EUROPEAN STATION FOR TIME SERIES IN THE OCEAN CANARY ISLANDS

ESTOC

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O.Llinás, A.Rodríguez de León, G.Siedler and G.Wefer

Instituto Canario de Ciencias Marinas (ICCM)
Instituto Español de Oceanografia (IEO)
Institut für Meereskunde Kiel (IFMK)
Fachbereich Geowissenschaften, Universität Bremen
(UBG)

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Apdo. 56. 35200 Telde. Gran Canaria. España. Tel.: (34 28 132900/04) Fax: (34 28 132908). *http:/neptuno.iccm.rcanaria.es.* E-mail: *ediciones@iccm.rcanaria.es.*

Instituto Español de Oceanografía. (Centro Oceanográfico de Canarias).

Ctra. San Andrés, s/nº. 38120 Tenerife. España. Tel.: (34 22 549400/01) Fax: (34 22 549554). *http:/www.ieo.rcanaria.es.* E-mail: *coc@ieo.rcanaria.es.*

Institut für Meereskunde. Universität Kiel.

Düsternbrooker Weg 20. D-24105 Kiel, Germany. Tel.: (49 431 597-3891) Fax: (49 431 565876). *http:/www.ifm.uni-kiel.de.*

Geowissenschaften. Universität Bremen.

Klagenfurter Str. D-28359 Bremen. Germany. Tel.: (49 421 218-3389) Fax: (49 421 218 3116). *http:/www.uni-bremen.de.*

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RESUMEN

Las observaciones de los cambios a gran escala en el océano son la clave para entender la variabilidad climática tanto a nivel global como regional. La Estación Europea de Series Temporales Oceánicas de Canarias (ESTOC) fue creada para complementar las estaciones oceánicas existentes en el borde este del Atlántico Norte. La estación se mantiene mediante la cooperación de cuatro instituciones: Institut für Meereskunde, Kiel (IFMK) y la Fachbereich Geowissenschaften der Universität Bremen (UBG) en Alemania y en España el Instituto Español de Oceanografia (IEO) y el Instituto Canario de Ciencias Marinas (ICCM). Las observaciones comenzaron a realizarse en 1994. La estación está situada nominalmente a 29°10'N, 15°30'W, a 100 km norte de las islas de Gran Canaria y Tenerife y tiene una profundidad de 3600 m. Se realizan observaciones mensuales de parámetros físicos, químicos y biológicos usando un buque de investigación, se mantienen fondeos de correntímetros y de trampas de sedimento y se hacen estudios de procesos con buques oceanográficos en el área circundante al menos una vez al año.

Éste es el segundo informe anual de la observaciones en la ESTOC de una serie que será publicada en los „Informes Técnicos del ICCM". En el informe se realiza una descripción de las medidas estándar tomadas en la estación y se presentan también las observaciones realizadas durante el estudio de los procesos en 1995 y 1996.

ABSTRACT

Observations of long-term changes in the ocean are a key to understanding regional and global climate variability. The European Station for Time-Series in the Ocean Canary Islands (ESTOC) was established to complement existing open-ocean stations in the eastern boundary regime of the North Atlantic. The station is maintained in cooperation by four institutions: Institut für Meereskunde, Kiel (IFMK) and the Fachbereich Geowissenschaften der Universität Bremen (UBG) in Germany, and in Spain the Instituto Español de Oceanografia (IEO) and the Instituto Canario de Ciencias Marinas (ICCM). Observations started in 1994. The nominal station position is at 29°10'N, 15°30'W, with the site about 100 km north of the islands of Gran Canaria and Tenerife at a depth of 3600 m. Activities include monthly observations of physical, chemical and biological parameters with a research vessel, the maintenance of a current meter mooring and a particle trap mooring and process studies with research ships in the surrounding area at least once per year.

This is the second annual report on the ESTOC observations in a series which will be published in the „Informes Técnicos del ICCM". The report provides a description of the standard measurements at the station site and also presents the observations made during the process study cruises in 1995 and 1996.

ESTOC
DATA REPORT 1995/1996

Contents

1 INTRODUCTION

The interdisciplinary time series station ESTOC (European Station for Time-series in the Ocean Canary Islands, Estación Europea de Series Temporales Oceánicas de Canarias) has been in operation since 1994. It is positioned at about 3600m depth at 29°10'N, 15°30'W, about 100 km north of the islands of Gran Canaria and Tenerife. Regular station observations once per month on a research vessel comprise measurements of physical, chemical and biological properties and include water sampling. In addition to these regular measurements other observations are performed during the monthly cruises on the initiative of individual researchers. The regular ship measurements are complemented by moored instrument observations.

In order to obtain an improved understanding of the processes governing the region and thereby to gain information on the representativeness of the time series data, repeated process studies are also carried out. These interdisciplinary experiments with research vessels combine hydrographic measurements, chemical and biological sampling, productivity experiments and drifting surface-tethered particle trap observations. The cruises are also used to exchange ESTOC moorings and to carry out the standard observations when appropriate. As a further contribution to the process studies, XBT lines were established between Gran Canaria and the station and also between Gran Canaria and Tenerife.

ESTOC is a Spanish-German joint project, with the participating institutions indicated on the cover of this report, and is coordinated by an international ESTOC Committee. Several Spanish and German ships have been used to carry out the observations. The funding for the German contribution is provided by the Ministry for Education, Science, Research and Technology (BMBF, Fkz.: 03F0108D) as part of the German JGOFS programme. The Spanish institutions obtain their funding from local and national government sources.

More information on the goals of ESTOC and the organisational structure can be found in the introduction to the first ESTOC annual report (Llinas et al., 1997) and on the web pages neptuno.iccm.rcanaria.es, www.ifm.uni-kiel and www.allgeo.uni-bremen.de. The annual reports for the periods 1995 and 1996 were prepared simultaneously and have therefore been combined here in one volume.

2 CRUISE SUMMARIES AND DEPLOYMENT INFORMATION

2.1 Regular Station Observations

2.1.1 Monthly Observations

(O. Llinás, R. Reuter, G. Siedler, T.J. Müller, S. Neuer, A. Spitzy)

The position of the ESTOC station is shown in Figure 1. The aim is to occupy the station regularly each month for two days. The list of cruises during the reporting period is presented in Table 1. The measurements are carried out by scientific and technical groups varying from cruise to cruise, with different people from the participating institutions (see Table 3). The journey from Las Palmas to the ESTOC position takes about 8 hours. The water depth of the station is 3600m and the work on station lasted approximately 9 hours.

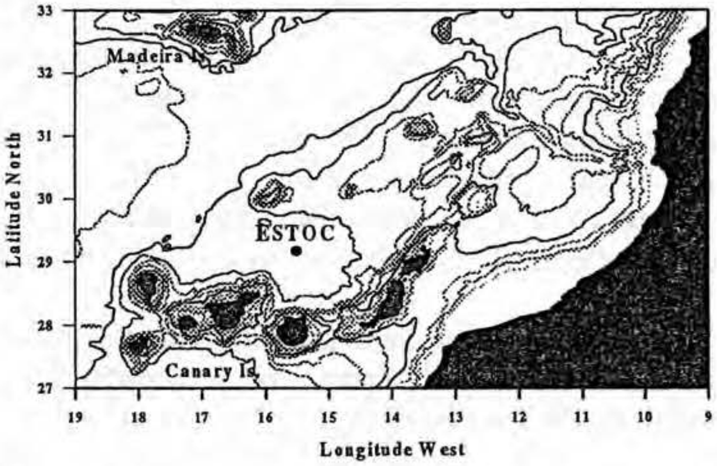

Figure 1. Map of the Canary-Madeira region with the position of ESTOC.

This report presents a summary of the station activities during the second and third year of operation. Due to some problems with BO "Taliarte" gaps occurred in the monthly sampling during 1995. During that year the station was occupied four times by BO "Taliarte" and several times during two periods by FS "Victor Hensen" and FS "Poseidon" The problems were overcome in 1996, with only one gap in November. A total of 8 cruises were done by BO "Taliarte", two by FS "Victor Hensen" and one by FS "Poseidon" (Table 1). On BO "Taliarte" the sampling was performed with Niskin bottles of 5 litres capacity fitted with reversing thermometers. Each bottle carried three thermometers and was mounted on stainless-steel hydrowire. A General Oceanics Rosette and a Neil Brown CTD were used on FS "Victor Hensen" and on FS "Poseidon".

Table 1. Summary of ESTOC cruises in 1995 and 1996.

ESTOC Month/year	Ship	Date	Max. depth (m) of observation
0195	Taliarte	25.01.95	2,800
0395	Taliarte	28.03.95	2,800
0595	Victor Hensen	01.06.95	1,000
0695	Victor Hensen	04.06.95	1,000
0895	Taliarte	30.08.95	2,750
0995	Poseidon	01.10.95	3,600
1095	Poseidon	03.10.95	3,600
		06.10.95	3,600
1195	Taliarte	25.11.95	2,750
0196	Victor Hensen	24.01.96	1,000
		28.01.96	1,000
0296	Victor Hensen	04.02.96	1,000
		10.02.96	1,000
0396	Taliarte	15.03.96	2,500
0496	Taliarte	24.04.96	2,500
0596	Poseidon	15.05.96	3,600
		20.05.96	3,600
		22.05.96	3,600
0696	Taliarte	12.06.96	2,500
0796	Taliarte	09.07.96	2,500
0896	Taliarte	29.08.96	-
0996	Taliarte	27.09.96	1,000
1096	Taliarte	30.10.96	1,000
1296	Taliarte	17.12.96	1,000

Table 2. Basic parameters measured at ESTOC in 1994-1996.

Parameters/Instruments	1994	1995	1996
Salinity (bottle)	------	------	------
Temperature (reversing thermometer)	------	------	------
CTD	------	------	------
XBT	------	------	------
Oxygen	------	------	------
Nitrate+Nitrite	------	------	------
Phosphate	------	------	------
Silicate	-----	-----	-----
Yellow substance			
Metal		------	------
Chlorophyll-a	------	------	------
Carbon dioxide			------
Isotopes			------

Table 3. Personnel participating in the monthly ESTOC cruises in 1995 and 1996.

Participant		Function during the cruise																							
Name	Inst.	Year 1995												Year 1996											
		1	2	3	4	5*	6*	7	8	9+	10+	11	12	1*	2*	3	4	5+	6	7	8	9	10	11	12
Betancor, J.	ICCM			T								T					T		T		T	T			T
Calderín, P.	ICCM								T										T	T					
Cianca, A.	ICCM											S		S	S	S	S	S	S	S	S		S		S
Delgado, E.	ICCM	S		S		S	S			S	S														
Escánez, J.	IEO	T																							
García-Ramos, C.	IEO			T																					
Godoy, J.	ICCM																					S	S		S
González, M.	ULPGC									S	S	S			S	S	S			S		S			
Haag, C.	IfMK					S	S			S	S														
Koy, U.	IfMK									T	T			T	T								T		
Langleras, L.	ULPGC																		S		S		S		S
López-Laatzen, F.	IEO	S																							
Luzardo, F.	ICCM														T	T	T	T	T	T	T	T	T		T
Martínez, D.	ICCM	S		S																					
Neuer, S.	GeoB					S	S				S				S			S					S		
Peña, F.	ICCM																		T	T	T				
Pérez, J.	ICCM																					S			S
Ramos, S.	ICCM	T		T					T			T				T	T			T	T	T	T		T
Rodríguez, C.	ICCM									S	S														
Rueda, M.J.	ICCM	S		S					S			S				S	S						S		
Santana, R.	ICCM	S		S						S	S	S				S	S					S	S		S

Hatched columns indicate months without sampling. Cruises were perfomed with BO "Taliarte" unless specified: * =Victor Hensen cruise, + = Poseidon cruise.

