	10:40			500	450-500													H_2O NaCl
		002			3630	11:14	#		465	150, 100, 75, 50, 25, 10					#					#	#		
07.02	039	000	29°09.5 15°30.4	N: 5-6	3660	13:00																	into water
		001			3660	13:58				1000, 800, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25			#	#	#	#	#						

Date	Sta	Prof	Lat N Lon W	Wea-ther	depth /m	time start	ctd nb 1	ctd sis	profile depth	sampling depth /m	He $/H_3$	CFC	O_2	Alk/ pH	Chl std	Nut	Trace metal	POC	Iso-topes	HPLC	Protis-ten	Dil-Exp	Trap depth
		002				15:01	#			150, 100, 50, 10											#		
		003				16:20				10			#	#	#	#	#						
		004				16:35				1000, 800, 600, 400, 200, 100, 75, 50, 25, 10								#		#			
		005				17:30				1000, 600, 400, 200, 150, 100, 50, 25, 10	#	#											
		006				18:55				25												#	
		007				19:15			200	200, 150, 100, 50, 10											multi-net		
		008				20:00				25												#	
07.02	040	001	29°03.0 15°06.0	NE: 5	3590	23:05			1000	1000, 800, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25			#	#	#	#	#						
08.02		002				00:36	#		465	10			#	#	#	#	#						
08.02	041	001	28°51.0 14°30.0	NE: 5/6	3100	08:05	#		1000	1000, 800, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25				#	#	#	#						
		002				09:18	#		465	10				#	#	#	#						
		003				09:50			1000	1000, 800, 600, 400, 200, 100, 75, 50, 25, 10								#					

Date	Sta	Prof	Lat N Lon W	Wea-ther	depth /m	time start	ctd nb 1	ctd sis	profile depth	sampling depth /m	He /H_3	CFC	O_2	Alk/ pH	Chl std	Nut	Trace metal	POC	Iso-topes	HPLC	Protis-ten	Dil-Exp	Trap depth
08.02	042	001	29°23.0 14°14.0	NNE: 5	3390	15:15			1000	800, 600, 400, 200, 100, 75, 50, 25				#	#	#	#						
		002				16:27	#		465	100, 75, 50, 25, 10				#	#	#	#				#		
08.02	043	001	29°10.0 13°52.0	NE: 3-4	1440	19:00			1000	1000, 800, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25				#	#	#	#						
		002			1440	20:20	#		465	100, 75, 50, 25, 10				#	#	#	#				#		
		003			1440	20:55		#	1000	1000, 800, 600, 400, 200, 100, 75, 50, 25, 10								#		#			
09.02	044	001	28°23.0 14°30.0	N: 4	2100	06:05		#	1000	1000, 800, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25			#	#	#	#	#						
		002			2100	07:15	#		465	100, 75, 50, 25, 10			#	#	#	#	#				#		
		003			2100	08:25		#	1000	1000, 800, 400, 200, 150, 125, 100, 75, 50, 10								#		#			

Date	Sta	Prof	Lat N Lon W	Weather	depth /m	time start	ctd nb 1	ctd sis	profile depth	sampling depth /m	He /H_3	CFC	O_2	Alk/ pH	Chl std	Nut	Trace metal	POC	Isotopes	HPLC	Protisten	Dil-Exp	Trap depth
09.02	045	001	27°54.0 14°53.0	N: 4	1030	13:00		#	800	1000,800, 600, 400, 300, 200, 150, 125, 100, 75			#	#	#	#	#						
		002				14:08	#		465	100, 75, 50, 10											#		
09.02	046	001	28°18.0 15°05.0	N: 4-5	3000	17:30		#	1000				#	#	#	#	#						
		002				18:46	#		465	100, 75, 50, 25, 10											#		
		003				19:30			200	200, 150, 125, 100, 75, 50, 25, 10			#	#	#	#	#	#		#			
		004				19:55			400	400, 75, 10								#					
09.02	047	001	28°30.5 14°52.5	N: 5	3460	22:20		#	1000	1000, 800, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25				#	#	#	#						
10.02		002				00:07	#		465	100, 75, 50, 10				#	#	#					#		
10.02	048	001	28°58.7 15°45.0	N: 5	3620	08:05																	re-trieve
		002				08:46	#			200, 150, 100, 75, 50, 10					#					#	#		
10.02	049	001	29°10.0 15°30.0	N: 5-6	3660	11:50			10	10		#											

Date	Sta	Prof	Lat N Lon W	Wea-ther	depth /m	time start	ctd nb 1	ctd sis	profile depth	sampling depth /m	He /H_3	CFC	O_2	Alk/ pH	Chl std	Nut	Trace metal	POC	Iso-topes	HPLC	Protis-ten	Dil-Exp	Trap depth
		002				12:00		#	1000	1000, 800, 600, 400, 300, 200, 150, 125, 100, 75, 50					#	#			#				
		003				13:12	#		465	125, 75, 50, 25, 10				#	#	#			#		#		
		004				15:05		#	1000	1000, 800, 400, 200, 150, 125, 100, 75, 50, 10					# frac >2 µm <20 µm			#		#			
		005				16:05			1000	1000, 600, 400, 200, 150, 100, 50, 25	#	#											
		006				17:15			200	200, 150, 100, 50, 10											Multi-net		
		007				18:05				30-20												#	
10.02	050	001	28°50.0 15°20.0	NE: 6-7	3610	22:30			1000	1000, 600, 400, 300, 200, 150, 125, 100, 75, 50				#	#	#							
		002				23:45			200	25, 10				#	#	#							
11.02	051	001	28°44.0 15°45.0	NNE: 6		08:05			1000	1000, 600, 400, 300, 200, 150, 125, 100, 75, 50, 25, 10				#	#	#				#	#		


VH, St. 30 , Pr.2, 4.2.96
Pressure
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-150
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-300
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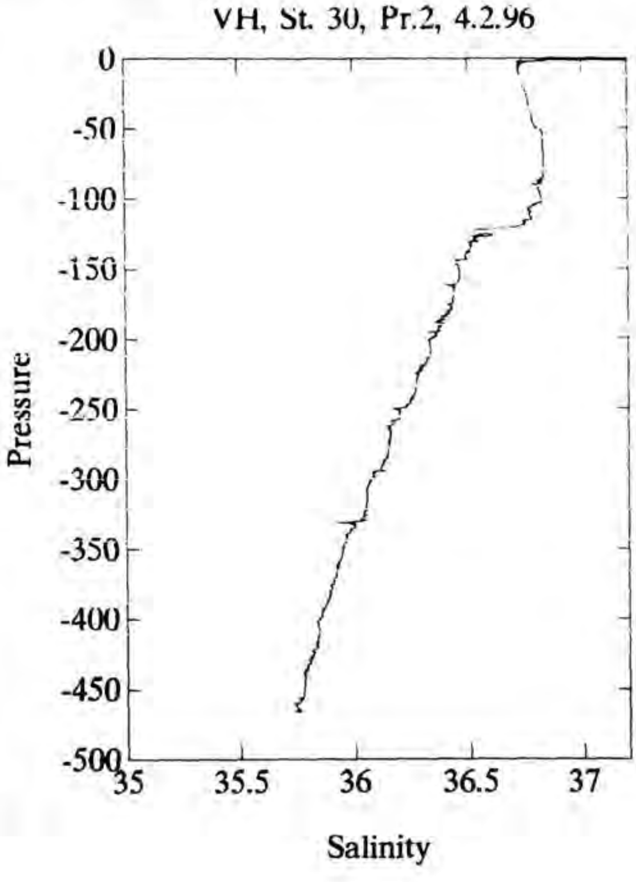
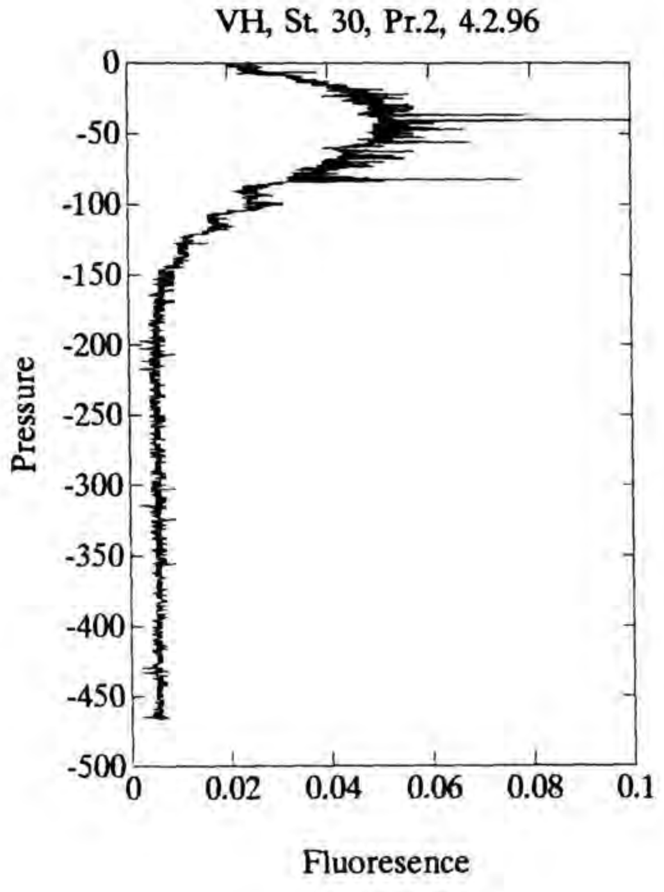
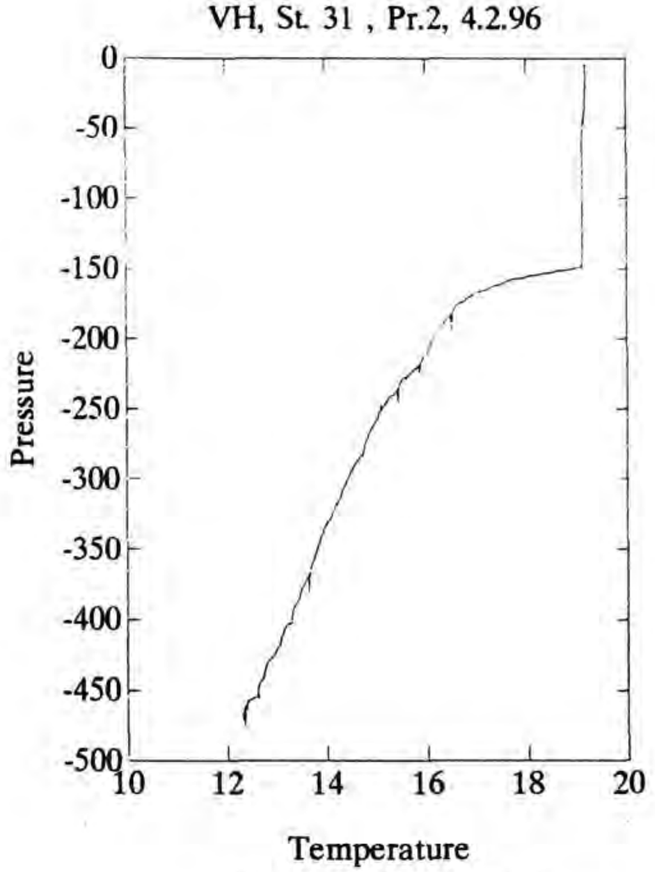
-400
-450
-500
10
12
14
16
18
20
Temperature


VH, St. 30, Pr.2, 4.2.96
Pressure
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
35
35.5
36
36.5
37
Salinity


VH, St. 30, Pr.2, 4.2.96
Pressure
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
0
0.02
0.04
0.06
0.08
0.1
Fluoresence


VH, St. 31 , Pr.2, 4.2.96
Pressure
Temperature
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-50
-100
-150
-200
-250
-300
-350
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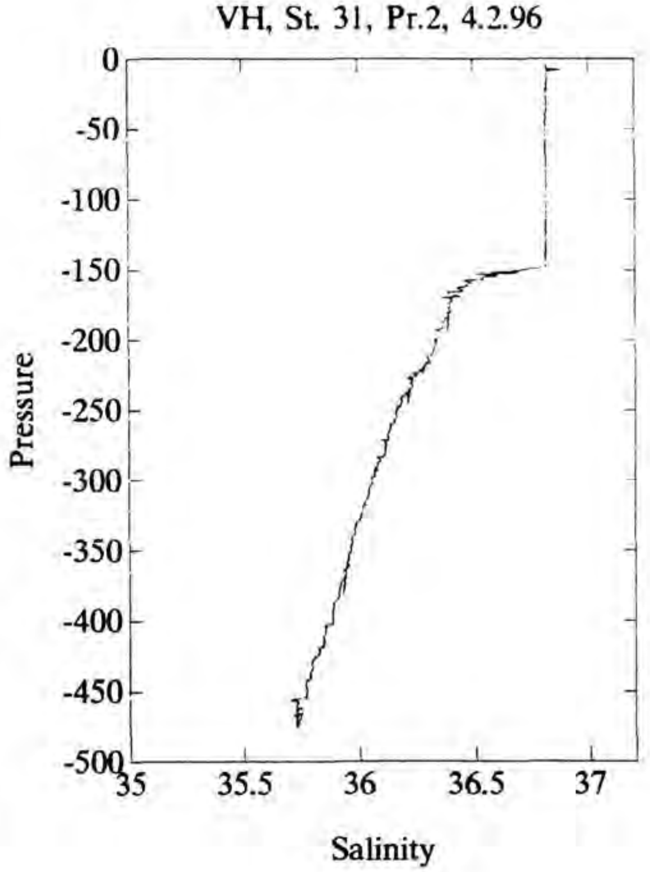
10
12
14
16
18
20


VH, St. 31, Pr.2, 4.2.96
Pressure
Salinity
0
-50
-100
-150
-200
-250
-300
-350
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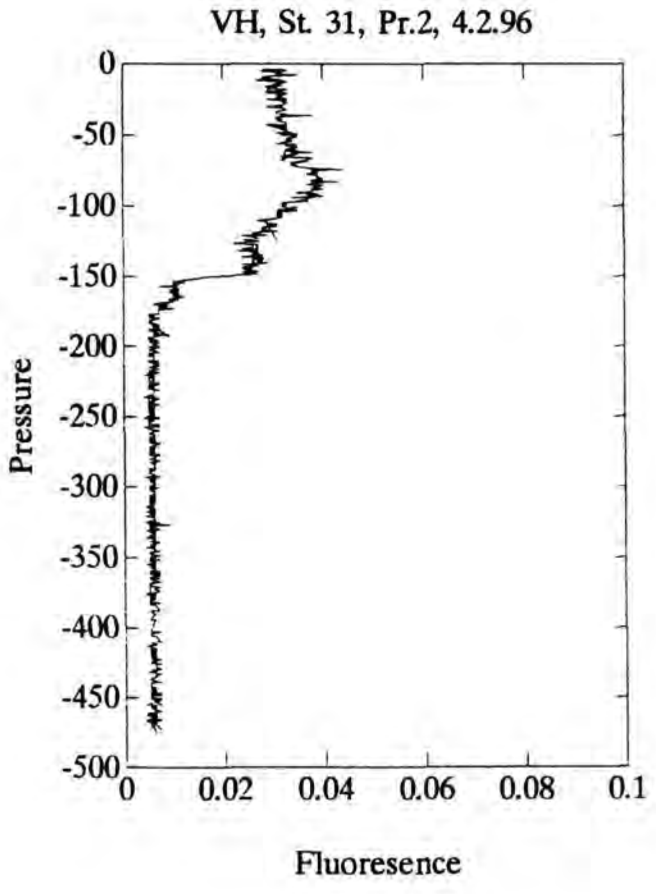
35.5
36
36.5
37