Participating institutes:

GeoB	: FB5, Geowissenschaften, Universität Bremen, Germany
ICCM	: Instituto Canario de Ciencias Marinas, Telde de Gran Canaria, Spain
IEO	: Instituto Español de Oceanografia, COC, Sta. Cruz, TF, Spain
IfMK	: Institut für Meereskunde an der Universität Kiel, Germany
ULPGC	: Universidad de Las Palmas, Gran Canaria, Spain

Functions:

S : scientist
T : technician

2.1.2 Moorings
2.1.2.1 Current/temperature measurements
(J. Reppin, T.J. Müller)

During the FS "Poseidon" cruise 202, a current meter mooring (see Figure D1 in data report 1994) was deployed on 22.09.1994 at 29°10.09'N and 15°40.25'W at a water depth of 3620m. The mooring was equipped with 7 Aanderaa current meters at 270, 500, 800, 1200, 1600, 2500, and 3500m depth. An upward looking ADCP was installed at 180m depth. The mooring was recovered during FS "Poseidon" cruise 212 on 17.09.1995.

The mooring was redeployed on 18.09.1995 at 29°09.75'N and 15°40.15'W during the same cruise. The number of Aanderaa current meters was reduced by one instrument (270, 540, 840, 1240, 2240, and 3590m). It was recovered during FS "Meteor" cruise 37 on 01.01.1997 and redeployed again on 04.01.1997.

2.1.2.2 Particle traps
(S. Neuer)

The particle trap mooring had already been deployed on FS "Meteor" cruise M20 on 25.11.1991 and was subsequently exchanged according to the schedule outlined in Table 4. The moorings carried up to three particle traps, current meters and a particle camera. The instruments and deployment depths are shown in Figure 2.

Table 4. Trap depths, mooring intervals and collection periods of the particle trap deployments CI 1-6 at the ESTOC station. No data are available from the 1 km trap of CI 3, and the 0.7 and 3 km traps of CI5.

Mooring	Trap depth (m)			Total collection period		Deployment	Sample
	0.7 km	1 km	3km	Start	End	(Days)	interval (Days)
CI 1		1006	3084	25.11.91	25.11.92	305	15
CI 2		1036	3067	01.10.92	09.04.93	190	10
CI 3		1026	3086	12.04.93	07.06.94	430	21
CI 4		923	3070	09.06.94	02.09.94	86	8
CI 5	713	976	3062	05.09.94	12.11.95	415	22
CI 6	731	976	3062	04.11.94	16.11.95	415	22

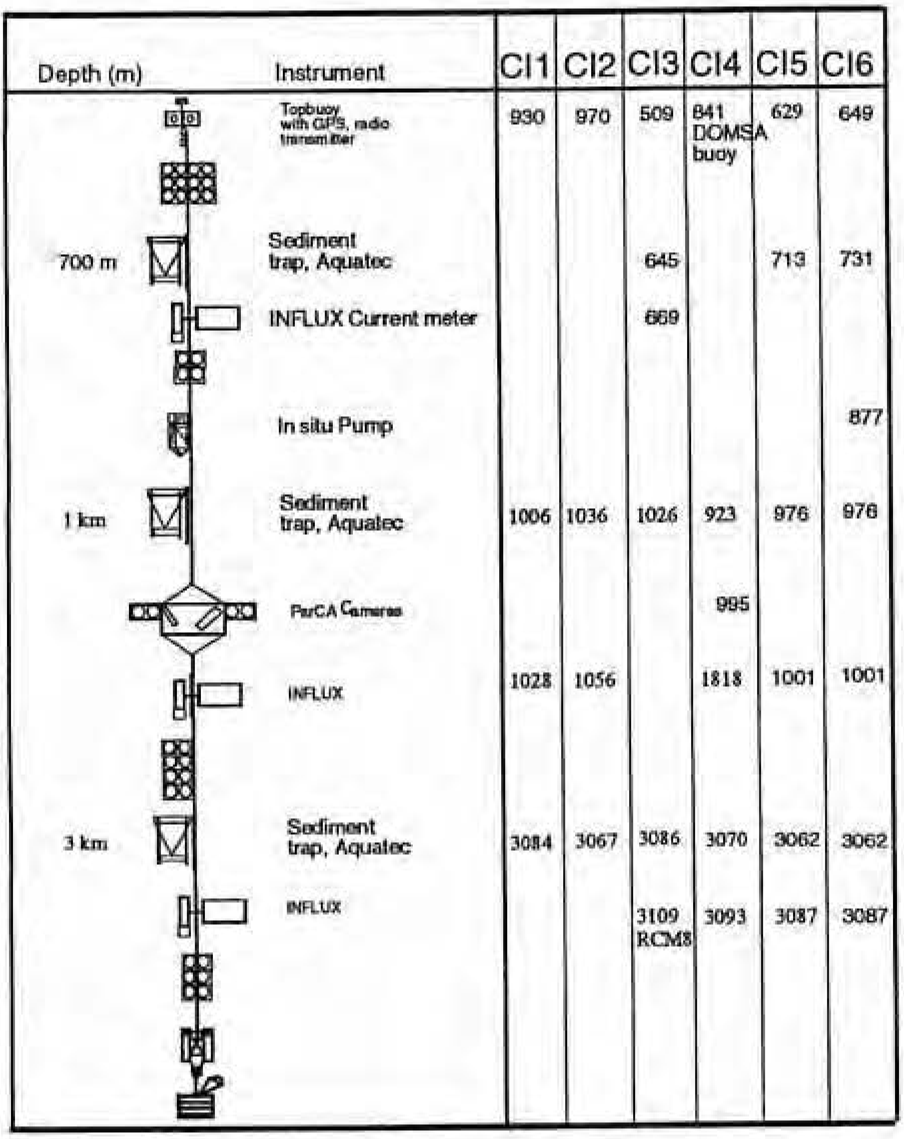

Figure 2. Design of the particle flux mooring at the ESTOC station. CI 1-6 refer to the mooring intervals described in Table 4.

2.1.3 XBT Lines
(E. Pérez-Martell, A. Cianca)
2.1.3.1 Methodology

Measurements are made using Sparton T5 (Deep Blue) probes, capable of measuring down to 1800 m for ship speeds up to 12 knots. In practice the launchings are made at ship speeds below 10 knots. Following WALSH (1996) the data in the upper 5 m are removed from the files because of the finite response time of the probes (0.63 s) generating unrealistic temperature values during the transition from air to water temperatures. A rate of fall of 6.5 m s^{-1} corresponds to a depth of 4.08 m.

Several computer routines have been written at the ICCM for the treatment and analysis of XBT data, using IDL as programming tool. These include:

- Quality control with rejection of poor data caused by failures of the insulation of wires, by resistance changes due to the stretching or by the breaking of the wires.
- The criteria used for data rejection is based on the establishment of thresholds for the maximum vertical temperature derivatives.
- Interpolation to standard depths, usually with 2m or 5m spacing.
- Processing routines including spatial and temporal averaging, calculation of anomalies, determinations of isotherm depths, determinations of inverse vertical gradients as a measure of stratification, and
- Comparisons with other XBT data sets and satellite-derived data sets.

2.1.3.2 XBT Line ESTOC-Gran Canaria

The observations started in March 1996 with typically 6 XBT probes launched on every monthly ESTOC cruise of BO "Taliarte". Usually these deployments are made during the way from ESTOC to Gran Canaria, with a nominal spacing between samples of 10 nautical miles (Figure 3). The numbers of observations are summarized in Table 5.

Table 5. XBT launches on ESTOC-Gran Canaria line.

Month	No. of XBTs (1996)
January	-
February	-
March	6
April	6
May	6
June	6
July	5
August	6
September	-
October	6
November	-
December	6

2.1.3.3 XBT Line Agaete-Sta.Cruz

The observations started in November 1995. The launches are made from Fred Olsen Line ferries cruising between Agaete/Gran Canaria and Sta.Cruz/Tenerife. Measurements began at 28° 10' N, 15° 50' W and ended at 28° 25' N, 16° 09' W. Positions were typically 8 nautical miles apart. The observations were performed monthly until February 1997, and bimonthly after that time. Table 6 summarizes the XBT launches on that route.

Table 6. XBT launches on Agaete-Sta.Cruz line.

Month	1995 No. of XBTs	1996 No. of XBTs
January	-	5
February	-	-
March	-	5
April	-	5
May	-	5
June	-	5
July	-	5
August	-	5
September	-	4
October	-	5
November	5	5
December	5	5

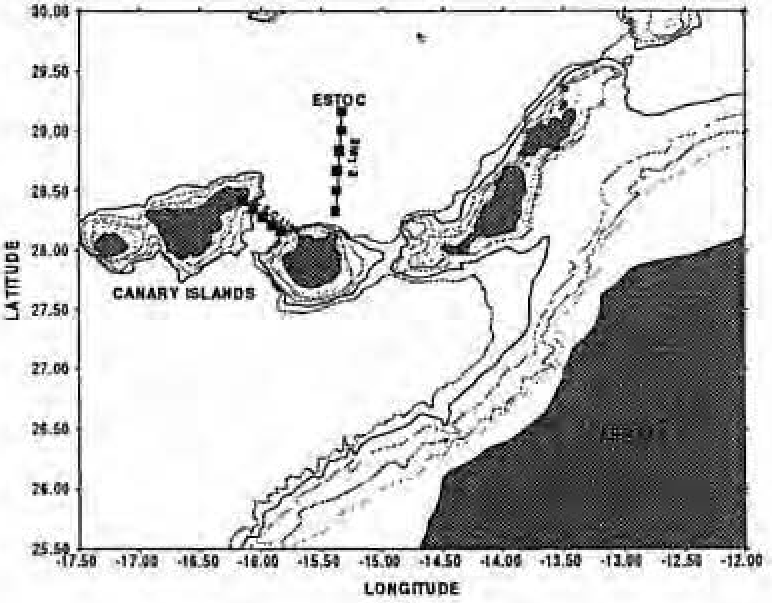

Figure 3. Positions of XBT observations.

2.2 Related Process Studies

2.2.1 Goals

Repeated cruises of research vessels were carried out in order to obtain an improved understanding of the processes governing the region. These observations have the goal to gain information on the representativeness of the ESTOC time series data for the larger region. The interdisciplinary experiments on the process study cruises included hydrographic measurements, chemical and biological sampling, productivity experiments and drifting surface-tethered particle trap observations. The cruises are also used to exchange ESTOC moorings and to carry out the regular monthly ship observations when appropriate.

2.2.2 "Victor Hensen" Cruise VH 95
(R. Reuter)

The FS "Victor Hensen" cruise (30.05.95-07.06.95) was aimed at investigating the circulation and the current system in the North Atlantic subtropical gyre, especially north of the Canary Islands. The hydrographic conditions in the eastern region of the Canary Islands are characterized by coastal upwelling of intermediate water to the surface. This high nutrient water generates an increase in phytoplankton growth in the upper 100 m, while the oligotrophic regions are characterized by low surface concentrations in nutrients and a sharp chlorophyll maximum at a depth of approx.100 m.

The cruise started at 30.05.95 (14H00 local time) at the port of Las Palmas. The chief scientist was Rainer Reuter. After test station 352 the port of Las Palmas was again called for repairing the vessel's engine. The ship left again on 31.05.95 and reached station 353. Until 07.06.95, station 401, measurements were performed with CTD (IfMK and UOL), bio-optical instruments (UOL), multinet (GeoB), with the analysis of nutrients (ICCM), chlorophyll (ICCM, GeoB), DOC (IBGM) and bacteria (UOL) from water samples from discrete depths (surface, 25, 50, 75, 100, 150, 400, 600, 800, 1000 m). On 01.06.95 at station 356 a floating sediment trap was released near ESTOC. It was planned to recover the trap again on 04.06.95 but search was stopped at 05.06.95 without success. The list of stations is presented in Table 8, and the participants in the cruise are listed in Table 7. From 03.06.95 - 06.06.95 daily flight operations by a German DO 228 maritime surveillance aircraft equipped with a scanning laser fluorosensor were conducted leading to spatial distribution maps of surface gelbstoff contents in the Canary Island region. On 07.06.95 FS 'Victor Hensen' arrived at the harbour of Las Palmas, finishing the cruise.

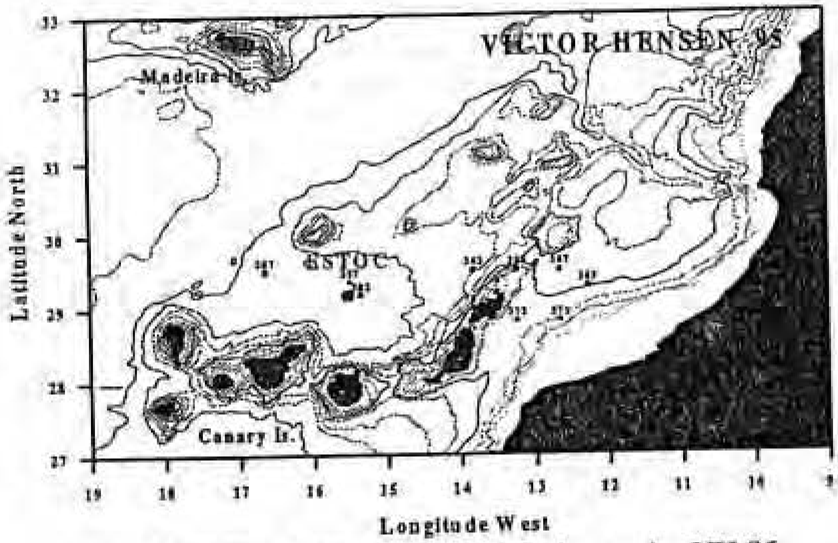

Figure 4. Stations sampled during cruise VH 95.

Table 7. Participants of FS "Victor Hensen" cruise 06/95.

Name	Institution
R. Reuter (C)	UOL
K.D. Loquay (T)	UOL
R. Heuermann (S)	UOL
H. Barth (S)	UOL
A. Laschke (S)	UOL
C. Becker (S)	UOL
G. Fengler (S)	IBGM
C. Haag (S)	IfMK
S. Neuer (S)	GeoB
E. Delgado (S)	ICCM

Institutions:

UOL Universität Oldenburg
IBGM Institut für Biogeochemie und Meereschemie, Hamburg
IfMK Institut für Meereskunde, Universität Kiel
GeoB Geowissenschaften, Universität Bremen
ICCM Instituto Canario de Ciencias Marinas, Telde, Gran Canaria

Functions:

C : chief scientist
S : scientist
T : technician

Table 8. Stations of FS "Victor Hensen" cruise 06/95.

STATION NO.	DATE	POSITION		TIME (UTC)
	1995	φ (°N)	λ (°W)	start
352	30.05.	28°11.0	15°21.8	14:45
353	31.05.	28°11.0	15°21.8	14:40
354	31.05.	28°20.0	15°30.0	18:30

STATION NO.	DATE	POSITION		TIME (UTC)
	1995	φ (°N)	λ (°W)	start
355	31.05.	28°35.0	15°30.0	21:00
356	01.06.	29°20.8	15°29.0	08:55
357	01.06.	29°20.9	15°28.9	09:20
358	01.06.	29°30.0	15°12.5	16:50
359	01.06.	29°30.0	14°55.3	19:40
360	01.06.	29°30.0	14°38.1	22:12
361	02.06.	29°30.0	14°21.0	01:01
362	02.06.	29°30.0	14°04.0	03:06
363	02.06.	29°30.0	13°48.0	05:45
364	02.06.	29°30.0	13°29.6	10:10
365	02.06.	29°30.0	13°12.5	12:36
366	02.06.	29°30.0	12°55.0	17:12
367	02.06.	29°30.0	12°38.0	17:30
369	03.06.	29°16.0	12°15.5	23:37
370	03.06.	29°02.0	12°26.8	04:20
371	03.06.	28°48.2	12°38.0	06:34
372	03.06.	28°48.2	12°55.3	10:00
373	03.06.	28°48.2	13°12.5	13:10
374	03.06.	28°48.2	13°30.0	18:13
375	03.06.	28°48.2	13°46.8	19:55
376	03.06.	28°48.2	14°04.0	22:20
377	04.06.	28°48.2	14°21.0	00:40
378	04.06.	28°48.2	14°38.0	02:35
379	04.06.	28°48.2	14°55.0	05:50
380	04.06.	28°48.2	15°12.5	07:45
381	04.06.	29°00.0	15°16.0	11:45
382	04.06.	29°10.0	15°20.0	14:35
383	05.06.	29°30.0	15°30.0	07:50
384	05.06.	29°30.0	15°47.0	14:00
385	05.06.	29°30.0	16°04.0	17:55
386	05.06.	29°30.0	16°38.0	20:00
387	05.06.	29°30.0	16°38.0	21:45
388	06.06.	29°20.0	16°38.0	01:30
389	06.06.	29°10.0	16°38.0	03:10
390	06.06.	29°21.0	16°21.0	05:10
391	06.06.	29°10.0	16°04.0	09:48
392	06.06.	29°10.0	15°47.0	12:24
393	06.06.	29°10.0	15°43.2	12:45
394	06.06.	28°59.0	15°30.0	15:02
395	06.06.	28°48.0	15°30.0	17:41
396	06.06.	28°48.0	15°47.0	19:48
397	06.06.	28°48.0	16°40.0	21:40
398	07.06.	28°34.0	16°04.0	23:00
399	07.06.	28°28.5	15°53.5	01:02
400	07.06.	28°23.0	15°43.5	04:06
401	07.06.	28°18.0	15°33.5	04:35

2.2.3 "Poseidon" Cruise P 212
(G. Siedler, T.J. Müller)

The ship departed from Las Palmas, Gran Canaria, on 30.09.95, 18.30. After the passage to the ESTOC position work started with the launching of a drifting sediment trap, followed by CTD casts. The ship then went to a position to the southwest of Fuerteventura, then along the western side of Fuerteventura and Lanzarote to the north (station 846) and from there westward on a zonal course to a position north of ESTOC (station 851). After retrieving the drifting sediment trap for the first time, the trap was relaunched at the ESTOC position, and CTD measurements were performed at this location. A north-south section to Tenerife followed to station 859, and consecutive sections between Tenerife and Gran Canaria and from there to Fuerteventura (station 867). The vessel then returned to the ESTOC position in order to recover the drifting sediment trap and to perform standard time series station operations again. After a passage to La Palma (station 870) the final section of P212/3 led from there to the north coast of Tenerife.

"Poseidon" arrived in the port of Sta. Cruz on 08.10.95, 09.00. The complete scientific group was exchanged, and the task of the chief scientist was transferred from G. Siedler to T.J. Müller. A reception for the participants of the Second ESTOC Workshop, for scientists of the University of La Laguna and local officials was organized in collaboration with the German consulate in Sta.Cruz. Participants of the cruise joined the 2nd ESTOC workshop organized by the IEO in their facilities in Sta. Cruz. The participants are given in Table 9, and the stations in Table 10.

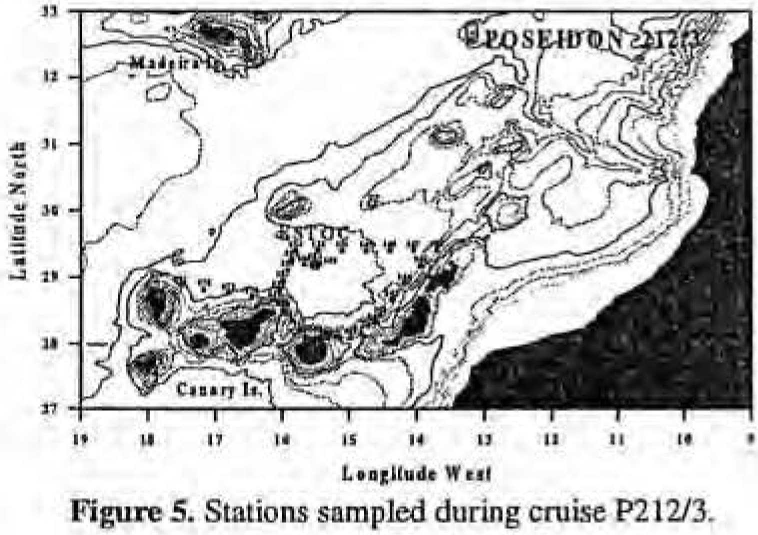

Figure 5. Stations sampled during cruise P212/3.

Table 9. Participants of FS "Poseidon" cruise P212/3.

Name	Institution
Busse, Markus (St)	IfMK
Delgado, Esther (S)	ICCM
Gonzalez, M. (S)	ULPGC
Haag, Christian (S)	IfMK
Koy, Uwe (T)	IfMK
Neuer, Susanne (S)	GeoB
Rodriguez, Cristina (S)	ICCM
Santana, Rosa (S)	ICCM
Siedler, Gerold, (C)	IfMK
Torres Padron, M.E. (S)	ULPGC

Institutions:

GeoB : FB5, Geowissenschaften, Universität Bremen, Germany
ICCM : Instituto Canario de Ciencias Marinas, Telde de Gran Canaria, Spain
IfMK : Institut für Meereskunde an der Universität Kiel, Germany
ULPGC : Universidad de Las Palmas, Gran Canaria, Spain

Functions:

C : chief scientist
S : scientist
St : student
T : technician

Table 10. Stations sampled and instruments used during FS "Poseidon" cruise P212/3.