VH, St. 31, Pr.2, 4.2.96
Pressure
Fluoresence
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
0
0.02
0.04
0.06
0.08
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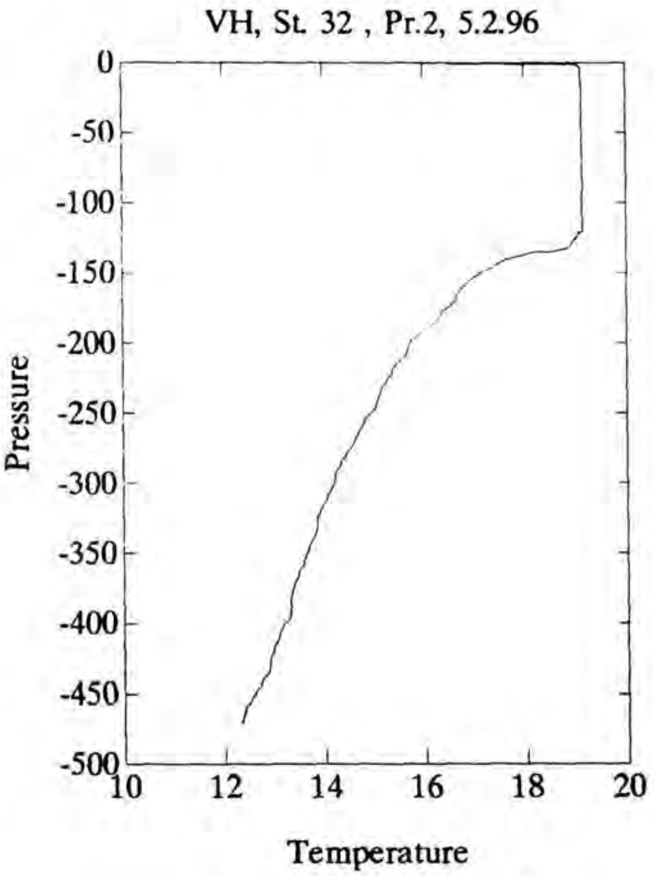
VH, St. 32 , Pr.2, 5.2.96
Pressure
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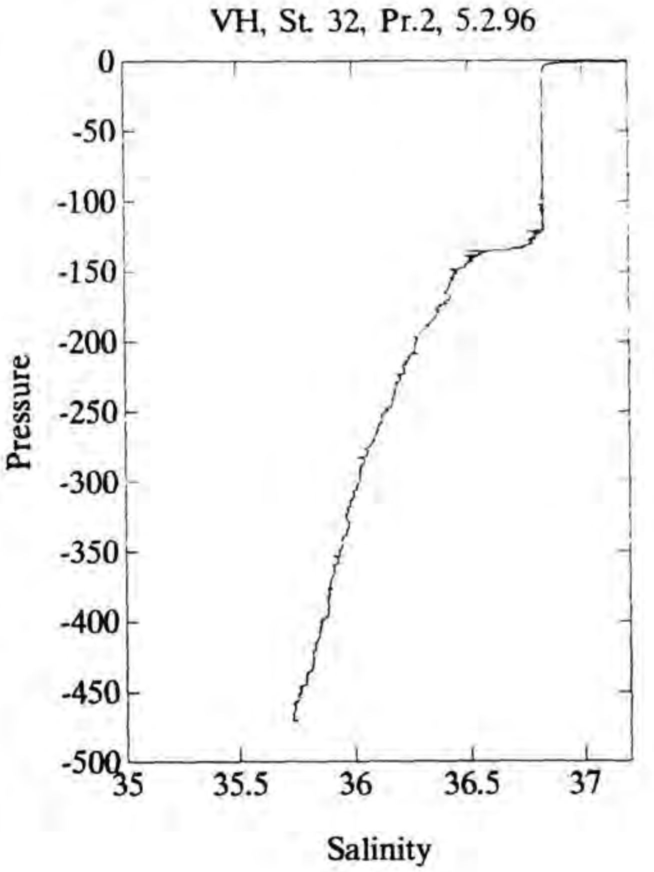
Temperature


VH, St. 32, Pr.2, 5.2.96
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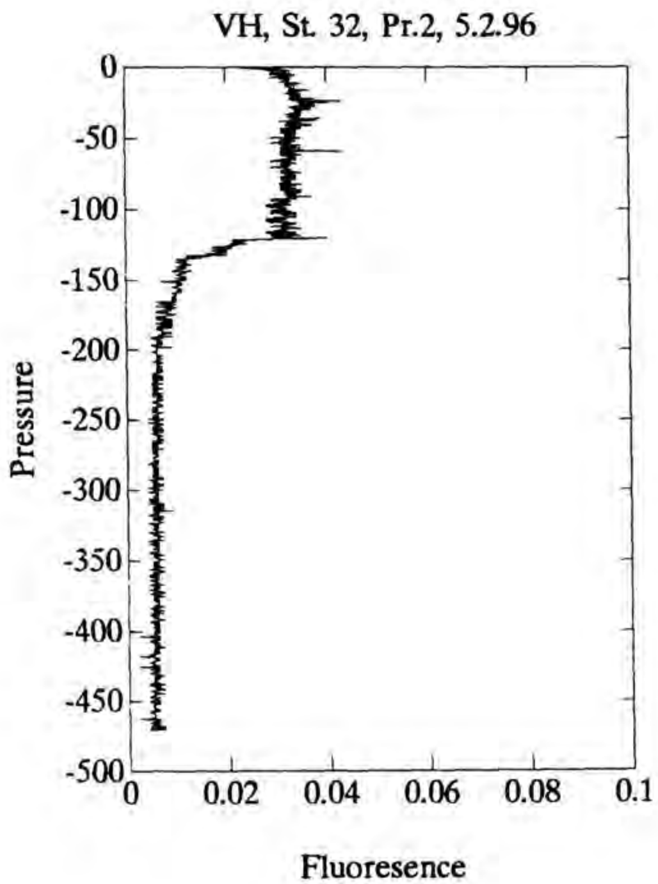
Salinity


VH, St. 32, Pr.2, 5.2.96
Pressure
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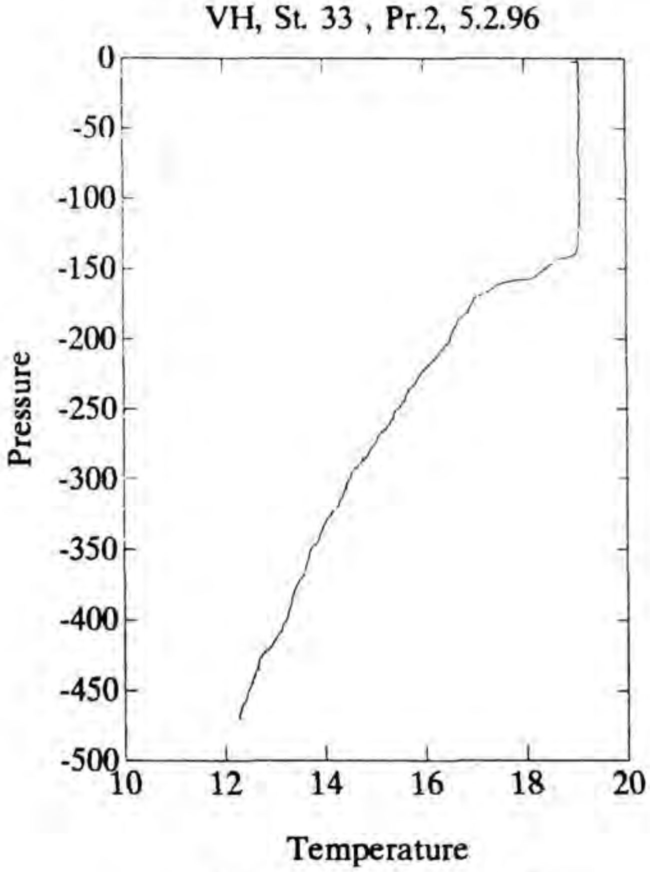
Fluoresence


VH, St. 33 , Pr.2, 5.2.96
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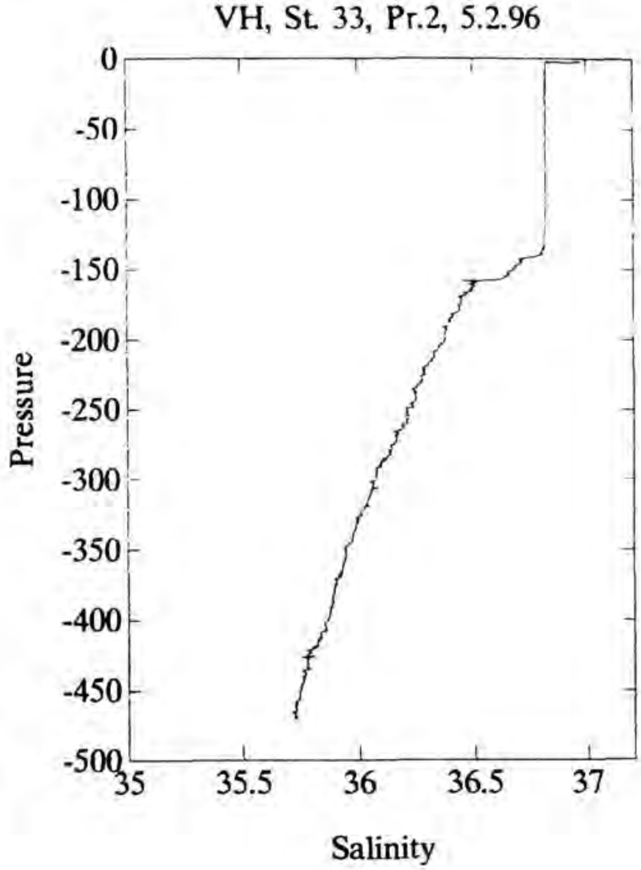
Temperature


VH, St. 33, Pr.2, 5.2.96
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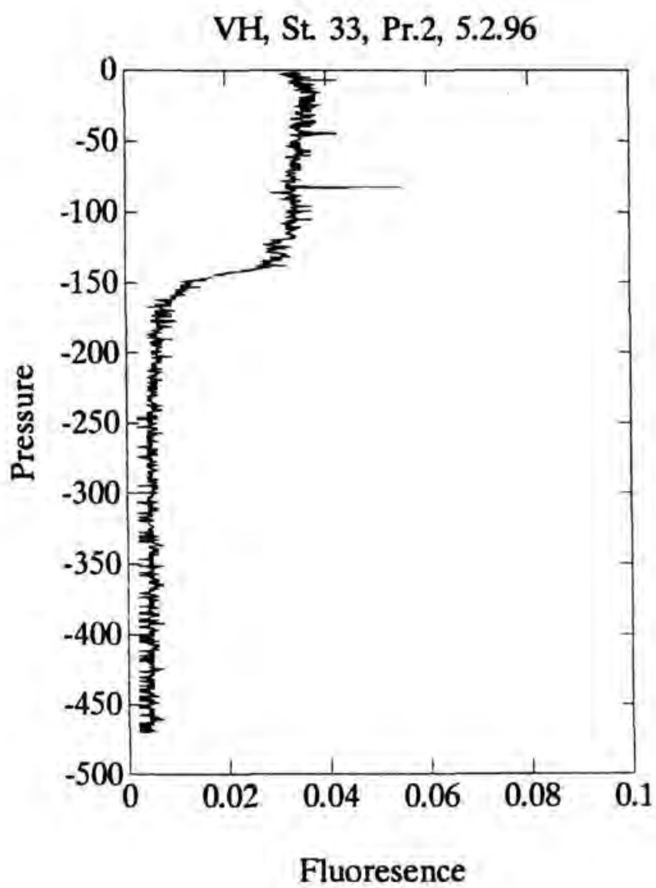
Salinity


VH, St. 33, Pr.2, 5.2.96
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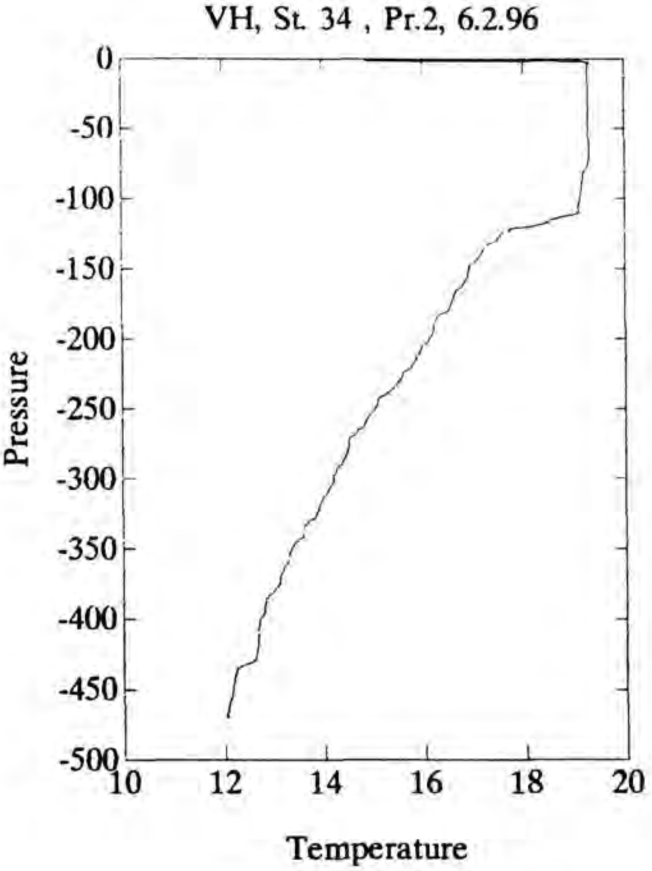
Fluoresence


VH, St. 34 , Pr.2, 6.2.96
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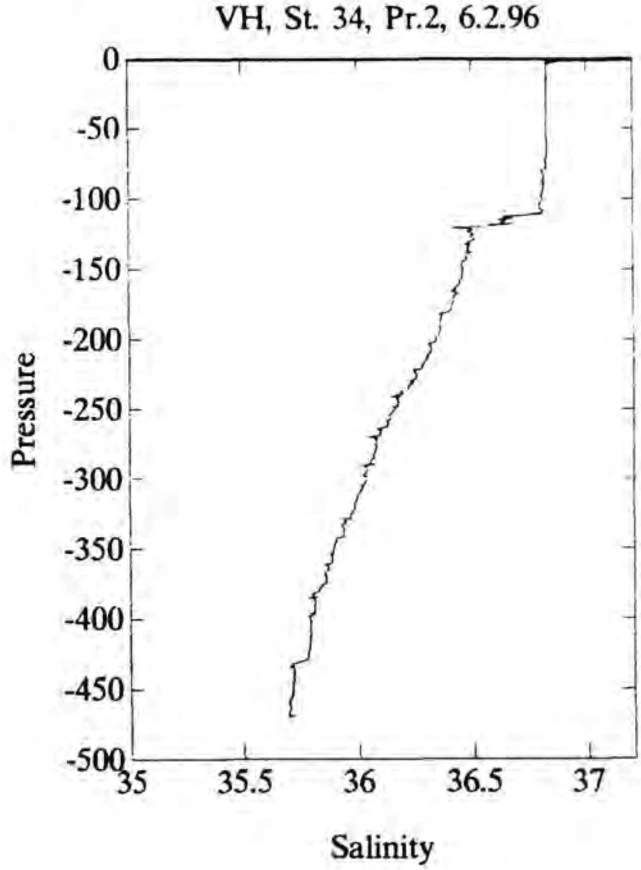
Temperature