STATION NO.	DATE 1995	POSITION φ (°N)	λ (°W)	TIME (UTC) start	stop	DEPTH corr. (m)	INSTRUMENTS
840	01.10.95	29°09.9	15°40.0	02.00	02.32	3513	CTD/ADCP
				02.40	04.15	3513	ICTD
				04.26	07.07	3513	CTD
841	01.10.95	29°10.0	15°40.1	08.20	08.39	3638	Launching drifting sediment trap no.7848
842	01.10.95	28°24.0	14°32.0	16.55	18.32	2010	CTD/ADCP
				19.34	19.55	3014	CTD (30 m)
843	01.10.95	28°39.0	14°21.5	22.00	23.38	1905	CTD/ADCP
844	02.10.95	20°53.9	14°10.5	01.45	03.23	2289	CTD/ADCP
845	02.10.95	29°09.0	13°55.9	05.50	07.34	2089	CTD/ADCP
846	02.10.95	29°23.0	13°41.5	09.46	11.20	1908	CTD/ADCP
				12.41	13.15	1872	CTD
847	02.10.95	29°23.0	14°02.8	15.18	17.37	3305	CTD/ADCP
848	02.10.95	29°23.0	14°23.1	19.44	22.16	3442	CTD/ADCP
849	03.10.95	29°22.9	14°44.4	00.25	02.28	3538	CTD/ADCP
850	03.10.95	29°23.0	15°05.8	04.30	06.45	3587	CTD/ADCP
851	03.10.95	29°23.0	15°26.6	08.55	11.38	3619	CTD/ADCP
				12.15	12.40	3618	CTD/ADCP (500m)
852	03.10.95	29°08.7	15°48.5	15.15	15.35	3638	Retrieval drifting sediment trap
853	03.10.95	29°12.0	15°30.0	17.30	17.46	3622	Launching drifting sediment trap
		29°11.8	15°29.5	18.00	18.12	3622	CTD/LADCP (30m)
				19.45	22.02	3623	CTD/LADCP
854	04.10.95	29°23.0	15°47.5	00.20	02.10	3641	CTD/LADCP
855	04.10.95	29°14.7	15°51.2	03.48	06.05	3644	CTD/LADCP
856	04.10.95	29°.05.7	15°54.8	07.20	10.28	3638	CTD/LADCP
857	04.10.95	28°56.5	15°58.5	11.47	13.57	3611	CTD/LADCP
858	04.10.95	28°47.2	16°02.3	15.15	17.27	3381	CTD/LADCP
859	04.10.95	28°38.4	16°06.0	18.45	19.30	466	CTD/LADCP
860	04.10.95	28°29.5	15°58.4	20.54	23.30	2929	CTD/LADCP
861	05.10.95	28°20.4	15°51.4	05.20	07.54	3272	CTD/LADCP
862	05.10.95	28°12.0	15°44.1	09.25	10.12	463	CTD/LADCP
863	05.10.95	28°05.0	15°20.5	13.10	13.50	543	CTD/LADCP
864	05.10.95	28°05.0	15°09.3	15.05	16.34	1690	CTD/LADCP
865	05.10.95	28°05.0	14°58.0	18.00	19.27	1569	CTD/LADCP
866	05.10.95	28°05.0	14°47.0	20.40	21.55	988	CTD/LADCP
867	06.10.95	28°17.9	14°37.1	00.10	01.30	1414	CTD/LADCP
868	06.10.95	28°58.0	15°40.2	08.08	09.20	3624	Retrieval drifting sediment trap
869	06.10.95	29°11.9	15°30.0	11.55	12.10	3625	CTD/LADCP (200m)

STATION NO.	DATE 1995	POSITION φ (°N)	λ (°W)	TIME (UTC) start	stop	DEPTH corr. (m)	INSTRUMENTS
				12.48	15.18	3624	CTD/LADCP
				16.24	16.55	3623	CTD/LADCP (300m)
870	07.10.95	28°55.1	17°51.5	06.16	07.56	1946	CTD/LADCP
871	07.10.95	28°51.3	17°30.5	10.13	12.19	3168	CTD/LADCP
872	07.10.95	28°48.1	17°09.2	14.30	16.27	3563	CTD/LADCP
		28°47.9	17°09.2	16.35	16.47	3565	ICTD (test)
873	07.10.95	28°45.1	16°48.0	18.57	21.00	3239	CTD/LADCP
874	07.10.95	28°41.5	16°26.8	23.00	00.45	2688	CTD/LADCP

2.2.4 "Victor Hensen" Cruise VH 96
2.2.4.1 VH 96-1
(R. Reuter)

Objectives

The FS "Victor Hensen" cruise (23.01.96-31.01.96) had the aim to investigate the circulation and current system in the North Atlantic subtropical gyre, especially north of the Canary Islands. It was part of the multi-year series of expeditions to investigate the region near the European time-series station ESTOC.

Narrative

The FS "Victor Hensen" cruise started at 23.01.96 (13h00 local time) at the port of Santa Cruz de Tenerife, with a 2-days delay due to bad weather. The chief scientist was Rainer Reuter. Strong wind conditions of up to 7 Bft remained stable during the entire cruise and were a problem during most station work.

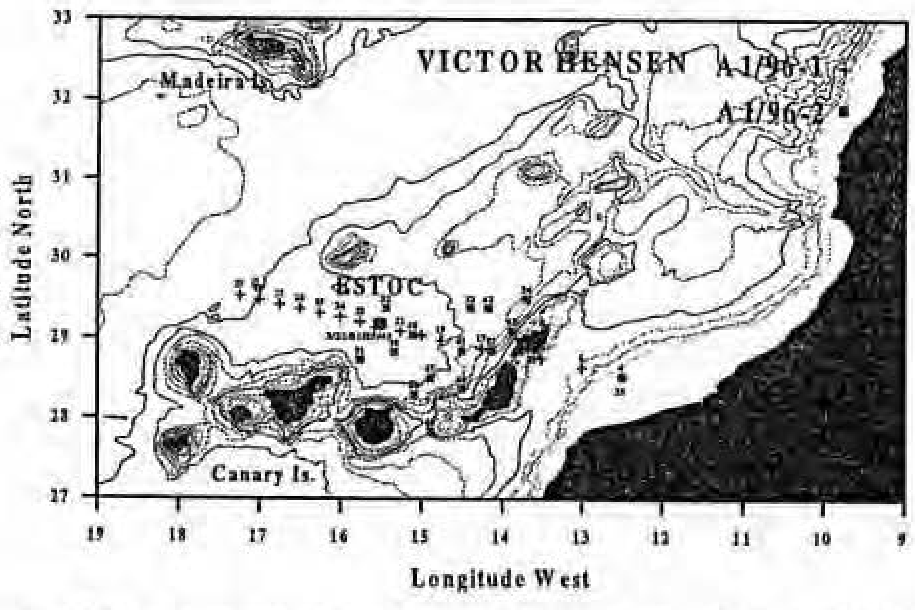

Figure 6. Map of stations visited during Victor Hensen A1/96-1 and A1/96-2.

Moreover, the *in situ*-fluorometer as part of the probing system became defective on 24.01.98 and could not be repaired on board the ship. Therefore, *in situ*-measurements were limited to temperature and salinity data sampling with a

Meerestechnik-Elektronik OTS 1500 (UOL) and an SIS (ICCM) CTD probe. Water samples were taken at 0 - 10 - 25 - 50 - 75 - 100 - 150 - 200 - 300 - 400 - 600 - 800 and 1000m depth for chlorophyll a, oxygen, nutrients, DOC, POC and isotope measurements. Moreover, coccolitophoride and foraminifera sampling was done at most stations. The cruise ended on 31.01.98 in the port of Las Palmas de Gran Canaria. The list of participants is presented in Table 11 and the stations sampled are given in Table 12. A complete set of calibrated and processed data on CD-ROM were made available to the participants of the cruise and to the German JGOFS Data Centre in November 1996.

Table 11. Participants of FS "Victor Hensen" VH 96-1.

Name	Institution
R. Reuter (C)	UOL
K.D. Loquay (T)	UOL
H. Barth (S)	UOL
Stefan Guess (S)	IBGM
Uwe Koy (T)	IfMK
J. Bollmann (S)	ETH
Andrea Spiedt (S)	GeoB
A. Cianca (S)	ICCM

Institutions:

UOL Universität Oldenburg
IBGM Institut für Biogeochemie und Meereschemie, Hamburg
IfMK Institut für Meereskunde, Universität Kiel
ETH Eidgenössische Technische Hochschule, Zürich
GeoB Geowissenschaften, Universität Bremen
ICCM Instituto Canario de Ciencias Marinas, Telde, Gran Canaria

Functions:

C : chief scientist
S : scientist
T : technician

Table 12. Stations sampled during the FS "Victor Hensen" cruise VH 96_1.

STATION NO.	DATE 1996	POSITION φ (°N)	λ (°W)	TIME (UTC) start	stop	DEPTH (m)	PROFILE NO.
002	23.01.	28°25.0	16°15.0	13:50 15:25 20:04	15:05 16:43	1500	Test 001 002
003	24.01.	29°08.3	15°34.0	08:20 09:40 11:05 13:15 14:30	08:45 10:05 12:55 13:50 14:50	1500	003 004 005 006
004	25.01.	28°32.0	12°30.0	06:30	06:40	104	007
004	25.01.	28°32.0	12°30.0	06:51	07:10	104	008
005	25.01.	28°35.0	12°45.4	08:55 09:20	09:10 09:40	150	009 010
006	25.01.	28:38.5	13.00.7	11:15	11:35	560	011

STATION NO.	DATE	POSITION		TIME (UTC)		DEPTH	PROFILE NO.
	1996	φ (°N)	λ (°W)	start	stop	(m)	
006	25.01	28:38.5	13.00.7	12:50	13:30		012
				13:38			013
				14:04			014
007	25.01.	28°40.1	13°07.3	14:46			015
008	25.01.	28°41.5	13°14.8	15:40		1080	016
008	25.01.	28°41.5	13°14.8	16:00	17:10	1080	017
							018
							019
009	25.01.	28°43.1	13°22.5				020
010	25.01.	28°44.7	13°30.3	19:10	19:36	1300	021
				19:40		1300	
				20:55		1300	022
				23:05		1300	023
011	26.01.	28°46.4	13°37.9	00:15			024
012	26.01.	27°49.9	13°23.6	08:10	08:20	105	025
				08:42	08:58	105	026
013	26.01.	27°56.5	13°32.4	10:07	10:30	1960	027
				10:30	11:15	1960	
				11:28	12:55	1960	028
014	26.01.	28°02.8	13°41.3	13:00	13:15		029
							030
				15:00	15:50		031
				16:00	16:10		032
015	26.01.	28°09.0	13°49.9	17:13	17:40	750	033
				17:40	17:55		034
				18:00	18:45		
				~18:50			035
016	27.01.	28°49.9	13°59.9	08:14	08:43	1500	036
				~9:17	9:40		037
017	27.01.	28°52.4	14°14.9	12:05	12:28	2620	038
				12:35	13.15		
				13:20	14:35		039
				14:45	15:25		040
018	27.01.	28°55.3	14°30.0	~17:08	17:19	3000	041
				*17:28	~17:50		042
				17:55	18:57		043
019	27.01.	28°58.9	14°44.9	20:45	21:07	3515	044
				21:30	21:50		045
				22:07	11:35		046
020	28.01.	29°02.2	15°00.0	06:07	06:29	3580	047
				06:32	7:15		
				07:20	8.43	3580	048
				09.03	09.23		049
	29.01			13:05	14:20		066
				14:25	14:40		067
				14:40	14:56		068
026	29.01	29°22.2	16°30.0	16:24	16:43	3700	069
				16:50			070
				17:00	18:10		071
				18:30	18:50		072
027	29.01	29°25.2	16°45.0	20:22		3840	073
				22:45	21:05		074
027	29.01	29°25.2	16°45.0	21:05	21:55		
				22:00	23:40		075
028	30.01	29°28.5	17°00.0	08:10	08:25	3930	076
				08:31	09:30		077
				09:42	10:03		078

STATION NO.	DATE 1996	POSITION φ (°N)	λ (°W)	TIME (UTC) start	stop	DEPTH (m)	PROFILE NO.
029	30.01	29°31.5	17°15.0	11:57		4050	079
				12:25	13:30		080
				13:53	14:15		081

2.2.4.2 VH 96-2
(S. Neuer)

The FS "Victor Hensen" left the port of Las Palmas on 04.02.96, two days later as scheduled due to bad weather conditions.The chief scientist was Susanne Neuer. The list of participants is presented in Table 13. 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. We returned to ESTOC on two occasions, to conduct station work and to recover and re-deploy the particle trap; the list of stations, instruments and parameters is displayed in Table 14. We returned to port as scheduled in the morning of 12.02.1996.