VH, St. 34, Pr.2, 6.2.96
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-500
Pressure
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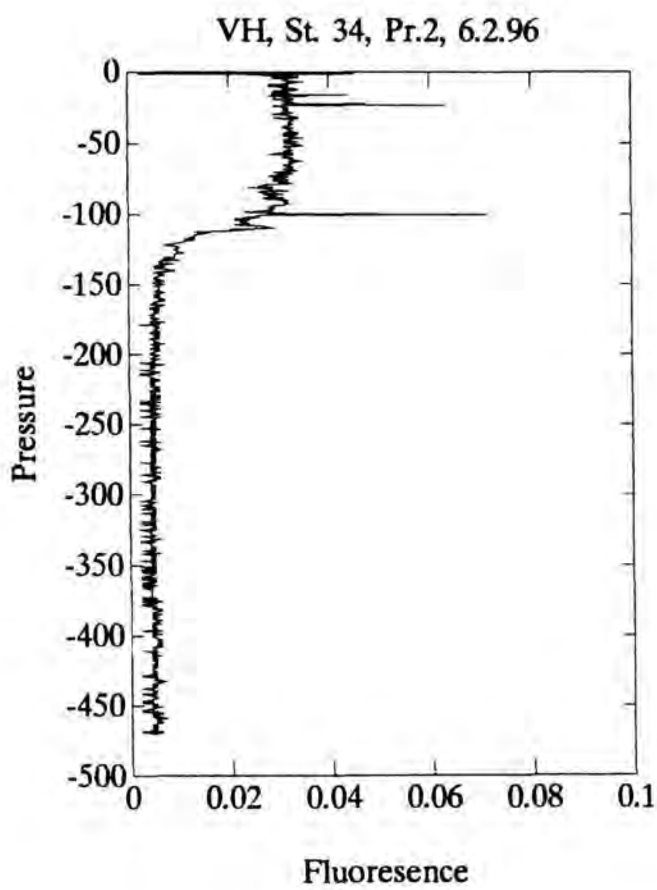
Salinity


VH, St. 34, Pr.2, 6.2.96
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Pressure
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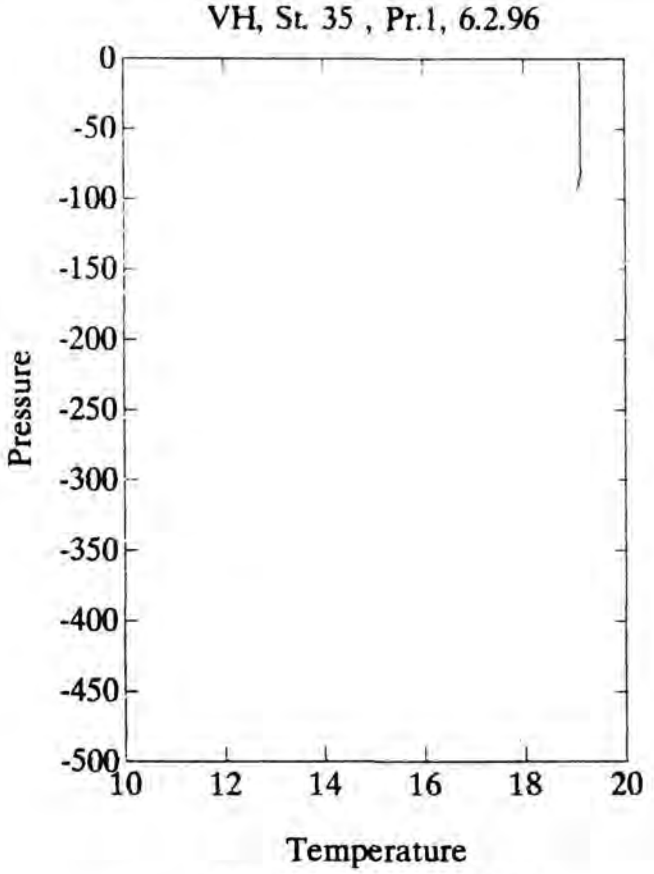
Fluoresence


VH, St. 35 , Pr.1, 6.2.96
Pressure
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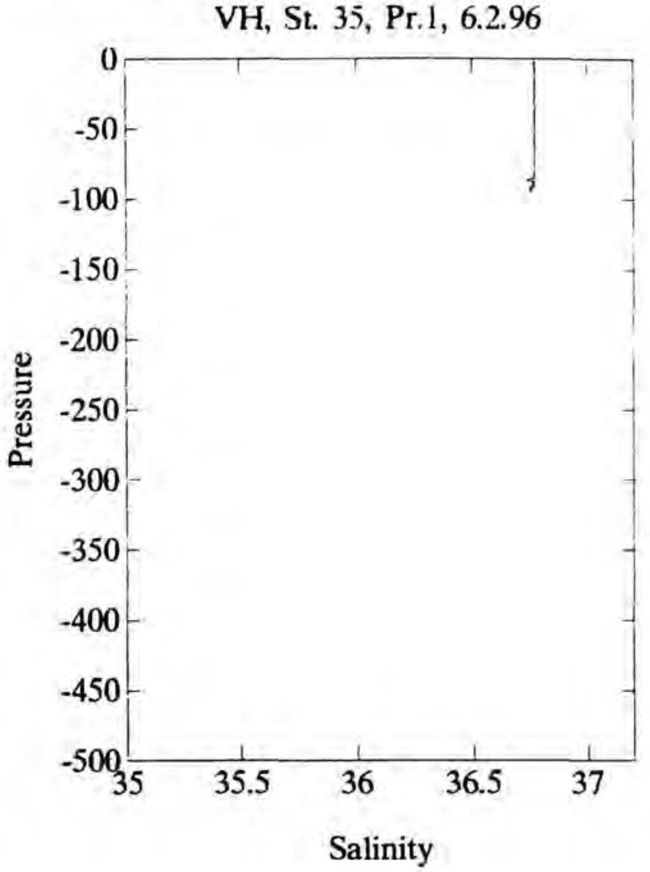
Temperature


VH, St. 35, Pr.1, 6.2.96
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35
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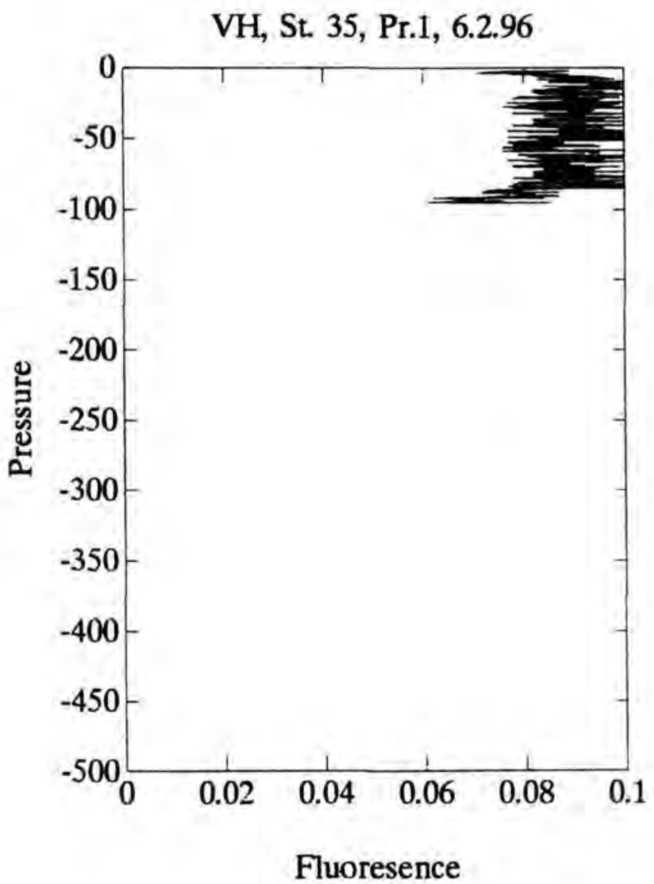
36.5
37
Salinity


VH, St. 35, Pr.1, 6.2.96
Pressure
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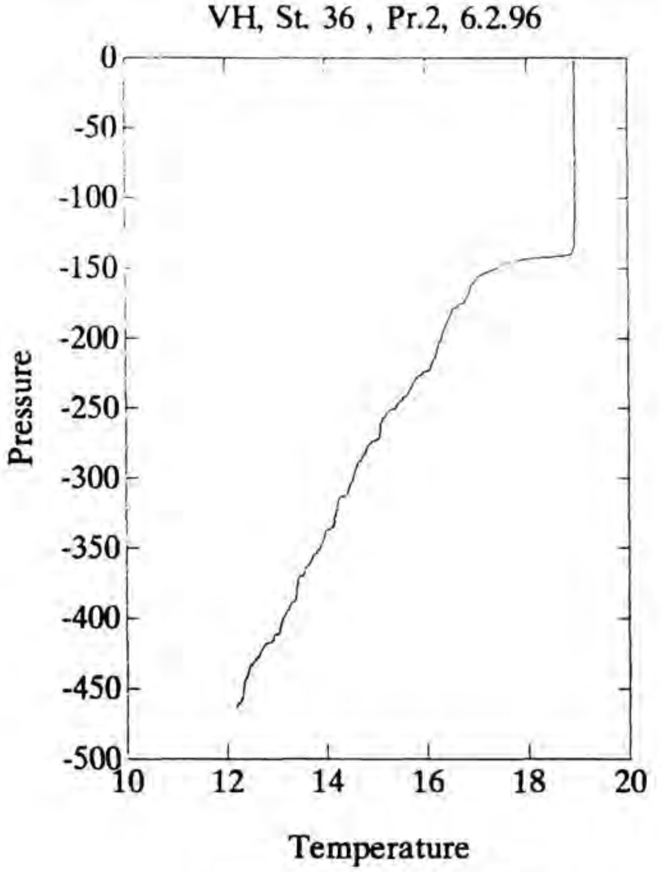
0.1
Fluoresence


VH, St. 36 , Pr.2, 6.2.96
Pressure
Temperature
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-500
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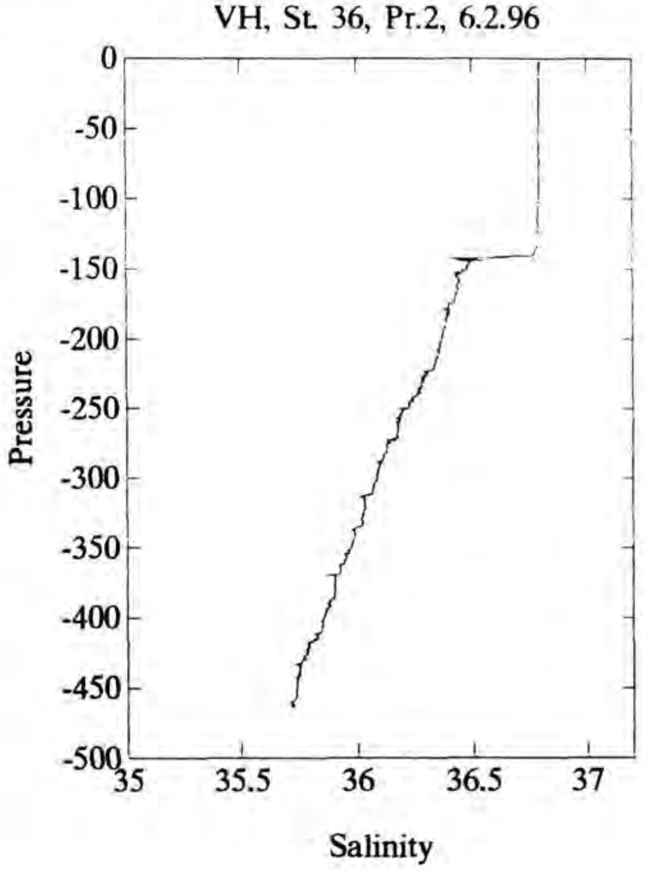
VH, St. 36, Pr.2, 6.2.96
Pressure
Salinity
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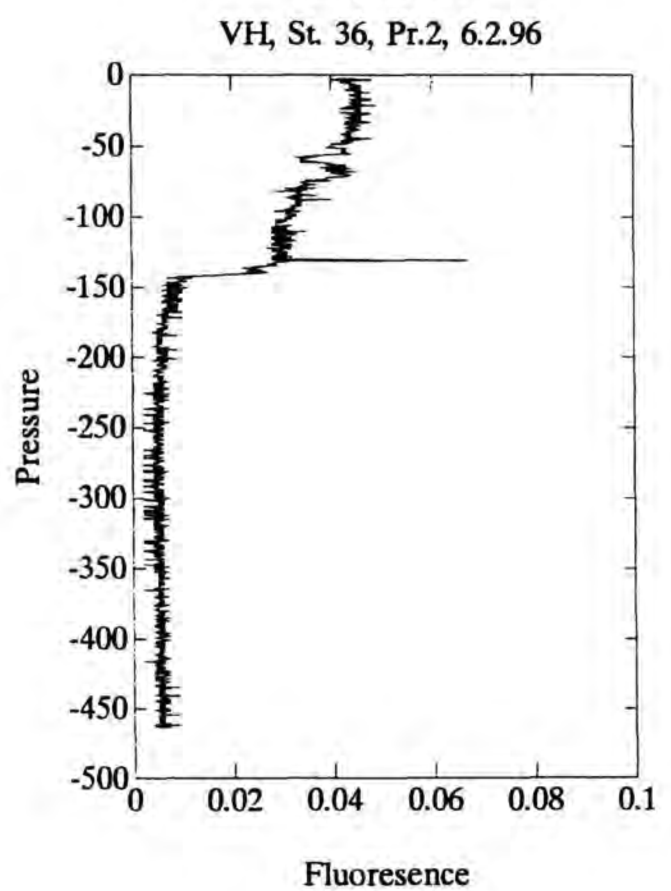
36.5
37


VH, St. 36, Pr.2, 6.2.96
Pressure
Fluoresence
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-100
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-450
-500
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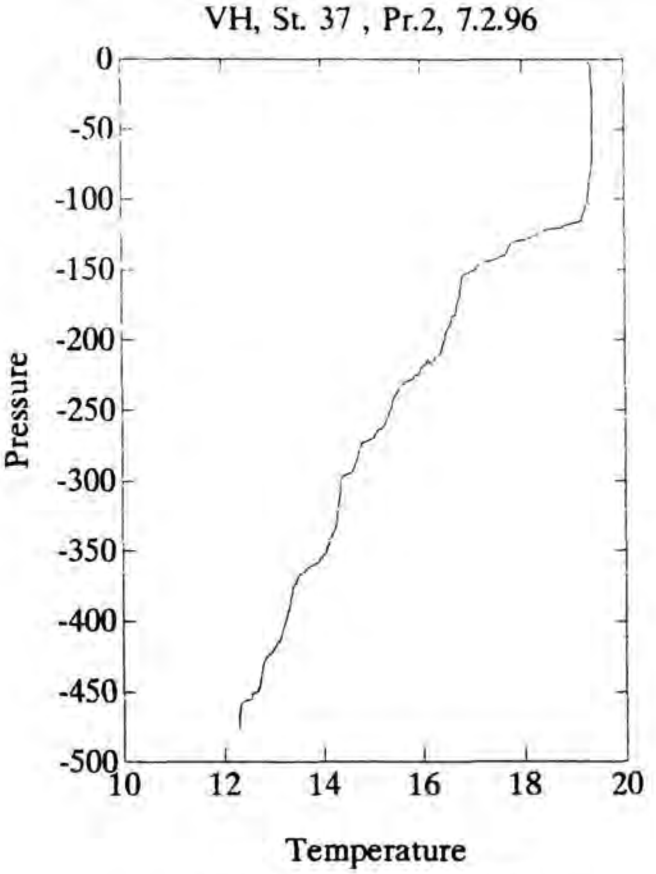
VH, St. 37 , Pr.2, 7.2.96
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Pressure
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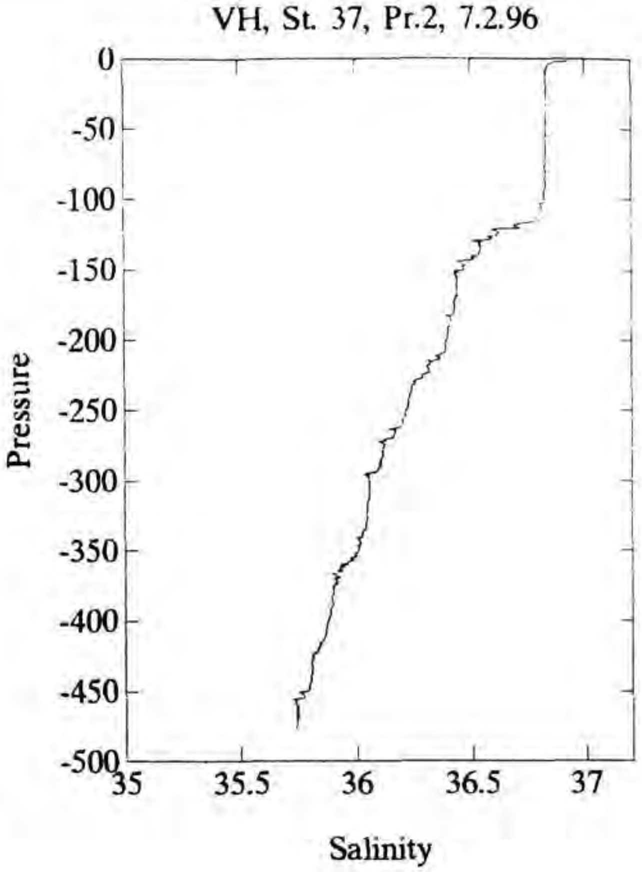
Temperature


VH, St. 37, Pr.2, 7.2.96
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-500
Pressure
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36.5
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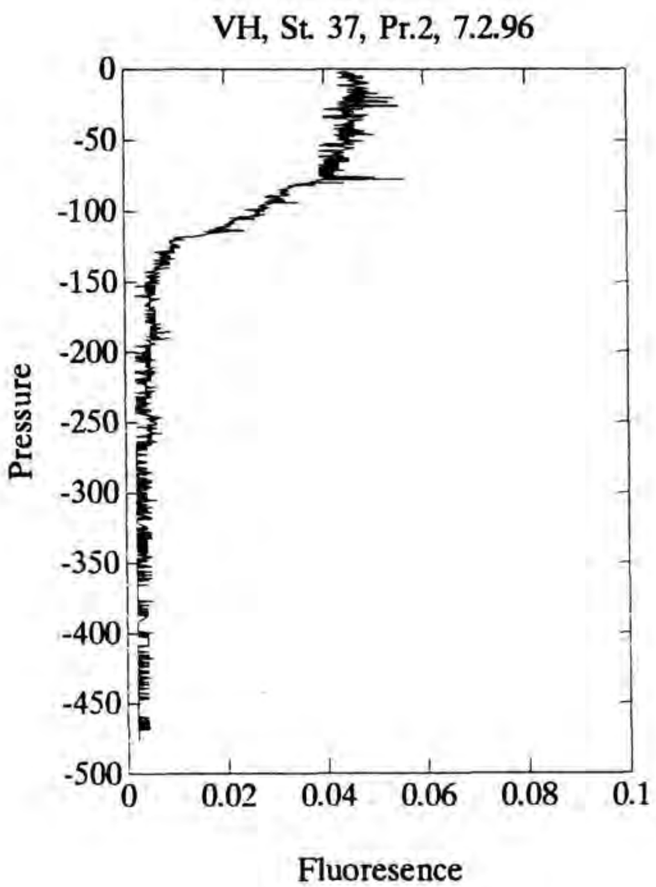
Salinity


VH, St. 37, Pr.2, 7.2.96
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Pressure
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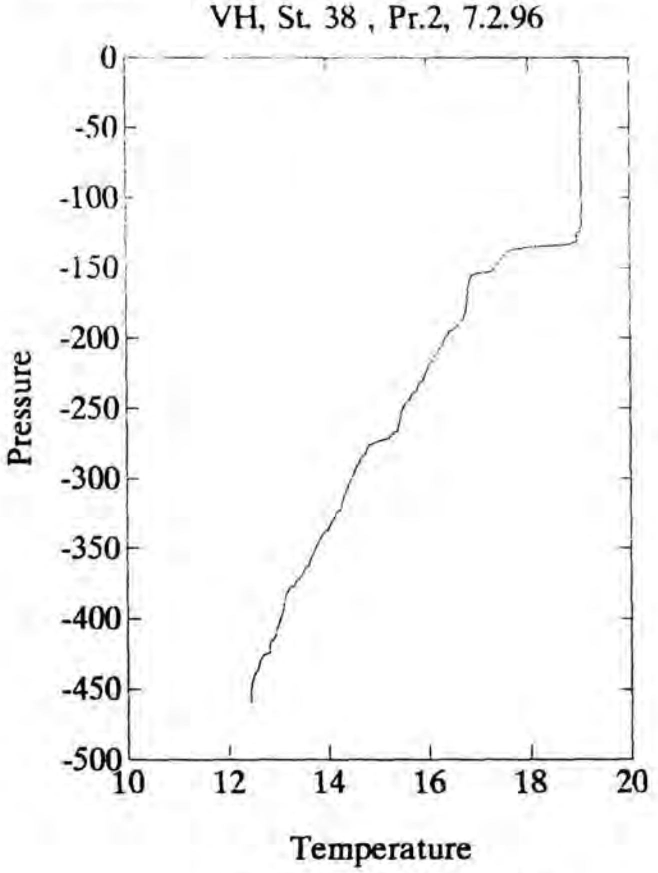
Fluoresence


VH, St. 38 , Pr.2, 7.2.96
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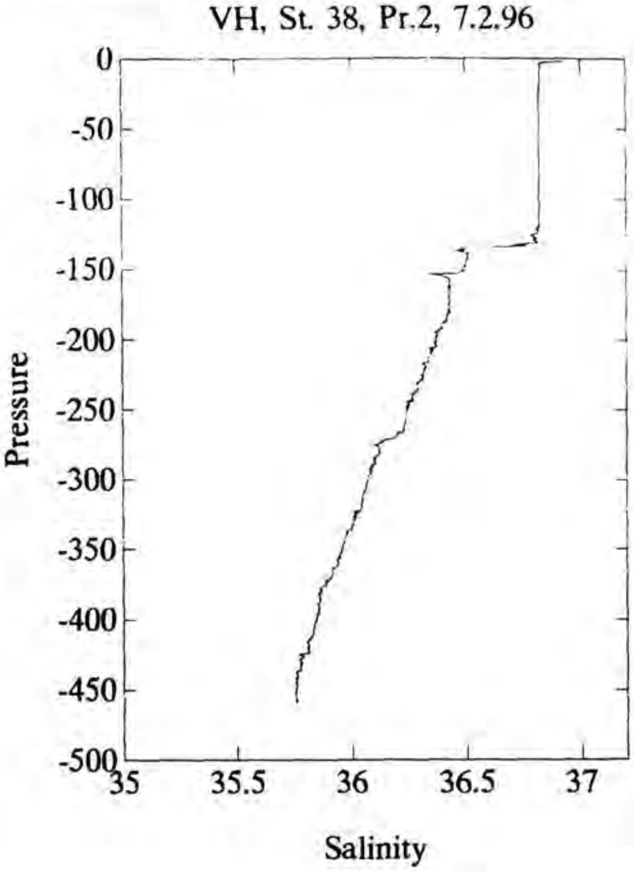
Temperature


VH, St. 38, Pr.2, 7.2.96
Pressure
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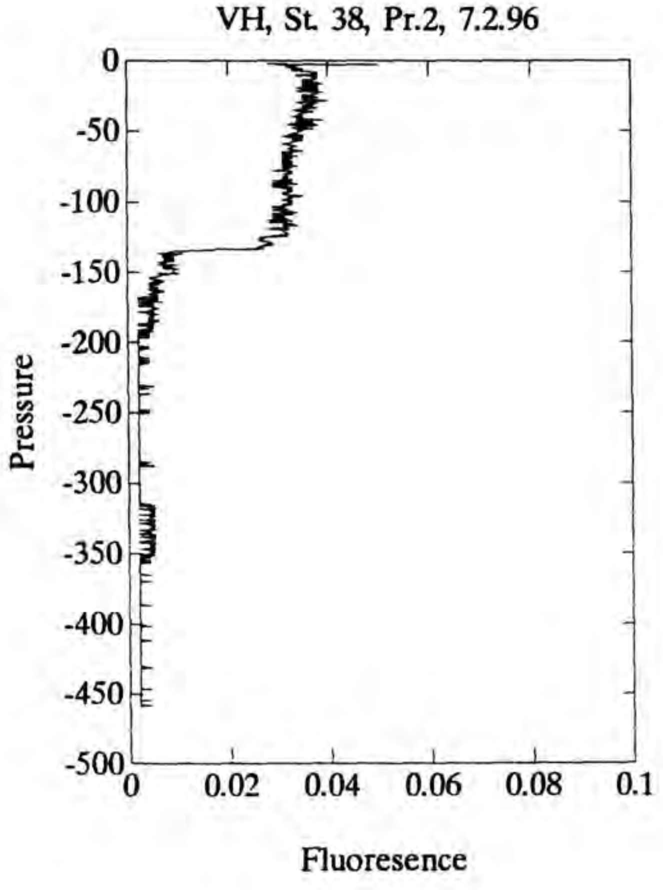
Salinity


VH, St. 38, Pr.2, 7.2.96
Pressure
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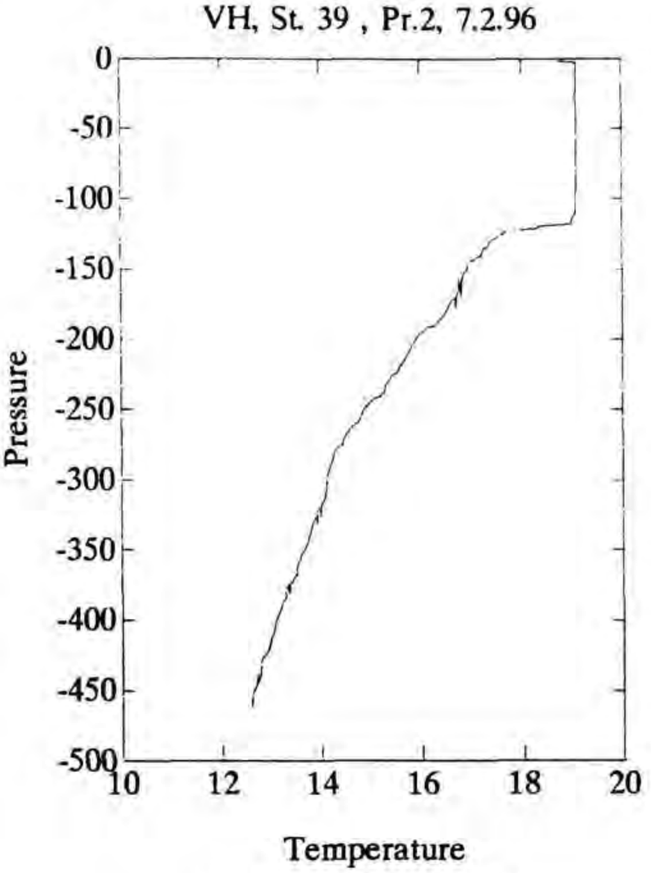
Fluoresence


VH, St. 39 , Pr.2, 7.2.96
Pressure
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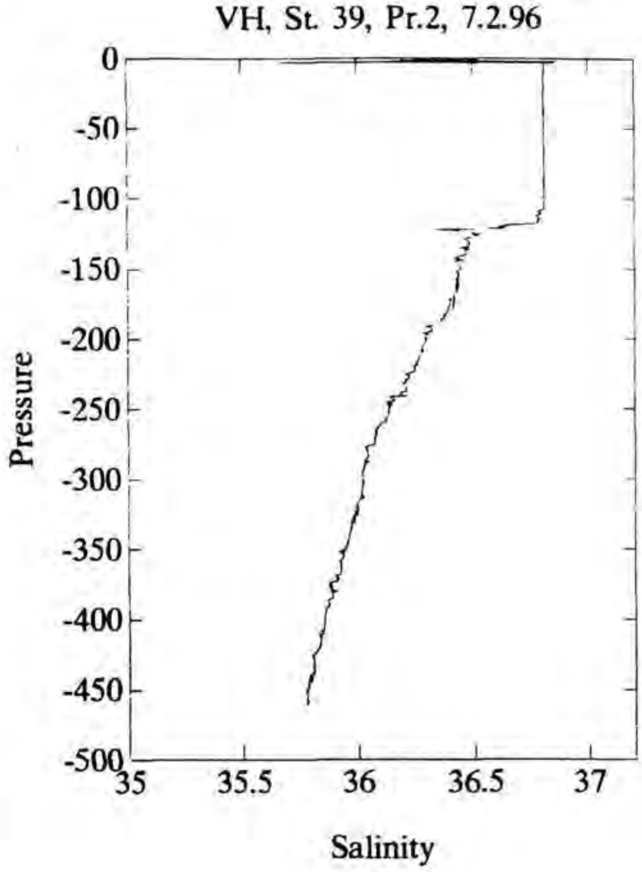
Temperature


VH, St. 39, Pr.2, 7.2.96
Pressure
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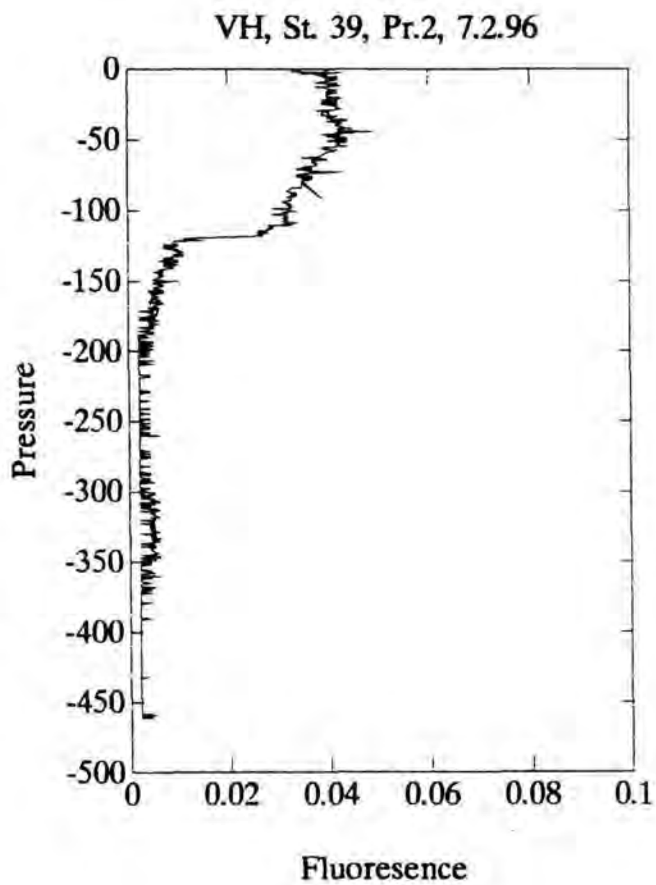
Salinity


VH, St. 39, Pr.2, 7.2.96
Pressure
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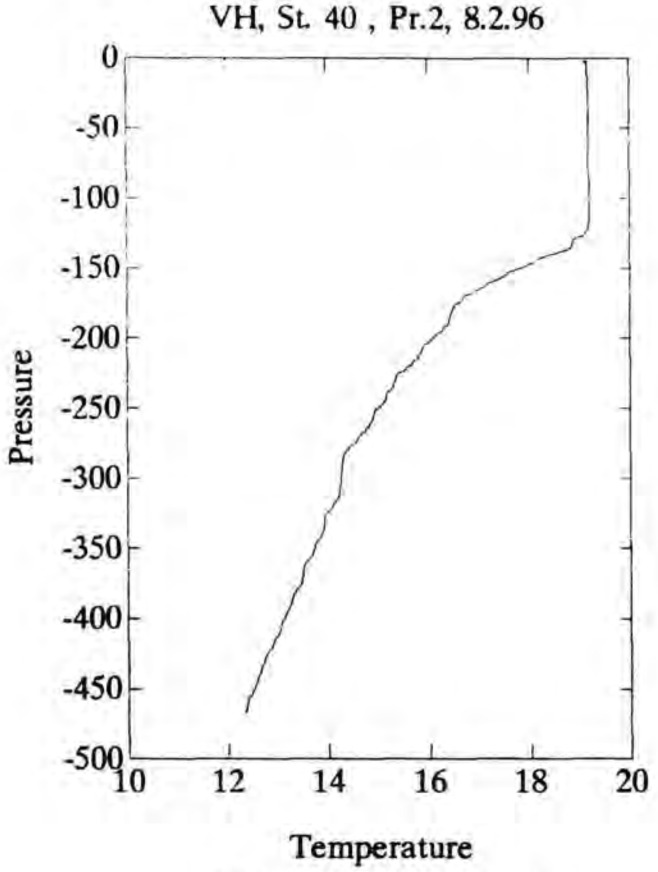
Fluoresence