Table 13. Participants of FS "Victor Hensen" cruise VH 96-2.

Name	Institution
Neuer, Susanne, (C)	GeoB
Cianca, Andres (S)	ICCM
Coca Saez de Albéniz, Josep (S)	ULPGC
Eberwein, Astrid (S)	GeoB
González-Dávila, Melchor (S)	ULPGC
Klein, Birgit (S)	TracerB
Koy, Uwe (T)	IFMK
Lorenzen, Christiane (S)	AWI
Luzardo-Hernández, Francisco (T)	ICCM

Institutions:

AWI
Alfred Wegener Institut für Polar und Meeresforschung

GeoB
Fachbereich für Geowissenschaften
Universität Bremen
Klagenfurter Strasse
D - 28359 Bremen

ICCM
Instituto Canario de Ciencias Marinas
Dirección General de Universidades e Investigación
Consejería de de Educación,
E - 35200 Telde,
Canary Islands, Spain

IFMK
Institut für Meereskunde
Universität Kiel
Düsternbrooker Weg 20
D - 24105 Kiel

ULPGC
Universidad de Las Palmas de G. Canaria
Edificio de Ciencias Básicas
Campus Universitario Tarifa
E - 35017 Las Palmas de Gran Canaria
Canary Islands, Spain

Functions:

C ; chief scientist
S : scientist
T ; technician

Table 14. Stations of FS "Victor Hensen" cruise VH96-2, 02.02-12.02.1996.

STATION NO.	DATE 1996	POSITION φ (°N)	λ (°W)	TIME (UTC) start	DEPTH corr. (m)	PROFILE NO.	PROFILE DEPTH (m)	INSTRUMENTS PARAMETERS
030	04.02	28°35.0	15°25.8	11.25	3650	001	500-530	Sampling seawater for traps
				12.24		002	465	CTD nb1
031	04.02	29°09.0	15°30.7	16.45	3660	000	200-220	Traps into water
				17.30		001	1000	CTD SIS (1000, 800,600,400,300, 200,150,125,100,75,50,25,10m)
				19.17		002		CTD nb1(150,90,75,25 m), protists
				20.10		003	1000	CTD SIS (1000, 800,600,400,200, 100,75,50,25,10m), POC, HPLC
				21.37		004	30	Dilution experiments
				21.50		005	1000	CTD SIS (1000, 600,400,200,15, 100,50,25,10m), He/H_3, CFC
				23.20		006	80	Dilution experiments (80,78,76,74m)
				23.40			1800	XBT-T5, #01
032	05.02	29°23.0	15°26.6	08.05	3700	001	1000	CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25m), Alk/pH, chl, nut, trace metals
032	05.02	29°23.0	15°26.6	09.30		002	465	CTD nb1, (200, 150,100,50,10m), Alk/pH, chl, nut, trace metals, protists
				18.24			1800	XBT-T5,#02

STATION NO.	DATE 1996	POSITION φ (°N)	λ (°W)	TIME (UTC) start	DEPTH corr. (m)	PROFILE NO.	PROFILE DEPTH (m)	INSTRUMENTS PARAMETERS
033	05.02	29°23.0	14°23.1	16.15	3450	001	1000	CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25,10m), Alk/pH, chl, nut, trace metals, protists
				17.22		002	465	CTD nb1, (200, 100,75,50,25,10m) HPLC
034	05.02	29°23.0	13°41.5	23.20	1840	001		CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25m), O_2, alk/pH, chl, nut, trace metals
				00.42		002		CTD nb1 (10m), O_2, alk/pH, chl, nut, trace metals
035	06.02	29°32.0	12°30.0	09.25	100	001	100	CTD nb1 (90,75,50,25,10m), O_2, alk/pH, chl, nut, trace metals, protists
						002	100	CTD nb1 (90,75,50,25,10m), Chl, POC, HPLC
036	06.02	28°45.0	13°38.0	17.45	1140	001	1000	CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25m),Alk/ pH, nut,trace metals
				19.16		002	465	CTD nb1, (100, 75,50,25,10m), Alk/ pH, nut,trace metals, protists
				19.56		003	1000	CTD nb1 (1000, 800,600,400, 200, 100,75,50,25,10m POC,HPLC
037	06.02	28°51.0	14°08.0	23.55	2000	001	1000	CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25m), O_2, Alk/ pH, chl, nut, trace metals
				01.16		002	465	CTD nb1, (100, 75,50,25,10m), O_2, Alk/ pH,chl, nut, trace metals, protists
038	07.02	29°06.5	15°42.6	09.40	3630	000	500	Retrieve traps (500-530m)
				10.40		001	500	Sampling seawater for traps (450-500m)

STATION NO.	DATE 1996	POSITION φ (°N)	λ (°W)	TIME (UTC) start	DEPTH corr. (m)	PROFILE NO.	PROFILE DEPTH (m)	INSTRUMENTS PARAMETERS
				11.14		002	465	CTD nb1, (150, 100,75,50,25,10m) Chl, isotopes, protists
039	07.02	29°09.5	15°30.4	13.00	3660	000		Traps into water
				13.58		001	1000	CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25m), O_2, Alk/ pH, chl, nut, trace metals
				15.01		002		CTD nb1, (150, 100,50,25,10m) Protists
				16.20		003		CTD nb1 (10m), O_2, Alk/ pH, chl,nut,trace metals
				16.35		004		CTD nb1 (1000, 800,600,400, 200, 100,75,50,25,10m POC,HPLC
				17.30		005		CTD SIS (1000, 600,400,200,15, 100,50,25,10m), He/H_3, CFC
				18.55		006		Dilution experiments (25m)
				19.15		007	200	Multinet (200,150, 100,50,10),protists
				20.00		008		Dilution experiments (25m)
040	07.02	29°03.0	15°06.0	23.05	3590	001	1000	CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25m), O_2, Alk/ pH, chl, nut, trace metals
				00.36		002	465	CTD nb1 (10m), O_2, Alk/ pH, chl,nut,trace metals
041	08.02	28°51.0	14°30.0	08.05	3100	001	1000	CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25m), Alk/ pH, chl, nut, trace metals
				09.18		002	465	CTD nb1 (10m), O_2, Alk/ pH, chl,nut,trace metals
				09.50		003	1000	CTD nb1 (1000, 800,600,400, 200, 100,75,50,25,10m) POC
042	08.02	29°23.0	14°14.0	15.15	3390	001	1000	CTD SIS (800,600, 400,200,100,75,50, 25m), Alk/ pH, chl, nut, trace metals

STATION NO.	DATE 1996	POSITION φ (°N)	λ (°W)	TIME (UTC) start	DEPTH corr. (m)	PROFILE NO.	PROFILE DEPTH (m)	INSTRUMENTS PARAMETERS
				16.27		002	465	CTD nb1,(100,50, 25,10m), Alk/ pH, chl, nut, trace metals, protists
043	08.02	29°10.0	13°52.0	19.00	1440	001	1000	CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25m), Alk/ pH, chl, nut, trace metals
				20.20		002	465	CTD nb1, (100, 75,50, 25,10m), Alk/ pH, chl, nut, trace metals, protists
				20.55		003	1000	CTD SIS (1000, 800,600,400, 200, 100,75,50,25,10m) POC,HPLC
044	09.02	28°23.0	14°30.0	06.05	2100	001	1000	CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25m), O_2, alk/ pH, chl, nut, trace metals
				07.15		002	465	CTD nb1, (100, 75,50, 25,10m), O_2, alk/ pH, chl, nut, trace metals, protists
				08.25		003	1000	CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25m), POC, HPLC
045	09.02	27°54.0	14°53.0	13.00	1030	001	800	CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75m), O_2, alk/ pH, chl, nut, trace metals
				14.08		002	465	CTD nb1, (100, 75,50, 10m), Protists
046	09.02	28°18.0	15°05.0	17.30	3000	001	1000	CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25m), O_2, alk/ pH, chl, nut, trace metals
				18.46		002	465	CTD nb1, (100, 75,50, 25, 10m), Protists
046	09.02	28°18.0	15°05.0	19.30	3000	003	200	CTD SIS (200,150, 125,100,75,50,25, 10m), O_2, alk/ pH, chl, nut, trace metals, HPLC

STATION NO.	DATE 1996	POSITION φ (°N)	λ (°W)	TIME (UTC) start	DEPTH corr. (m)	PROFILE NO.	PROFILE DEPTH (m)	INSTRUMENTS PARAMETERS
				19.55		004	400	CTD nb1 (400, 75, 10m), POC
047	09.02	28°30.5	14°52.5	22.20	3460	001	1000	CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25m),alk/ pH, chl, nut, trace metals
047	10.02	28°30.5	14°52.5	00.07	3460	002	465	CTD nb1, (100, 75,50, 25,10m), O_2, alk/ pH, chl, nut, protists
048	10.02	28°58.7	15°45.0	08.05 08.46	3620	001 002	 200	Retrieve traps CTD SIS (200,150, 125,100,75,50, 10m), chl, HPLC, protists
049	10.02	29°10.0	15°30.0	11.50 12.00 13.12 15.05 16.05 17.15 18.05	3660	001 002 003 004 005 006 007	10 1000 465 1000 1000 200 	CFC CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25m), chl, nut, isotopes CTD nb1, (125, 75,50, 25,10m), Alk/ pH, chl, nut, isotopes, protists CTD SIS (1000, 800,600,400,300, 200,150,125,100, 75,50,25m), chl (2µm<frac <20µm POC, HPLC CTD SIS (1000, 600,400,200,15, 100,50,25m), He/H_3, CFC Multinet (200,150, 100,50,10),protists Dilution experiments (20-30m)
050	10.02	28°50.0	15°20.0	22.30	3610	001	1000	CTD SIS (1000, 600,400,300, 200, 150,125,100,75, 50m),alk/ pH, chl, nut
				23.45		002	200	CTD SIS (25,10m) alk/ pH, chl, nut
051	11.02	28°44.0	15°45.0	08.05		001	1000	CTD SIS (1000, 600,400,300, 200,150,125,100, 75,50,25,10m),alk/ pH, chl, nut,HPLC, protists

alk = alkalinity   CFC = chlorofluorocarbons   chl = chloropyll a
flu = fluorescence   He/H_3 = helium/Tritium   nut = nutrients
HPLC = high pressure liquid chromatography   POC = particulate organic matter

2.2.5 "Poseidon" cruise P219
(A. Spitzy)

The ship departed from Las Palmas, Gran Canaria, on 14.05.96 in the morning northward towards the ESTOC station. On the way, the first station 370 was reached at 14.00 hours where CTD/rosette cast was followed by launch of a drifting sediment trap. The ship then went on to ESTOC where CTD/rosette cast was done, followed by further CTD/rosette casts in the vicinity of the trap, which was recovered at station 380 on 17.05.96. The trap was relaunched at station 382 on 17.05.96. The ship then moved away from the trap to station 383 to obtain CTD/rosette casts along east-west and north south transects until station 389, where the trap was recovered on 19.05.96 in the evening. The last CTD/rosette cast was obtained at ESTOC, station 390, on 20.05.96 in the morning. The ship then went back to Las Palmas, with XBT launches on the way at stations 391 through 396. The ship reached Las Palmas on 20.05.96 in the afternoon, where the cruise ended and part of the scientific crew was exchanged for the next cruise.