VH, St. 40 , Pr.2, 8.2.96
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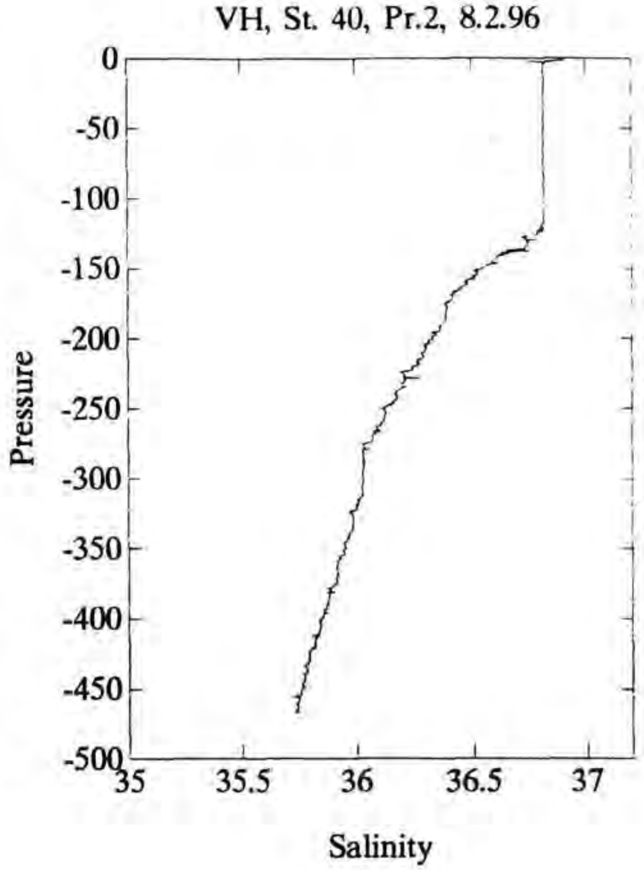
Temperature


VH, St. 40, Pr.2, 8.2.96
Pressure
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36.5
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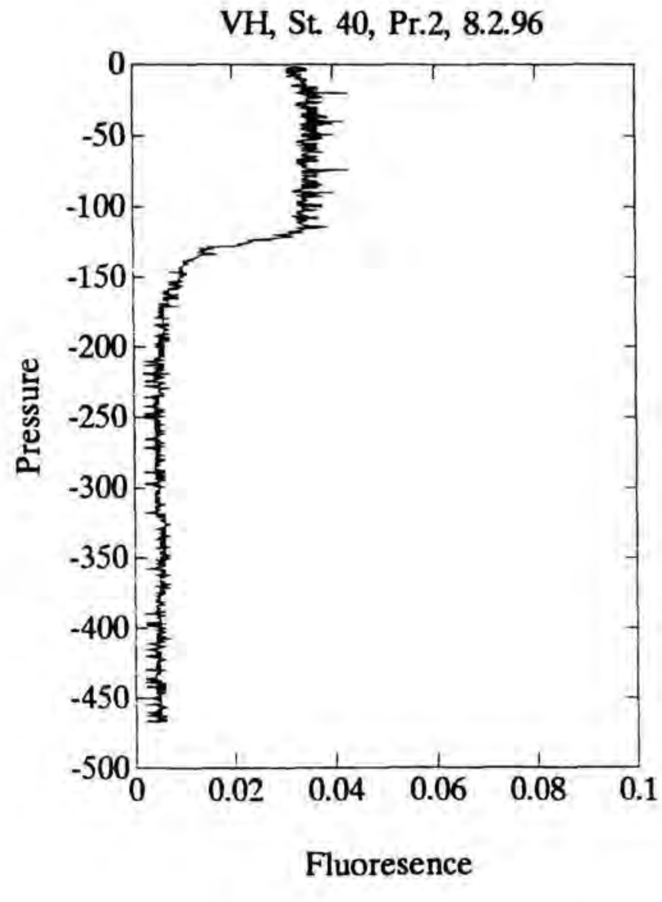
Salinity


VH, St. 40, Pr.2, 8.2.96
Pressure
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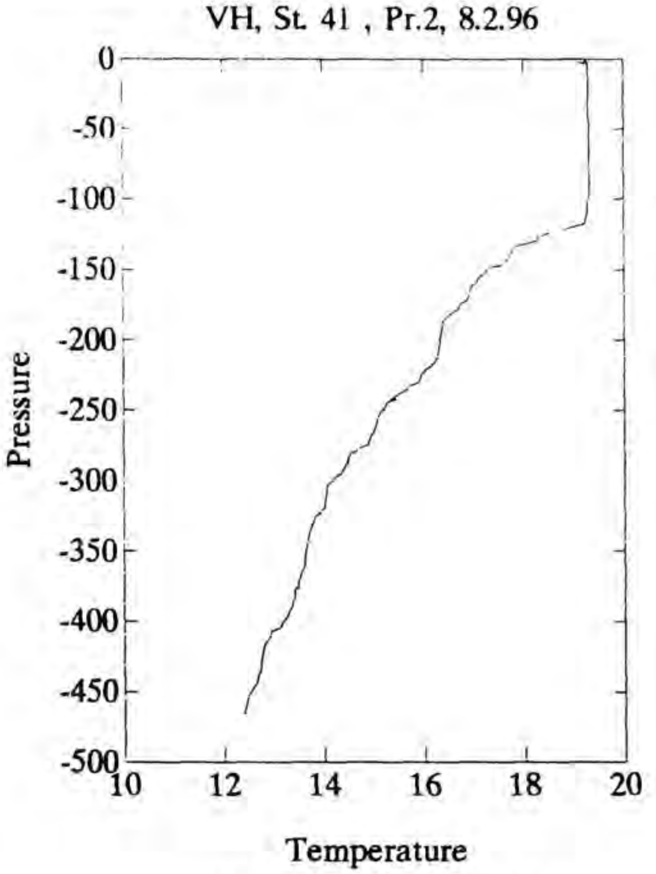
0.1
Fluoresence



VH, St. 41 , Pr.2, 8.2.96
Pressure
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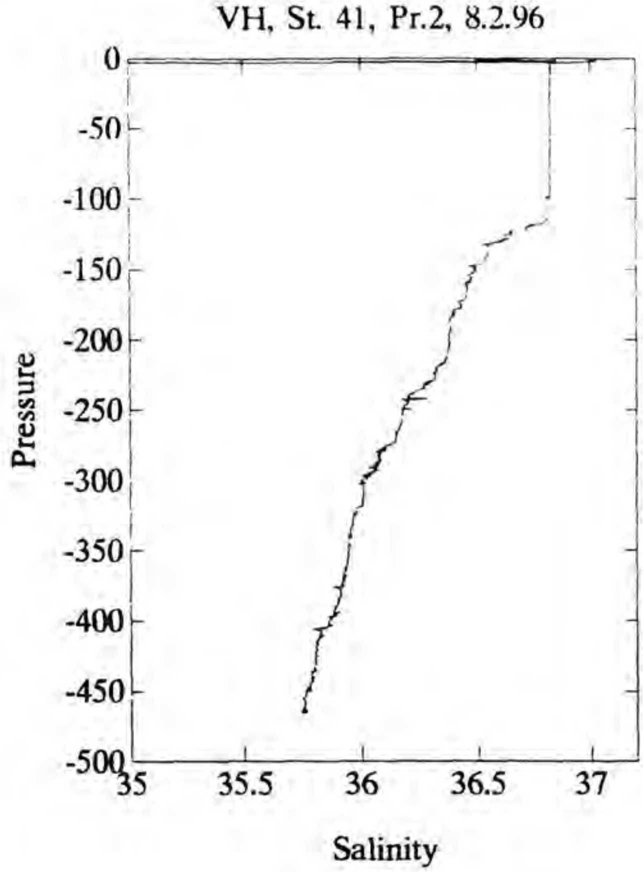
Temperature



VH, St. 41, Pr.2, 8.2.96
Pressure
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-500
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36.5
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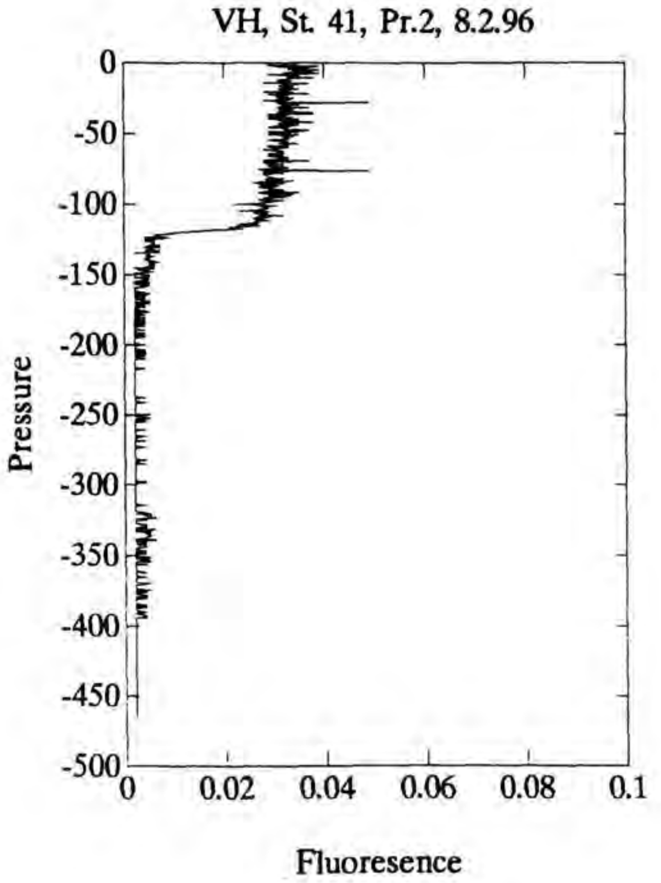
Salinity



VH, St. 41, Pr.2, 8.2.96
Pressure
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-500
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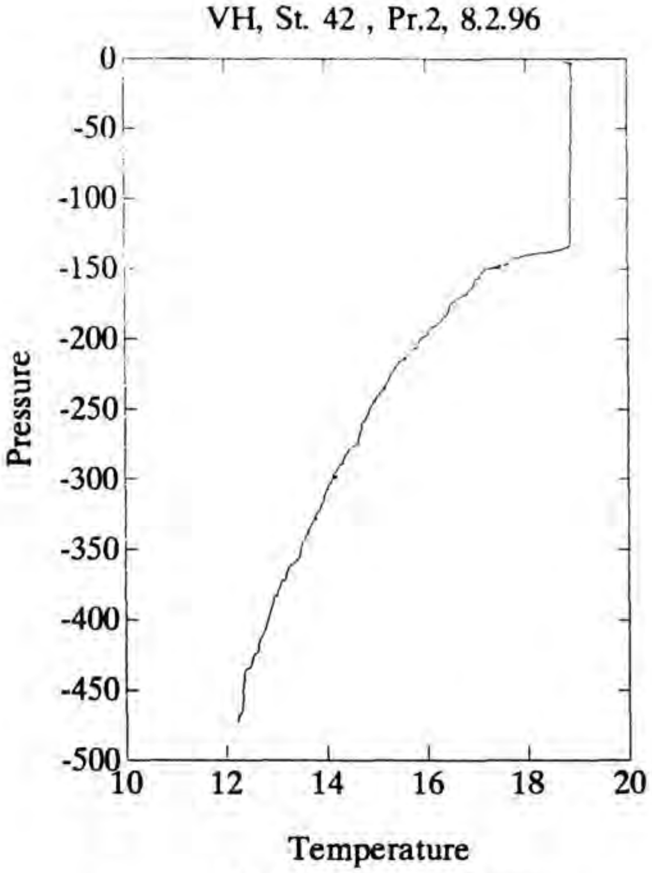
Fluoresence


VH, St. 42 , Pr.2, 8.2.96
Pressure
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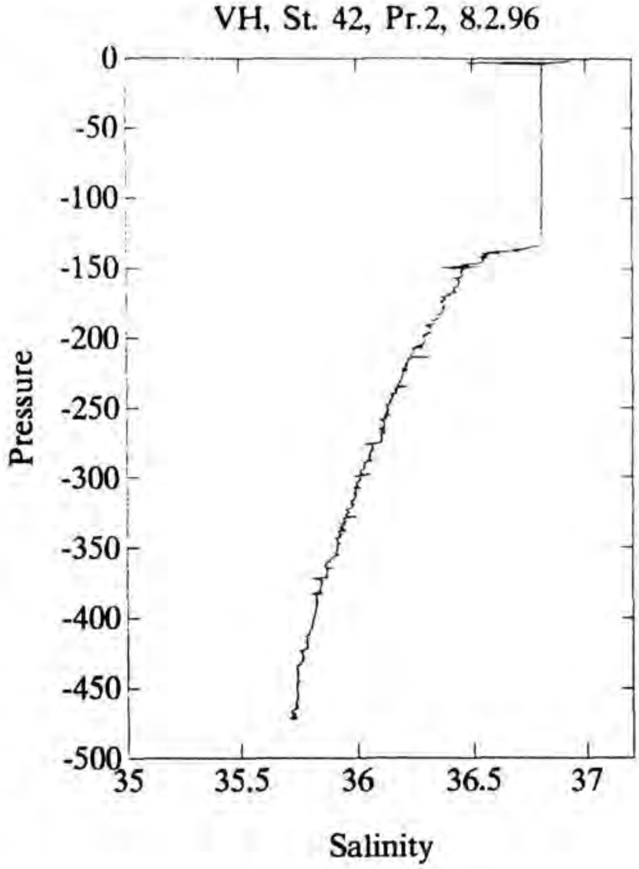
Temperature


VH, St. 42, Pr.2, 8.2.96
Pressure
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-500
35
35.5
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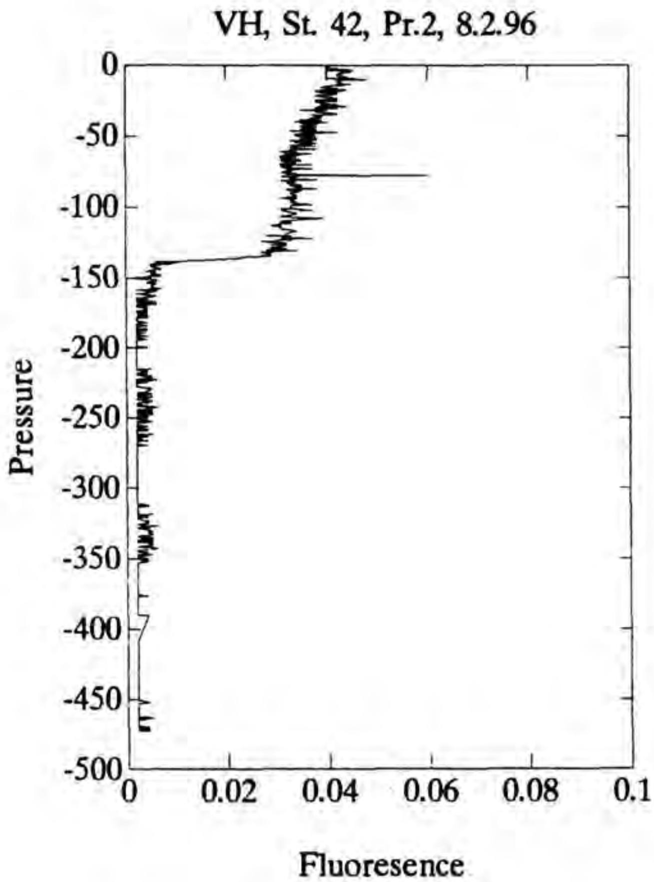
37
Salinity