Table 15. Participants of FS "Poseidon" cruise P 219.

Name	Institution
Spitzy, Alejandro (C)	IFBMH
Cianca, Andrés (S)	ICCM
Henne, Andreas (St)	IFBMH
Hernández, Francisco (S)	ICCM
Jäppinen, Tom (St)	IFBMH
Laglera Baguer, Luis (S)	ULPGC
Lendt, Ralf (St)	IFBMH
Link, Rudolf (T)	IFMK
Neuer, Susanne (S)	GeoB
Steffen, Sönke (St)	IFBMH

Institutions:

IFBMH
Insititut für Biogeochemie und Meereschemie
Universität Hamburg
Bundesstrasse 55
D - 20146 Hamburg

IFMK
Institut für Meereskunde
Universität Kiel
Düsternbrooker Weg 20
D - 24105 Kiel

GeoB
Fachbereich für Geowissenschaften
Universität Bremen
Klagenfurter Strasse
D - 28359 Bremen

ICCM
Instituto Canario de Ciencias Marinas
Dirección General de Universidades e Investigación
Consejería de de Educación
E - 35200 Telde
Canary Islands, Spain

ULPGC
Universidad de Las Palmas de G. Canaria
Edificio de Ciencias Básicas
Campus Universitario Tarifa
E - 35017 Las Palmas de Gran Canaria
Canary Islands, Spain

Functions:

C	: chief scientist
S	: scientist
St	: student
T	: technician

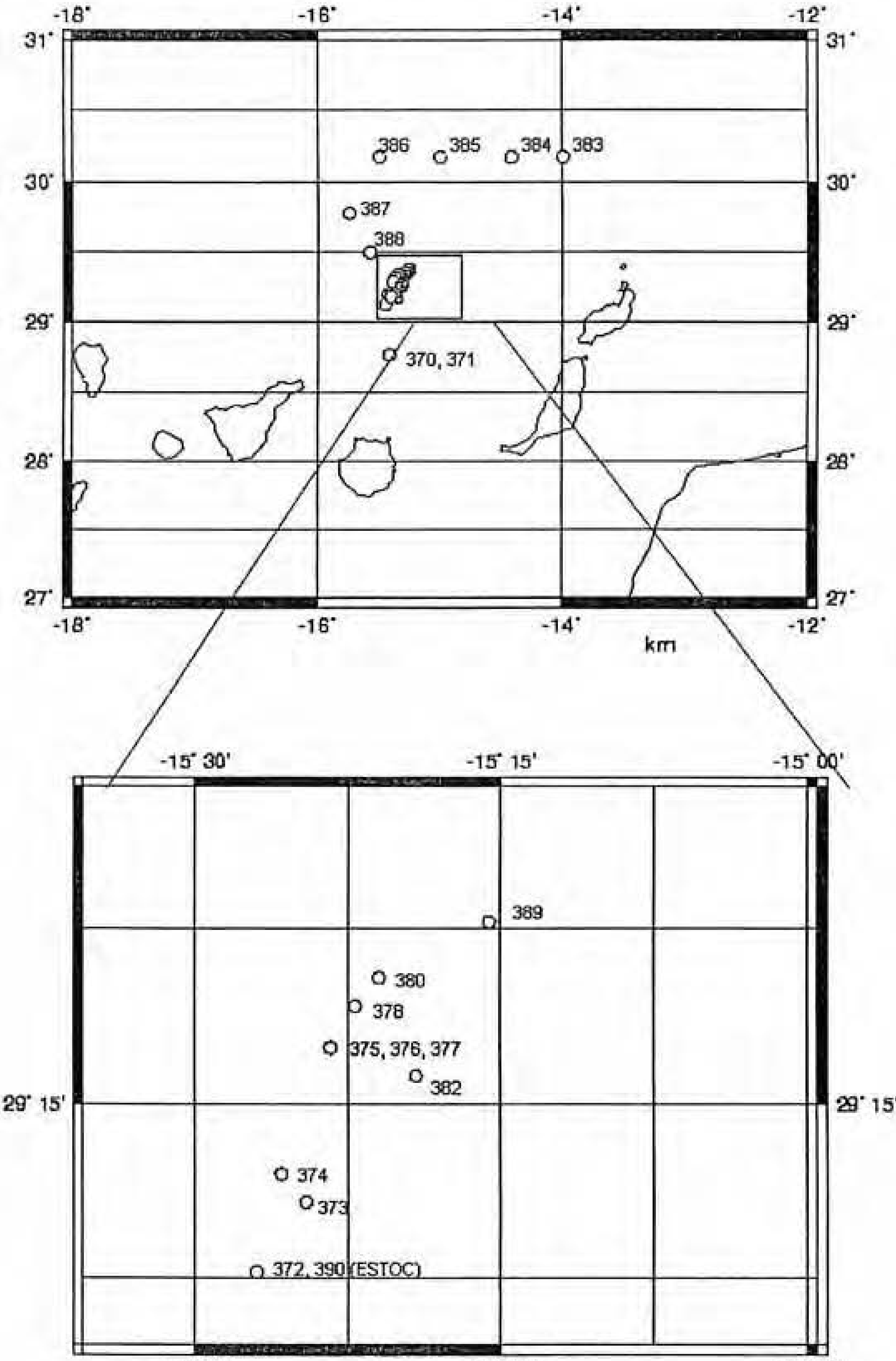

Figure 7. Map showing stations from FS "Poseidon" cruise 219 (leg 1).

Table 16. Stations sampled, instruments used and parameters measured during FS "Poseidon" cruise P219.

STATION NO.	DATE 1996	POSITION φ (°N)	λ (°W)	TIME (UTC) start	stop	DEPTH corr. (m)	PROFILE NO.	INSTRUMENTS PARAMETERS
370	14.05.	28°46.1	15°25.0	13:04	13:34	3600	001	CTD, seawater for traps
371	14.05	29°46.1	15°26.1	16:06	16:37	3605		Traps deployment (200,220m)
		29°08.2	15°26.1	17:30	18:00	3604	002	CTD(10/25/50/75/100/125/150/200m POC, chl
		29°09.1	15°26.0	19:35	19:43	3604	003	Dilution experiments 10/30
372	15.05.	29°07.7	15°27.0	05:10	07:55	3606	004	CTD (2/10/25/50/(75/100/200/300/400/600/800/1000/1100/2500/3000/3660m), O_2, nut, chl*, Al, CO_2, DOC, flu, isotopes (^{13}C, ^{18}O)
373	15.05.	29°10.8	15°24.7	11:16	12:09	3603	005	CTD, POC
374	15.05.	29°11.9	15°25.5	19:33	19:41	3602	006	CTD
375	16.05.	29°13.8	15°23.4	05:00	07:42	3600	007	CTD (400/600/800/1000/1100/1200/1300/1500/2000/2500/3000/3660m) O_2, nut, Al, CO_2, DOC, flu
376	16.05.	29°16.0	15°23.0	11:47	12:13	3600		Multinet 440-300m,300-150m, 150-50m, 50-25m, 25-0m
377	16.05.	29°17.2	15°22.0	17:35	18:33	3598	008	CTD (10/25/50/75/125/150/200/300/400/500/800m), isotopes (^{13}C, ^{18}O), chl 200m up, water for traps
378	17.05.	29°18.1	15°22.0	07:02	08:36	3598		Multinet failure
379	17.05	29°19.8	15°21.1	08:55	09:47	3596	009	CTD (3/10/20/30/40/50/60/70/80/90/100/125/150/175/200/230/250/300/400/500/600m) O_2, nut, chl*, Al, CO_2, DOC, flu,POC, chl
380	17.05.	29°20.0	15°21.0	11:36	12:01	3597		Recovery drifting traps
381	17.05.	29°15.0	15°19.0	13:00	13:30	3597		
382	17.05.	29°15.9	15°18.1	17:05	19:32	3596	010	CTD (700/800/900/1000/1100/1200/1300/1400/1500/2000/2500/3000/3650), O_2, nut, chl*, Al, CO_2, DOC, flu, POC

STATION NO.	DATE 1996	POSITION φ (°N)	λ (°W)	TIME (UTC) start	stop	DEPTH corr. (m)	PROFILE NO.	INSTRUMENTS PARAMETERS
383	18.05.	30°10.0	14°00.0	05:03	07:15	3012	011	CTD (3/10/25/50/75/100/150/200/300/400/600/800/1000/1100/1200/1300/1500/2000/2500/3050m) O_2, nut, chl*, Al, CO_2, DOC, flu, trap deployed at 200, 220m
384	18.05.	30°10.0	14°25.0	09:28	11:50	3046	012	CTD (5/10/25/50/75/100/150/200/300/400/600/800/1000/1200/1300/1500/2000/2500/3084m), O_2, nut, chl*, Al, CO_2, DOC, flu, POC
385	18.05.	30°10.0	15°00.0	15:00	17:30	3196	013	CTD (3/10/25/50/75/100/125/150/200/300/400/600/800/1000/1100/1200/1300/1500/2000/2500/3238m) O_2, nut, chl*, Al, CO_2, DOC, flu
386	19.05.	30°10.0	15°29.0	05:00	07:11	3348	014	CTD (2/9/50/75/100/200/300/400/600/800/1000/1100/1200/1300/1500/2000/2500/3400m) O_2, nut, chl*, Al, CO_2, DOC, flu
387	19.05.	29°47.0	15°44.9	09:46	12:13	3483	015	CTD (3/10/25/75/100/150/200/300/600/800/1000/1100/1200/1300/1500/2000/2500/3535m), O_2, nut, chl*, Al, CO_2, DOC, flu, POC
388	19.05.	29°30.0	15°34.9	14:15	17.21	3604	016	CTD (3/10/25/50/75/100/200/300/400/600/800/100/1100/1200/1300/1500/2000/3000/3660m) O_2, nut, chl*, Al, CO_2, DOC, flu
389	19.05.	29°23.0	15°15.1	19:22	20:26	3589	017	CTD
390	20.05.	29°07.0	15°26.1	05:57	07:12	3606	018	CTD (250/300/400/450/600/650/750/800/900/978/1008/1050/1095/1136/1190/1222/1237/1300/1400/1500m) O_2, nut, chl*, Al, CO_2, DOC, flu

chl* : only subset of sampling depths given in table sampled

nut = Nutrients	DOC = Dissolved organic carbon
Al = dissolved Aluminum	POC = Particulate organic carbon
flu = Dissolved Fluorescence	chl = Chlorophyll

3 SAMPLING PROCEDURES AND ANALYTICAL METHODS

In this chapter the procedures and methodologies which were applied during the monthly sampling on BO "Taliarte" are described; when the sampling was made on other vessels (FS "Victor Hensen" and FS "Poseidon"), the procedures and instrumentation used are given in the corresponding sections.

3.1 CTD
(J. Reppin)

During 1995 and 1996, a self-contained SIS CTD with sampling to a maximum depth of 1000m was used on BO "Taliarte". Neil-Brown CTD-O_2 instruments were used onboard the German ships. Comments on the procedures can be found in the ESTOC Data Report 94 (LLINÁS ET AL., 1997).

3.2 ADCP
(J. Reppin)

3.2.1 Vessel-mounted ADCP

No vessel mounted ADCP data were obtained during the reporting period.

3.2.2 Lowered ADCP

The LADCP data (FS "Poseidon" cruise 212) were processed following the procedures of FISCHER & VISBECK (1993). The instrument was pressure resistant only down to 3000m. Due to problems with the GPS data acquisition the profiles could not be corrected for shipdrift. The profiles were therefore referenced to their mean to get relative profiles.

3.3 Discrete Water Column Measurements
(M.J. Rueda, A. Cianca, R. Santana, M. González-Dávila, S. Neuer, E. Delgado, J. Godoy, C. Rodriguez, M. Santana-Casiano, J. Hernández-Brito, M.D. Gelado-Caballero, F. López-Laatzen, C. Moos, M. Segl)

3.3.1 Cast Order
The cast order of the monthly station work was as follows:

Cast 1:
Deep sampling I: from 600 to 3000 m, taking samples at the 600, 800, 1000, 1100, 1200, 1300, 1500, 2000, 2500, 2800 and 3000m levels (depending on the available length of wire on the winch).

Cast 2:
Surface sampling II: from 0 to 400m, taking samples at the 0, 10, 25, 50, 75, 100, 150, 200, 300 and 400m levels.

Cast 3:
Chlorophyll sampling III: duplicates from 0 to 200m were taken to have the volume of water necessary to obtain a significant filtered sample; the sampling was done at the 0, 10, 25, 50, 75, 100, 150 and 200m levels.

During the sampling of type I and II samples for oxygen, metals, carbon dioxide, isotopes, salinity and nutrients were taken. In the sampling of type III only chlorophyll was measured.

3.3.2 Water Sampling

Samples were collected immediately after the bottles aarived on board. The sampling sequence was as follows:

1. Oxygen (duplicated at each level) was fixed at once, then was kept for further analysis at the laboratory.
2. Metal samples were collected and frozen at –20°C inside a plastic container.
3. Nutrients (triplicate sampling): Nutrient samples were frozen immediately at -20°C.
4. pH and alkalinity samples were fixed and kept in boxes at room temperature for the analysis ashore.
5. Isotope samples were fixed and stored at 4°C for the analysis ashore.
6. Salinity (duplicate sampling): Salinity samples were kept in boxes to protect them from light.
7. Pigments: The pigment samples were filtered and the filters were frozen subsequently at –20°C.

In addition, 4 to 6 duplicates were made at variable depths for quality control. All samples were taken using the procedures established in the WOCE Operations Manual, WHP Office Report WHPO 91-1/WOCE Report No.68/91.

3.3.3 Salinity

The salinity samples were taken from 5 l Niskin bottles at the depths established in the station protocol.

Samples were measured with a salinometer, model Autosal 8400a, whose measurement range was between 0.005 and 42 (psu), with an accuracy of ±0.003 according to the manufacturer. It was calibrated following the manufacturer's information and standarized with IAPSO Standard Seawater. Salinity values were calculated as practical salinity units according to UNESCO (1978, 1981, 1984).

3.3.4 Dissolved Oxygen

The water samples used to analyse oxygen were gathered from the Niskin bottles placed either on the rossette or on the stainless steel hydrowire if single bottles were used. In both cases, the oxygen samples were the first ones to be obtained from the bottles, following the customary protocol described in the WOCE Operations Manual. BOD bottles were used, always in duplicate. The samples were fixed immediately for subsequent analysis in the laboratory.

From ESTOC 1294 onwards, the samples were analysed using the method described in the WOCE Report No. 68/91 (CULBERSON, 1994); bottles with 125 ml volume were used and the final titration point was determined using a Metrohm 665 Dosimat Oxygen Auto-Titrator Analyser.

3.3.5 Nutrients

Nutrients were taken in triplicate in polypropylene bottles which had been previously cleaned and washed with HCl acid and were completely dry, according to the instructions of the following manuals: WOCE Operations Manual, WHP Office Report WHPI 91.1., WOCE Report No.68/91. Samples were immediately frozen at –20°C and analysed as soon as possible after arrival at the laboratory. Freezing the samples is a common practice. It does not, or only in a non-significant way, affect the nitrate+nitrite and the phosphate values (by a slight decrease) and is not noticeable in the silicate values (KREMLING & WENCK,1986; MCDONALD & MCLUNGHLIN, 1982).

The nutrient determination was performed with a segmented continuous-flow autoanalyzer, a Skalar© San Plus System (ICCM) and a 4-channel Technicon© AA II Auto Analyzer (IEO).

Nitrate+Nitrite: The automated procedure for the determination of nitrate and nitrite is based on the cadmium reduction method; the sample is passed through a column containing granulated copper-cadmium to reduce the nitrate to nitrite (WOOD ET AL.,1967), using ammonium chloride as pH controller and complexer of the cadmium cations formed (STRICKLAND & PARSONS, 1972). The optimal column preparation conditions are described by NYDAHL (1976) and GARSIDE (1993).

Phosphate: Orthophosphate concentration is understood as the concentration of reactive phosphate (RILEY & SKIRPOW,1975) or according to KOROLEFF (1983a) as dissolved inorganic phosphate. The automated procedure for the determination of phosphate is based on the following reaction: ammonium molybdate and potassium antimony tartrate react in an acidic medium with the diluted solution of phosphate to form an antimony-phospho-molybdate complex. This complex is reduced to an intensely blue-coloured complex, ascorbic acid. The complex is measured at 880nm. The basic methodology for this anion determination is given by MURPHY & RILEY (1962); the used methodology is the one adapted by STRICKLAND & PARSONS (1972).

Silicate: The determination of the soluble silicon compounds in natural waters is based on the formation of the yellow-coloured silicomolybdic acid; the sample is acidified and mixed with an ammonium molybdate solution forming molybdosilicic acid. This acid is reduced with ascorbic acid to a blue dye, which is measured at 810nm. Oxalic acid is added to avoid phosphate interference. The used method was described by KOROLEFF (1983b).

3.3.6. Aluminium

This parameter became part of the regular sampling of the ESTOC station from ESTOC 09.94 onwards; the investigators responsible for taking these measurements are members of the Chemistry Department of the ULPGC. The sampling is carried out with the Niskin bottles, being the second samples taken in the collection order; the samples are kept in polypropylen bottles previously cleaned, washed with HCl, dried, and wrapped in plastic bags (each bottle individually) to avoid any contact with other ship materials. The samples are taken with gloves and each bottle is rinsed at least three times with water from the respective level, being subsequently frozen at –20°C before being transferred to the laboratory, where they are analysed following the methodology developped by HERNÁNDEZ-BRITO *ET AL.* (1994a).

The method is based on the complexation of aluminum with 1,2-dihydroxyan-thraquinone-3-sulphonic acid (DASA) and measurement of the reduction current of this complex using high speed cathodic stripping voltametry (HSCSV). Samples were prepared in Teflon cups of a polarographic cell, containing 10 ml of water, $2x10^{-6}$ M DASA and 0.01 M BES. The adsorption potential (-0.9 V/Ag/AgCl) was applied to the working electrode, while the solution was stirred. After 40s accumulation time, the stirring was stopped and 5s were allowed for the solution to become quiescent. The scanning was started at -0.9 V and terminated at -1.4 V. The scanning 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. A standard addition procedure is used to quantify the aluminium concentration of the sample.

The electrochemical system used has been designed to measure the instantaneous currents at short times with a low noise level (HERNANDEZ-BRITO *ET AL.*, 1994b). Thus, the analytical time required for each sample is substantially reduced. A PAR-303A electrochemical cell with hanging mercury drop electrode (HMDE) was connected to a locally produced computer-controlled potentiostat.

The detection limit was 1.7 nM for 40s adsorption time. It was calculated as 3 times the standard deviation of seven repeated determinations. The standard deviation was less than 3% for a 19 nM Al concentration.

3.3.7 pH

pH determination is carried out at 25°C by using the potentiometric technique in the total scale. The electrodes used to measure the emf of the sample consisted of a ROSS glass pH electrode and an Orion double junction Ag/AgCl reference electrode, connected to an Orion 720A pH meter. The electrodes are calibrated by using tris/HCl buffer in a synthetic sea water with salinity 35. Before a pH cell is used to measure pH, it is tested to ensure that it is performing properly, i.e., that it has an ideal Nernst response. After bringing the tris buffer and the seawater samples to be measured to 25°C, the EMF of the pH cell is measured, first in the tris buffer and then in the seawater sample. The pH of the unknown seawater samples was determined according to standard operation procedures (SOP 6, DOE 1994).

3.3.8 Alkalinity

The determination of alkalinity by closed cell titration is performed with two separate potentiometric systems in parallel. The titration systems consist of a titrator type Titrino 702SM (Metrohm, Herisau, Switzerland) and a Titrino 719S, respectively, both interfaced to personal computers. The electrodes used to measure the electromotoric force (EMF) of the sample were a ROSS glass pH electrode and a double junction silver/silverchloride reference electrode (Orion Research Inc., Boston, Massachusetts, USA). All measurements were made in thermostated plastic cells provided by Frank J. Millero (Rosenstiel School of Atmospheric and Marine Science, Miami, Florida, USA). Both the acid in a water-jacketed burette and the seawater sample in a water-jacketed cell are maintained at 25°C using a constant temperature bath. The titration is performed by adding HCl to the seawater past the carbonic acid end point. A computer program is used to run the titration, record the volume of the acid added and the EMF readings of the electrodes. The software stores the EMF value after readings become stable (±0.07 mV for 5 measurements in 10 seconds) and adds enough acid to change the voltage by a preset increment (here: 13 mV) in order to get sufficient points in the range of rapid EMF increase near the endpoint. A full titration (22 points) takes about 12 minutes, and using two systems up to eight samples can be measured per hour.

The HCl solution (25 L, 0.25 M) is made from concentrated analytical grade HCl (Merck, Darmstadt, Germany) in 0.45 M NaCl, in order to yield an ionic strength similar to open ocean seawater. The acid is standardized by titrating weighed amounts of Na_2CO_3 dissolved in 0.7 M NaCl solutions. The acid factor was also determined by coulometry at RSMAS (F. J. Millero). The results for the acid factor of both methods agree within ±0.0001.

The volume of the cells used at sea is determined in the laboratory by weighing the cell filled with degassed high purity deionized water. The density of water at the temperature of the measurements is calculated from the international equation of state of seawater (MILLERO & POISSON, 1981).

The total alkalinity of seawater is evaluated from the proton balance at the alkalinity equivalence point, $pH_{equiv} = 4.5$, according to the exact definition of total alkalinity (DICKSON & WHITFIELD, 1981). A FORTRAN computer program (provided by F.J. Millero) is used to calculate the carbonate parameters (pH_{sws}, E^*, A_T, C_T and $pK_1{}^*$) (MILLERO *ET AL.*, 1993). The computer program assumes that the effects of nutrients such as phosphate, silicate and ammonia are negligible. The precision of the fit (s-value) is better than 0.4 $\mu mol°kg^{-1}$ for the samples analyzed.