VH, St. 42, Pr.2, 8.2.96
Pressure
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-500
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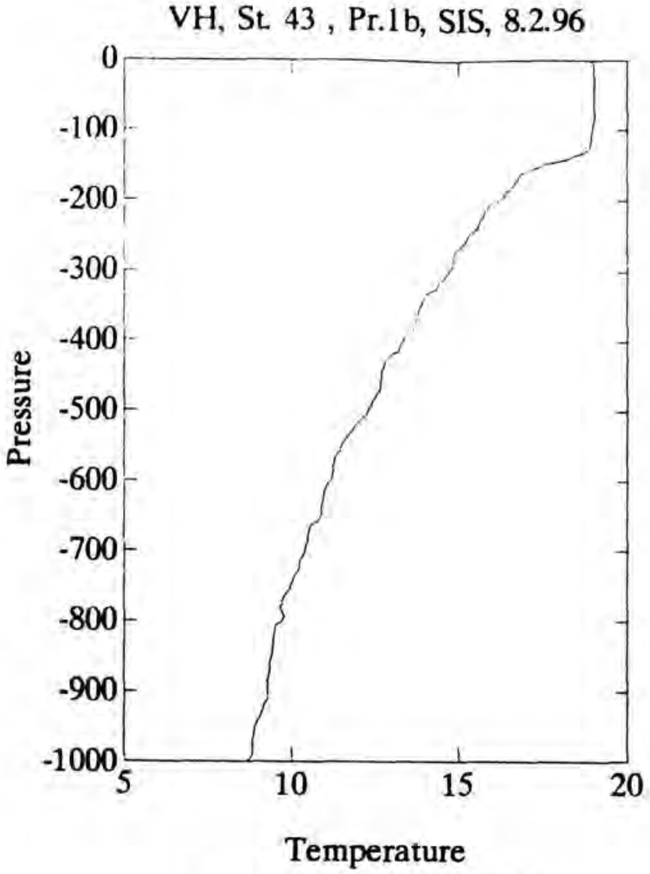
Fluoresence


VH, St. 43 , Pr.1b, SIS, 8.2.96
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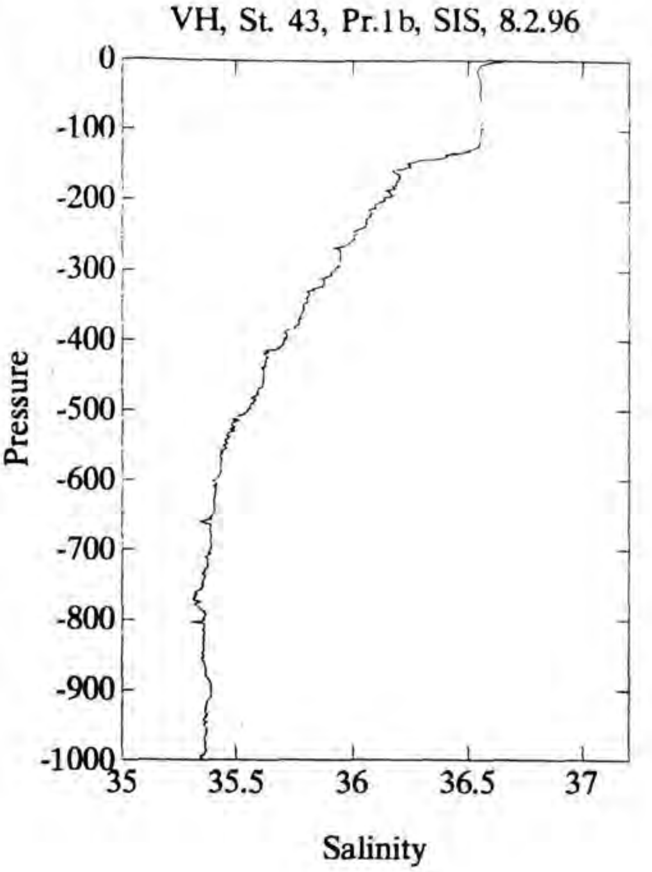
20
Temperature


VH, St. 43, Pr.1b, SIS, 8.2.96
Pressure
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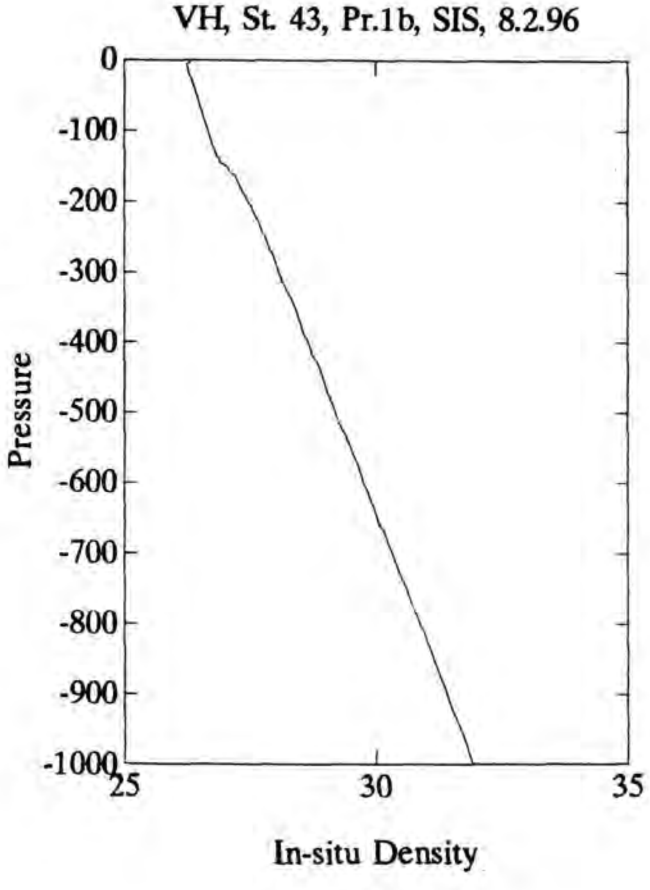
36.5
37
Salinity


VH, St. 43, Pr.1b, SIS, 8.2.96
Pressure
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-600
-700
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-900
-1000
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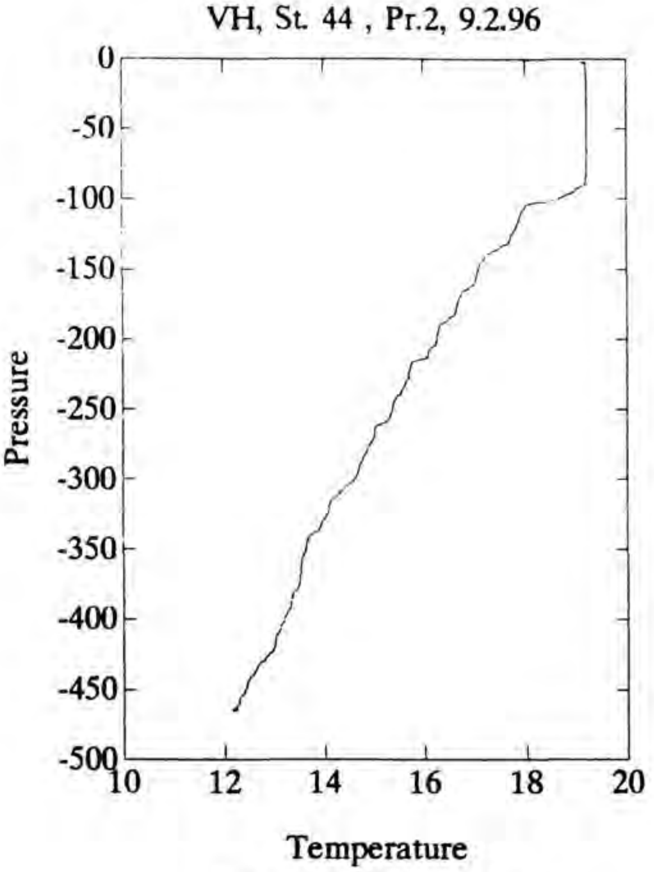
In-situ Density


VH, St. 44 , Pr.2, 9.2.96
Pressure
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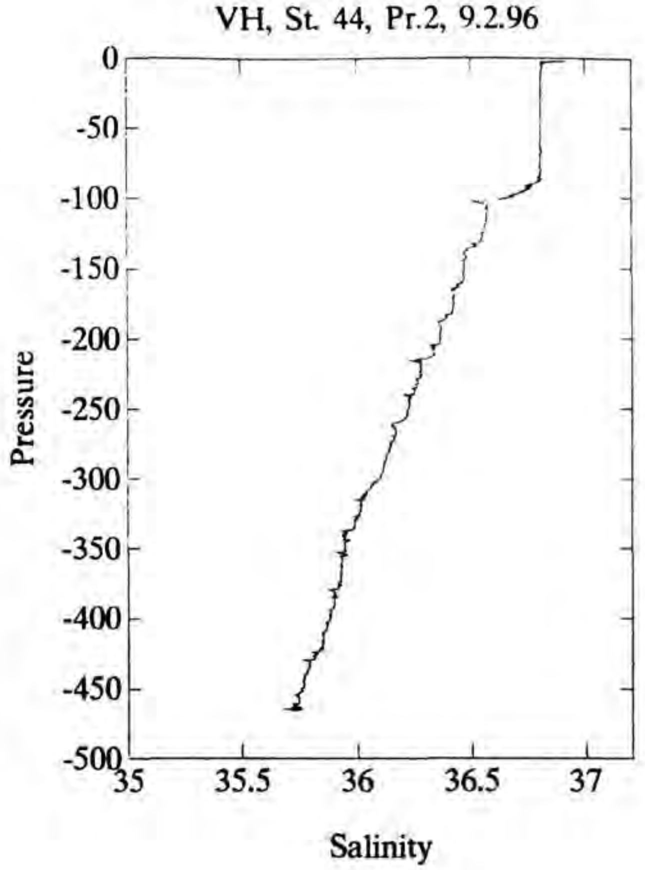
Temperature


VH, St. 44, Pr.2, 9.2.96
Pressure
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-300
-350
-400
-450
-500
35
35.5
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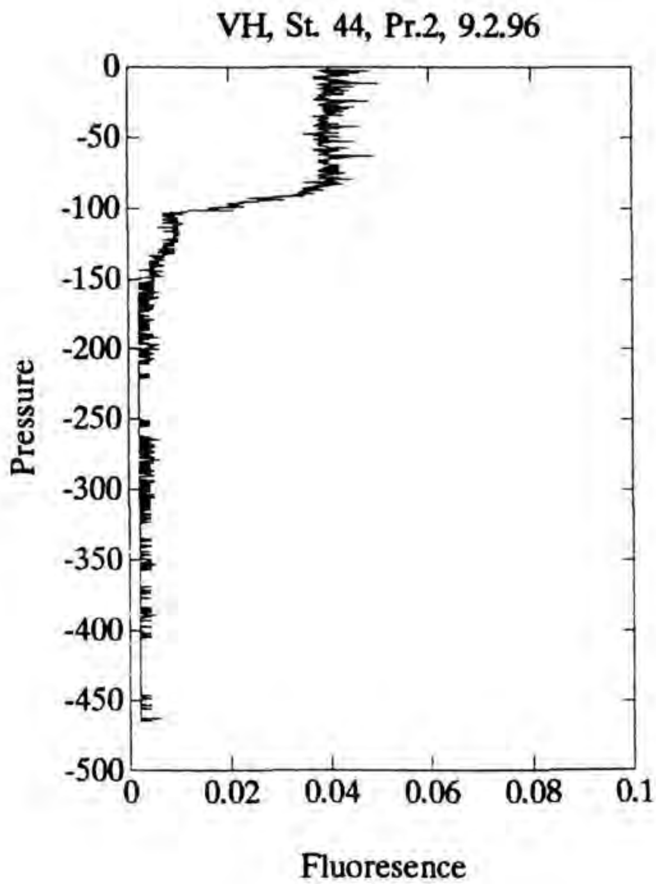
36.5
37
Salinity


VH, St. 44, Pr.2, 9.2.96
Pressure
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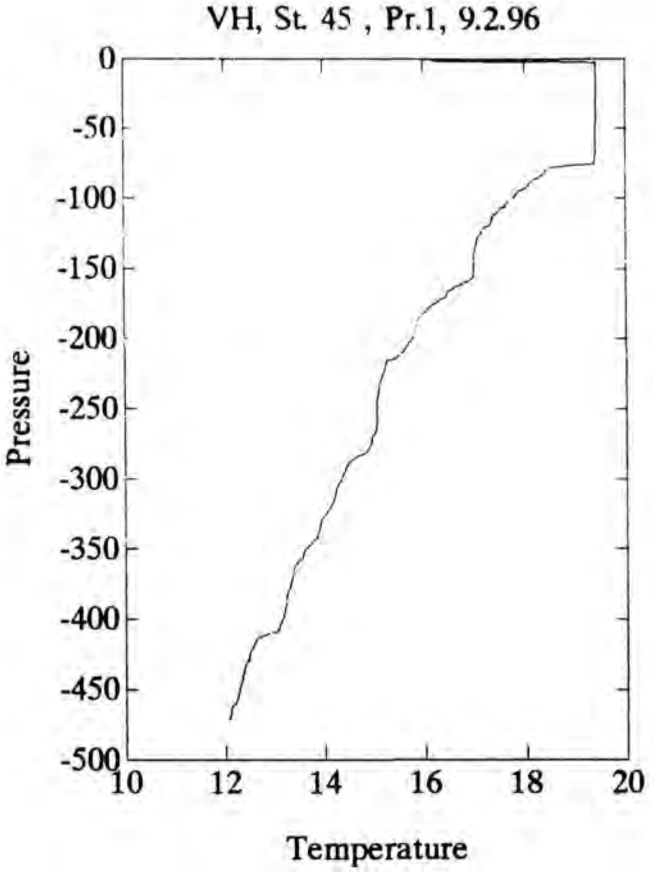
0.1
Fluoresence


VH, St. 45 , Pr.1, 9.2.96
Pressure
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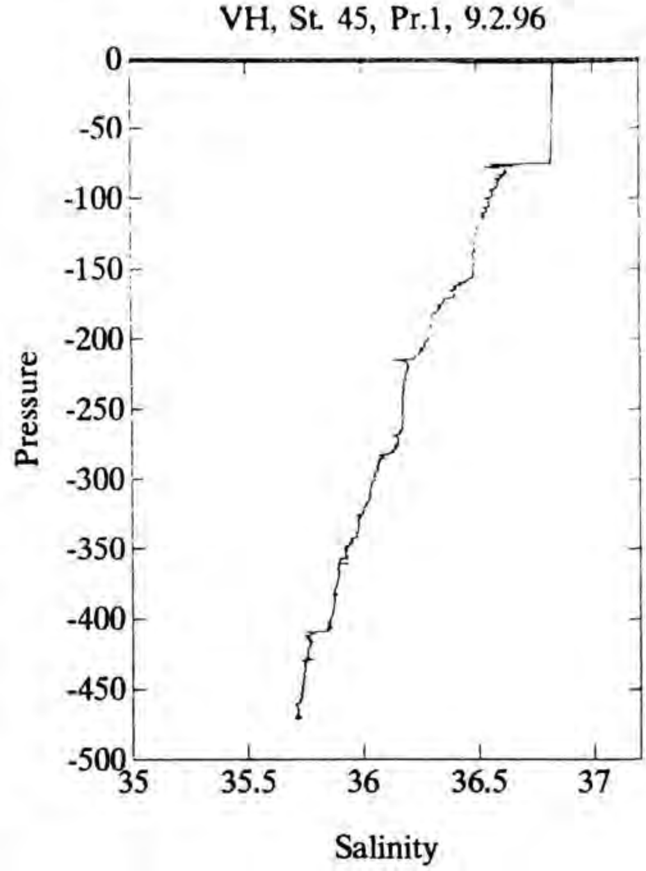
Temperature


VH, St. 45, Pr.1, 9.2.96
Pressure
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-500
35
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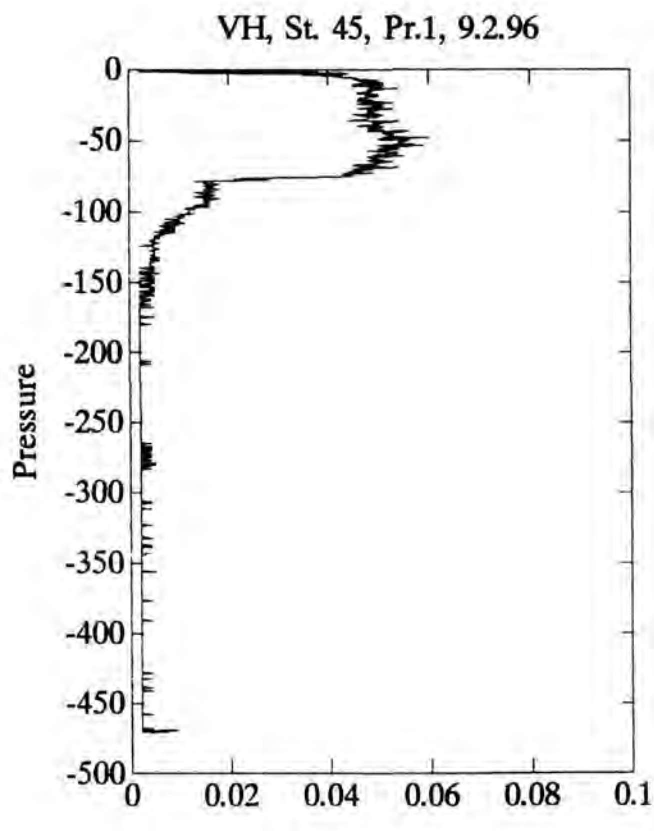
36.5
37
Salinity


VH, St. 45, Pr.1, 9.2.96
Pressure
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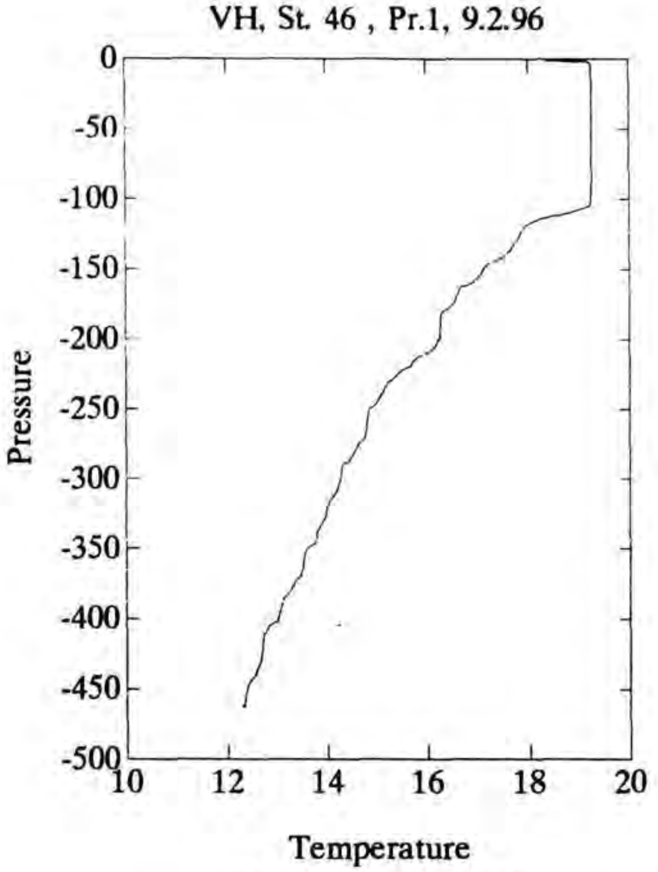
-400
-450
-500
0
0.02
0.04
0.06
0.08
0.1
Fluoresence


VH, St. 46 , Pr.1, 9.2.96
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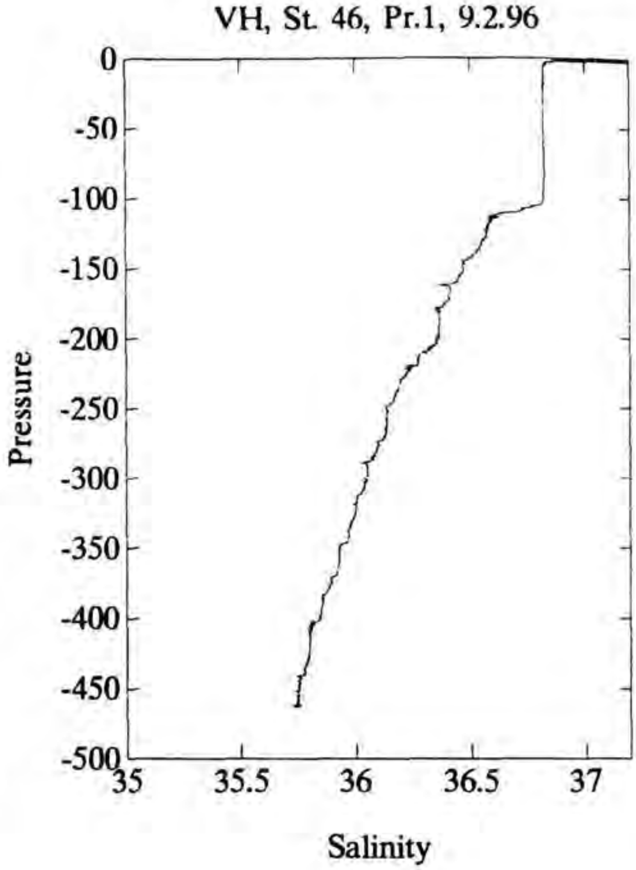
-500
10
12
14
16
18
20
Temperature


VH, St. 46, Pr.1, 9.2.96
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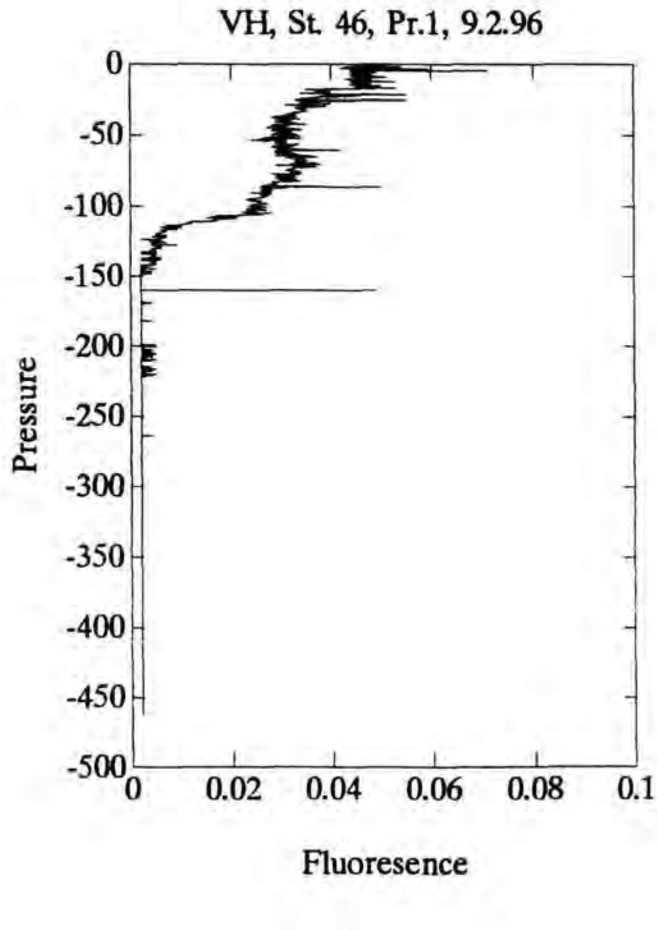
-500
35
35.5
36
36.5
37
Salinity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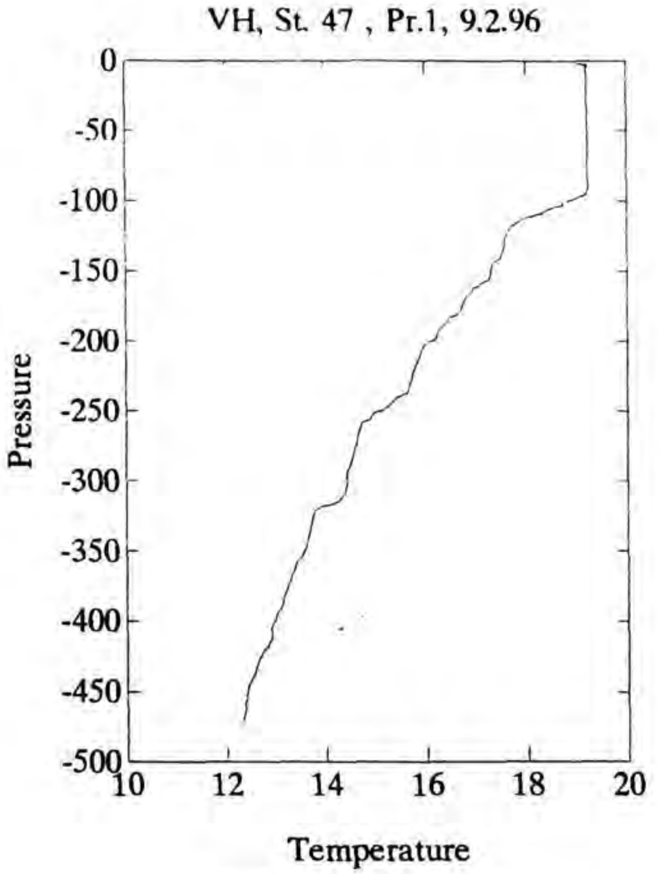
0.1
Fluoresence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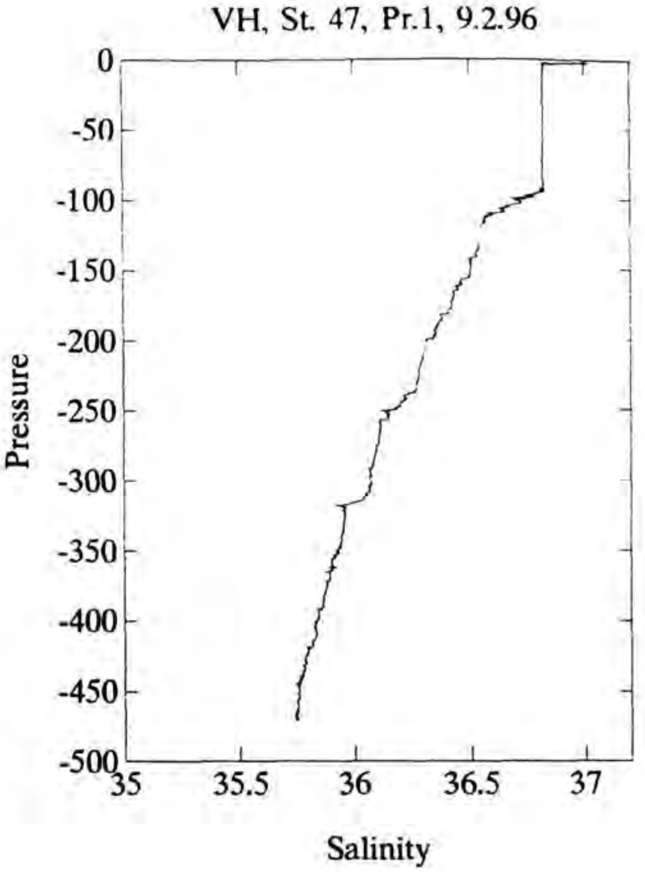
Temperature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Pressure
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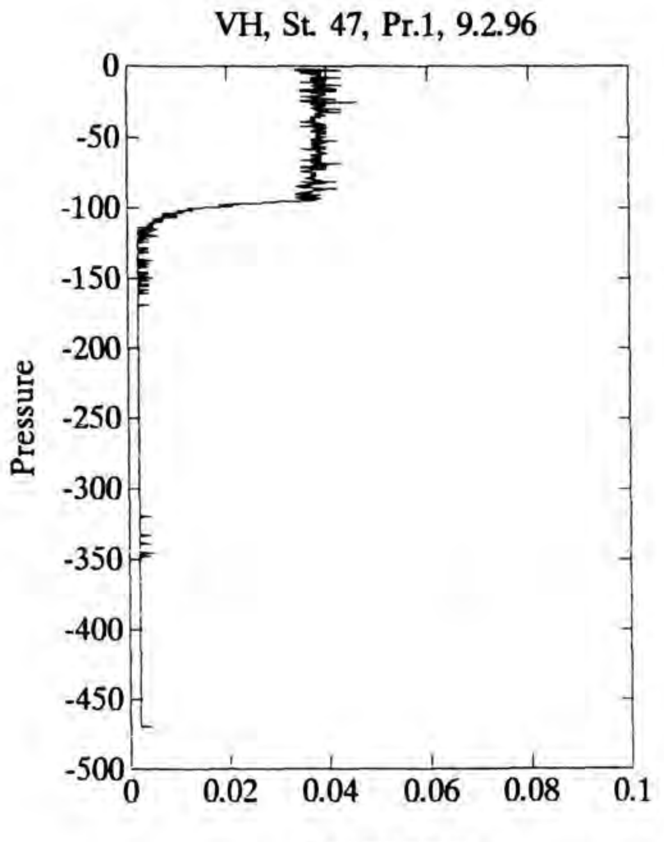
Salinity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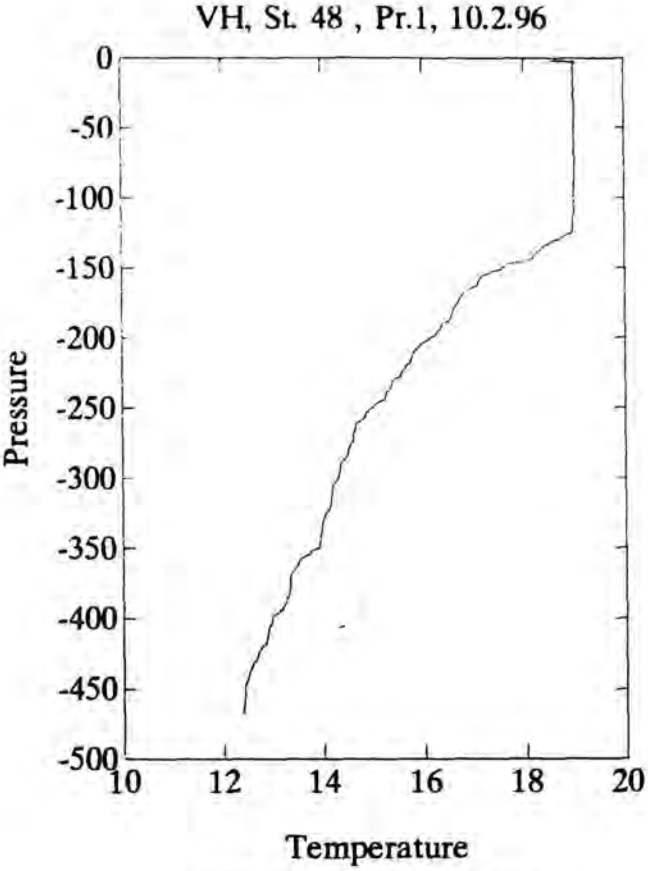
0.1
Fluoresence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Pressure
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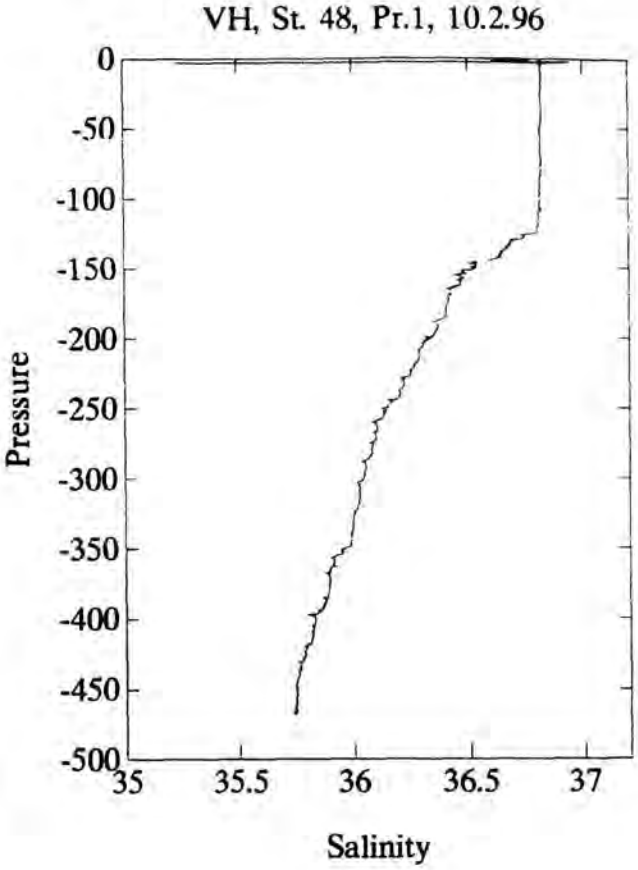
20
Temperature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-500
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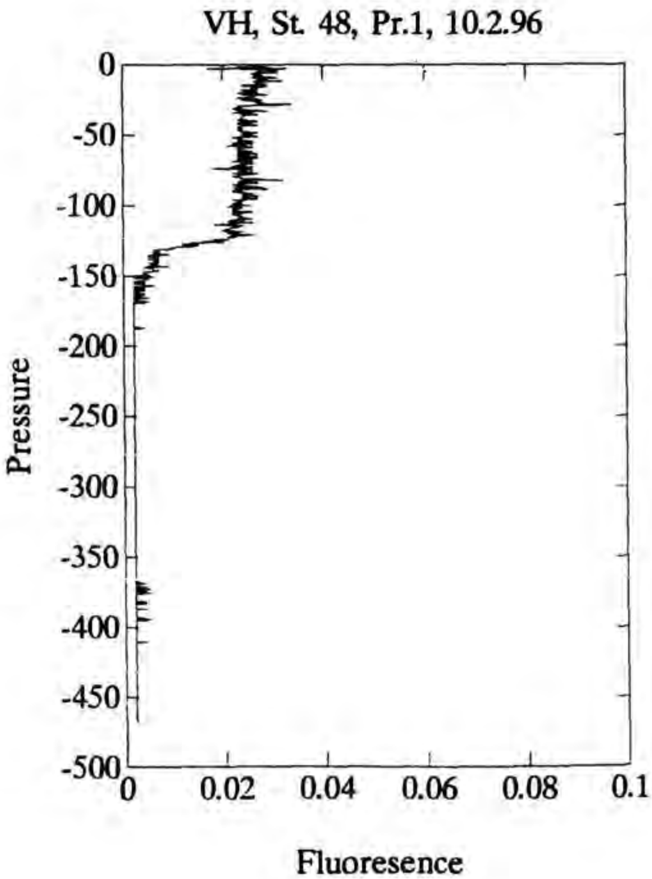
36.5
37
Salinity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-500
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0.02
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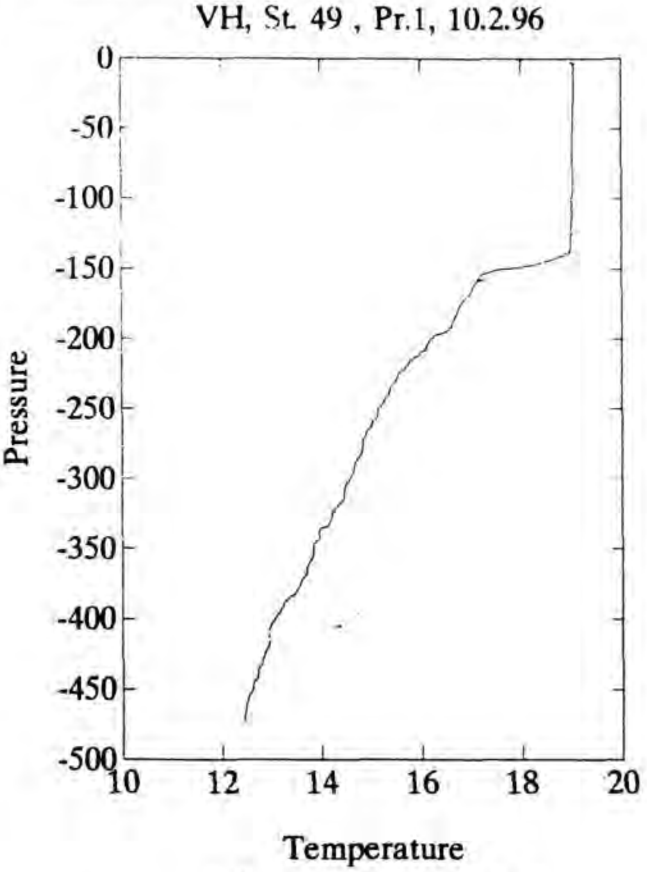
0.06
0.08
0.1
Fluoresence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10
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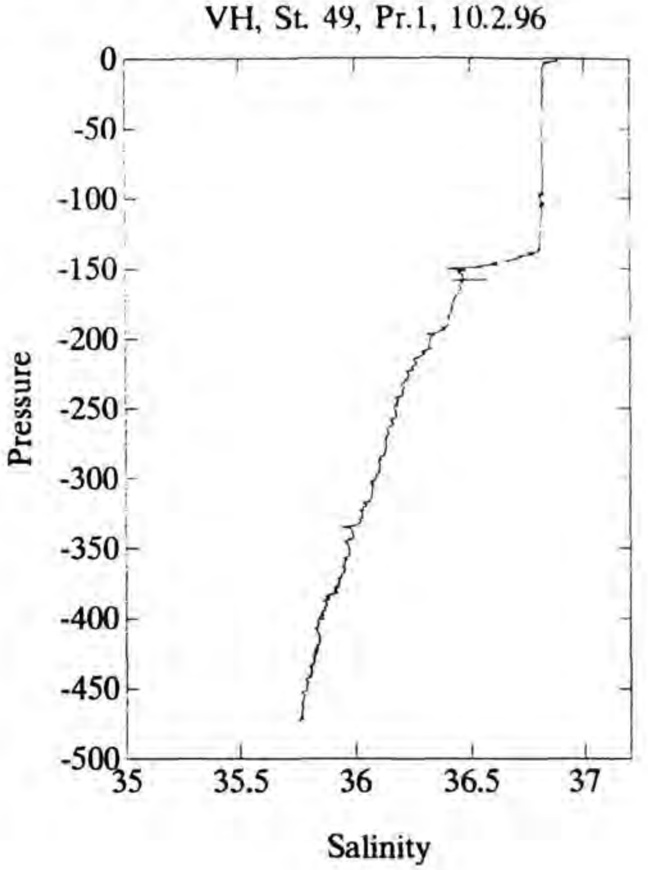
16
18
20
Temperature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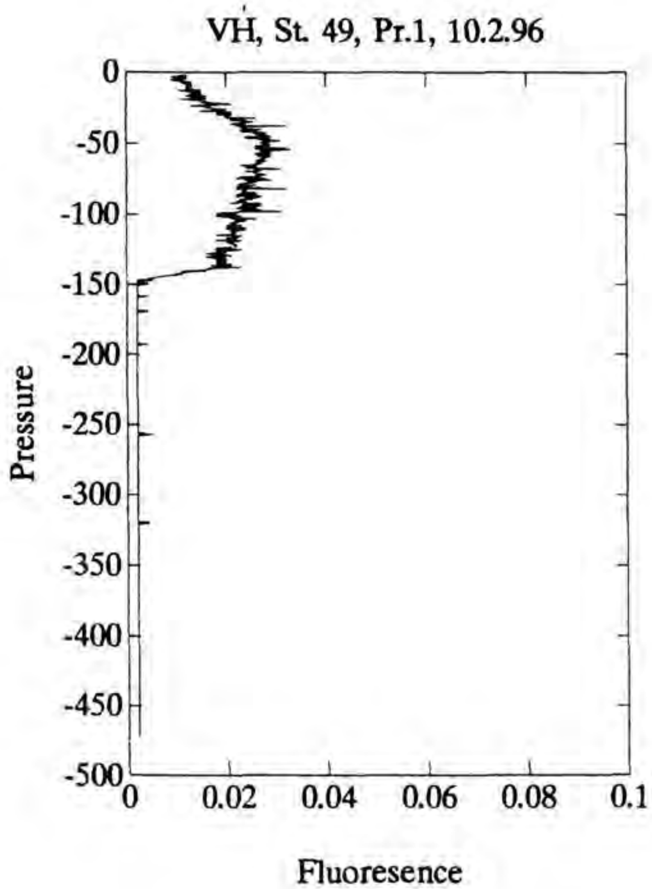
36.5
37
Salinity


VH, St. 49, Pr.1, 10.2.96
Pressure
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-100
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-200
-250
-300
-350
-400
-450
-500
0
0.02
0.04
0.06
0.08
0.1
Fluoresence

GeoB No.	Date 1996	Equipment	Bottom Contact (UTC)	Lattitude (N)	Longitude (W)	Water Depth (m)	Recovery GKG/CTD cm / m	Remarks
Profil A								
4023 - 1	14.02.	BG		27°34,0'	13°18,5'	26		
4023 - 2		GKG		27°34,0'	13°18,5'	24	25	sample washed out
4023 - 3		CTD		27°34,0'	13°18,5'	26	20	
4024 - 1		CTD		27°41,2'	13°25,6'	96	91	
4024 - 2		BG		27°40,9'	13°25.8'	98		no sample
4024 - 3		GKG		27°40,7'	13°25,9'	95	31	
4025 - 1		CTD		27°44,9'	13°29,2'	500	465	
4025 - 2		GKG		27°44,9'	13°29,3'	504		no sample
4025 - 3		GKG		27°44,9'	13°29,2'	496	19	
4026 - 1		GKG		27°48,5'	13°32,6'	990	28	
4026 - 2		CTD		27°48,5	13°32,6	990	465	
4027 - 1		CTD		27°53,2'	13°37,5'	1300	465	
Profil B								
4028 - 1	15.02.	GKG		28°13,0'	13°18,1'	970	30	surface washed out
4028 - 2		CTD		28°13,0'	13°18,1'	970	465	
4029 - 1		CTD		28°11,2'	13°15,9'	700	465	
4029 - 2		GKG		28°10,8'	13°15,8'	680	26	
4030 - 1		CTD		28°09,8'	13°14,1'	400	390	
4030 - 2		GKG		28°09,9'	13°14,2'	400		surface washed out
4031 - 1		GKG		28°07,7'	13°11,3'	100	16	
4031 - 2		CTD		28°07,7'	13°11.3'	100	95	
4032 - 1		CTD		28°01,0'	13°03,1'	50	45	
Profil C								
4033 - 1	16.02.	CTD		28°02,0'	12°40,0'	35	30	
4034 - 1		CTD		28°04,4'	12°41,6'	50	45	
4035 - 1		CTD		28°29,6'	12°51,3'	100	95	
4035 - 2		GKG		28°21,7'	12°51,3'	98		washed out
4036 - 1		CTD		28°28,1'	12°55,5'	220	215	
4037 - 1		CTD		28°30,5'	12°56,6'	405	395	
4037 - 2		GKG		28°30,4'	12°56,6'	400		Box damaged
4037 - 3		GKG		28°30,6'	12°56,7'	400		washed out
4038 - 1		CTD		28°40,5'	13°02,2'	695	465	
4038 - 2		GKG		28°40,6'	13°02,2'	695	28	
4039 - 1	17.02	CTD		29°13,5'	13°21,1'	200	190	
4040 - 1		CTD		29°11,6'	13°19,9'	1000	465	

GeoB No.	Date 1996	Equipment	Bottom Contact (UTC)	Lattitude (N)	Longitude (W)	Water Depth (m)	Recovery GKG/CTD cm / m	Remarks
4040 - 2		GKG		29°11,6'	13°20,1'	1000	28	
4041 - 1		CTD		29°02,7'	13°14,8'	1310	465	
4042 - 1		CTD		28°53,6'	13°09,7'	1240	465	
Profil D								
4043 - 1		CTD		28°60,0'	12°38,1'	1060	465	
4044 - 1		CTD		28°55,6'	12°36,1'	700	465	
4045 - 1		CTD		28°49,2'	12°33,0'	400	390	
4046 - 1		CTD		28°40,9'	12°28,9'	100	93	
4047 - 1		CTD		28°26,3'	12°22,2'	88	78	
Profil E								
4048 - 1	18.02.	CTD		28°11,0'	12^°00,2	32	22	
4049 - 1		CTD		28°23,8'	12°02,2'	50	40	
4050 - 1		CTD		28°29,2'	12^°04,4'	100	90	
4050 - 2		BG		28°29,3	12°04,3'	100		
4051 - 1		CTD		29°00,8'	12°07,7'	400	370	
4051 - 2		BG		29°00,7'	12°07,6'	400		
4052 - 1		CTD		29°04,5'	12°08,4'	700	465	
4052 - 2		BG		29°04,5'	12°08,4'	700		
4053 - 1		CTD		19°08,6'	12°09,0'	1000	465	
4053 - 2		BG		29°08,5'	12°08,9'	1000		
Profil F								
4054 - 1	19.02.	CTD		28°20,1'	13°27,0'	1170	465	
4055 - 1		CTD		28°24,9	13°32,8'	1300	465	
4056 - 1		CTD		28°30,0'	13°38,3'	1160	465	
4057 - 1		CTD		28°35,0'	13°44,1'	1000	465	
4057 - 2		GKG		28°35,0'	13°44,1'	1000	22	
Profil G								
4058 - 1		CTD		28°11,1'	13°54,5'	60	51	
4059 - 1		CTD		28°09,6'	13°53,3'	210	195	
4059 - 2		GKG		28°09,7'	13°53,3'	210		washed out
4060 - 1		CTD		28°07,3'	13°50,8'	1000	465	
4060 - 2		GKG		28°07,5'	13°50,9'	1000	31	
4061 - 1		CTD		28°00,7'	13°44,2'	1510	465	

GeoB No.	Date 1996	Equipment	Bottom Contact (UTC)	Lattitude (N)	Longitude (W)	Water Depth (m)	Recovery GKG/CTD cm / m	Remarks
Profil H								
4062 - 1	20.02.	CTD		27°05,9'	13°31,1'	50	40	
4063 - 1		CTD		27°12,8'	13°38,8'	100	90	
4064 - 1		CTD		27°15,7'	13°41,7'	400	390	
4065 - 1		CTD		27°32,4'	14°00,2'	1750	465	
4066 - 1		CTD		27°50,9'	14°20,1	1850	465	
4067 - 1		CTD		28°00,1'	14°30,0'	830	465	
4068 - 1		CTD		27°57,1'	14°46,8'	410	400	