(SOAEFD), Marine Laboratory, Aberdeen.

3.4 Drifting particle collectors
(S. Neuer)

The drifting particle collector design is presented in Figure 8, and the deployment information is given in Table 17.

Table 17. Deployment information on drifting traps at the ESTOC station (see Figure 8).

Cruise	Deployment interval	Depth(m)
POS 212	01.10.95 – 03.10.95	160
	03.10.95 – 06.10.95	160
VH 96/1	04.02.96 – 07.02.96	200, 220
	07.02.96 – 10.02.96	200, 220
POS 219	14.05.96 – 17.05.96	200, 220
	17.05.96 – 19.05.96	200, 220
Tal 10/96	30.10.96 – 01.11.96	200

In addition to the drifting trap GeoB 1 a new, smaller design was tested. It consisted of four cylinders, 480 mm in length that had four smaller cylinders inserted into them (GeoB 2, Figure 8). By this way the same aspect ratio as in the first model, GeoB 1, could be maintained at a smaller overall size. This design is the one currently in use at ESTOC. The four cylinders also each carried 200 mm long baffles.

Particles were collected with 250ml sample bottles srewed into the collection funnels below the cylinders. The sample bottles were filled with a density gradient solution made up with Suprapur NaCl (final salinity of about 40 PSU) and formalin (final concentration 2%). The deployment time ranged from two to four days.

Before the analysis of the samples in the laboratory, zooplankton swimmers that had entered the traps actively were removed using a binocular. The samples then were dried and analysed in a HERAEUS CHN analyser after acidification with a few drops of 1 N HCl to determine the elemental composition of the organic material.

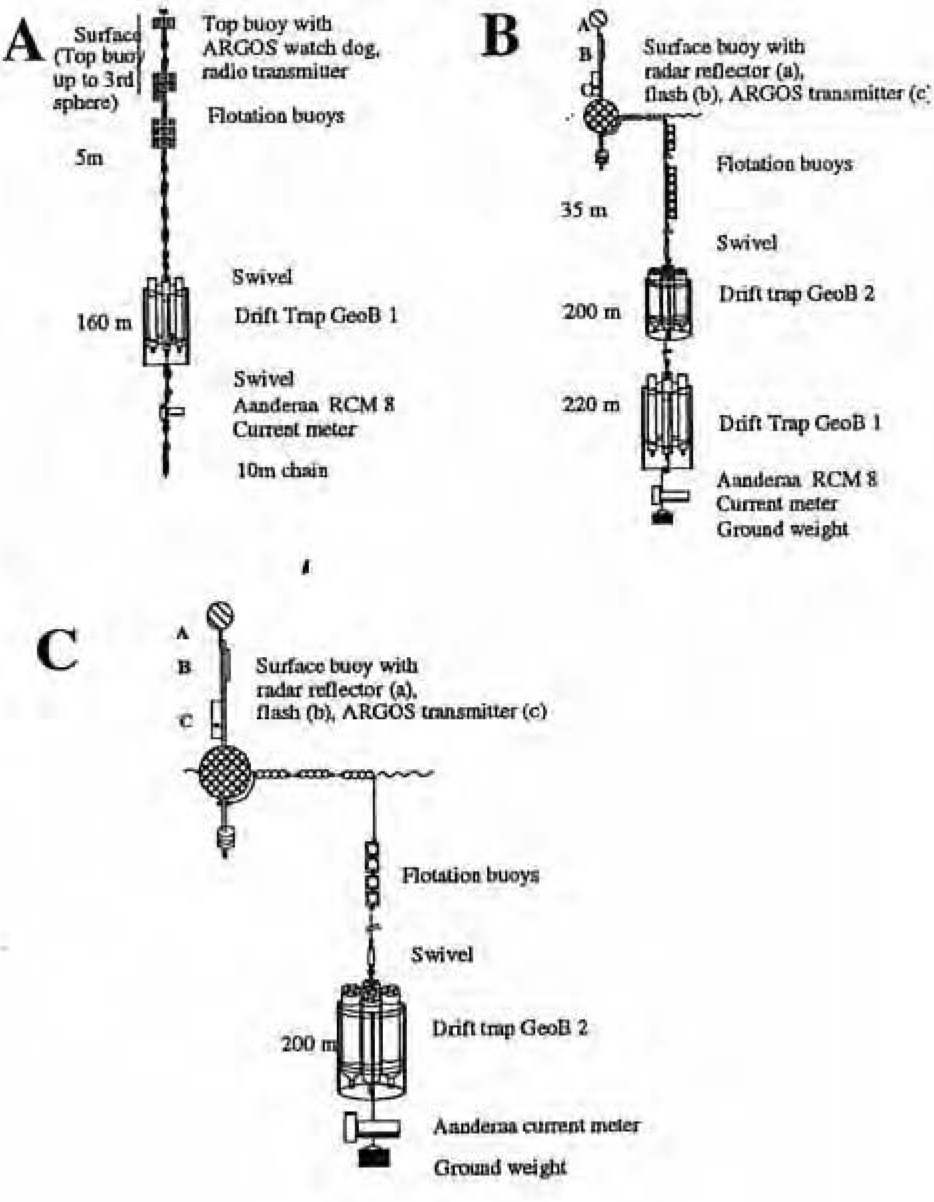

Figure 8. Design and array of the surface tethered particle trap used during "Poseidon" 212 (A), "Victor Hensen" 96/1(B), "Poseidon" 219(B) and Taliarte 10/96 (C).

The ADCP velocity data were sampled at 17m vertical and one hour temporal resolution. For the presentation the horizontal velocities were interpolated to the constant depth levels of 50, 100 and 150m depth. They were 40-hour low-pass filtered to remove tides and were then subsampled to obtain daily values.

3.5.2 Aanderaa Current Meter
(J. Reppin)

The Aandera current meter data were sampled as 2-hour mean velocities. For the presentation they were 40-hour low-pass filtered to remove tides and were then subsampled to obtain daily values.

3.5.3 Sediment Traps
(S. Neuer)

Particle flux is determined at the ESTOC Station using 20 cup particle traps of the Kiel type (AQUATEC, sampling area 0.5 m^2) in six mooring deployments with varying length and sampling intervals (CI 1-6, Table 1). The sampling cups of the particle traps were poisoned prior and after deployment with mercury cloride in a 40 psu density gradient (Suprapur NaCl). The > 1mm fraction was not further analysed and mainly contained pteropod shells, insignificant amounts of amorphous aggregates and occasionally fish rests. Samples were omitted if during sample preparation fish remains were detected. The < 1mm size-fraction was analysed according to FISHER & WEFER (1991).

3.6 Remote Sensing
(J. Pérez-Marrero)
3.6.1 Methodology

During the time of the last ESTOC data report only AVHRR data were avaliable. New passive sensors suitable for oceanographic studies have become avalaible to the scientific community and have been added to the ESTOC time series studies. Among them, the Along Track Scanning Radiometer (ATSR) on board the ERS satellite series, Marine Optical Sensor (MOS) on the IRS platform and SeaWIFS (Sea WIde Field of view Sensor) on board the SeaStar. These new data allow a more detailed monitoring of the upper layer of the ocean, given that they include a new scanning design for infrared measurements in the case of ATSR, as well as a considerable amount of new information at visible wavelengths (MOS and SeaWIFS). Furthermore, there has been a considerable improvement in temporal coverage due to the increasing number of platforms, which facilitates studies of higher frequency processes. Table 18 gives the main characteristics of the sensors used.

Table 18. Satellite sensor properties. AOT stands for Aerosol Optical Thickness, SST is Sea Surface Temperature and CPC is Chlorophyll-like Pigment Concentration.

Sensor	Wavelength (μm)	Spatial Resolution (km)	Swath Width (km)	Parameters
AVHRR	0.67, 0.86, 3.7, 10.8, 12.0	1.1 x 1.1	2750	AOT, SST
ATSR	1.6, 3.7, 11.0, 12.0	1.0 x1.0 1.5 x 2.0	512	AOT, SST
MOS	0.41, 0.44, 0.52, 0.56, 0.62, 0.65, 0.68, 0.75, 0.81, 0.87, 0.94, 1.0	0.5 x 0.5	250	AOT, CPC
SeaWIFS	0.41, 0.44, 0.49, 0.51, 0.55, 0.67, 0.76, 0.86	1.1 x 1.1	2500	AOT, CPC

3.6.2 Acquisition

Cruises and high resolution satellite data: In accordance with the scheduled campaigns, satellite data were provided by CREPAD (Centro de Recepción Proceso Archivo y Distribución de Datos de Observación de la Tierra) in Maspalomas, Gran Canaria, where high resolution data from the available overpasses of AVHRR, MOS and SeaWIFS, are stored. Data of ATSR were obtained from the Rutherford Appelton Laboratory (RAL) through the ESA establishment at Esrin in Italy.

Regular Observations: In addition to the above mentioned high resolution raw data, a complete data set of monthly averaged Sea Surface Temperature (SST) and Chlorophyll-like Pigment Concentration (CPC) obtained from satellites was used to characterize long-term oceanographic patterns of the region. These data were updated regularly with input from the Physical Oceanography Distributed Active Archive of the Jet Propulsion Laboratory in Pasadena, California.

3.6.3 Data Processing

Raw satellite data in digital counts were transformed into geophysical parameters (radiances, reflectances and brightness temperatures) according to state of the art models. From these, SST, CPC, AOT and ancillary information (sun-satellite geometry, cloud coverage, etc.) were derived using a set of routines developed at ICCM. Thus, all the geophysical parameters and ancillary information were known for every pixel in the data sets.

Complete atmospheric correction and cloud rejection was performed on each scene using different models in order to allow the selection of the most suitable one for a given situation. Satellite information was merged with the corresponding conventional oceanographic data. Every sampling point in the ocean was located on the images (geolocation accuracy is always better than 1 pixel for high resolution imagery) and taken as the centre of a study window, which was tested first for homogeneity and Gaussian behaviour and was then compared to the field measurements.

4 RESULTS

4.1 Regular Station Observations

4.1.1 Monthly Observations

4.1.1.1 Chemical and Biological Parameters

(M.J. Rueda, R. Santana, M. Villagarcía)

The results from the first years of regular station observations at ESTOC provide an estimate to the variability scales which are typical for this station and also give a first indication of the questions that may be answered with the use of these data.

In Figure 10 we show time series of temperature, salinity, oxygen concentration and chlorophyll in the surface layer down to about 200m where a regular seasonal signal is recognized, but deviations from the periodic behaviour are seen.

It should be remembered that the sampling frequency is often limited by logistic requirements. This can introduce errors. Thus, it can be that the 1995 chlorophyll maximum is really of the order it was recorded, but it could also be that the limited sampling could have prevented to record possible higher maximum values. In the other hand, the thermohaline structure appearing in October 1995 can point to a significative interannual variation or a high frequency phenomenon possibly sampled by chance during that year.

The salinity, oxygen and silicate concentrations for the full depth are plotted in Figure 11. In the range between 700 and 1500m depth salinity maxima and minima occur in an irregular pattern. The resulting sawtooth-shaped structure of the isoline variations indicate the merging of Antarctic Intermediate Water and Mediterranean Water in the Canary region. The layers above and below this range, i.e. between 200 and 700m and between 1500 and 2500m have less variability. They correspond to the North Atlantic Central Water and North Atlantic Deep Water. At depths greater than 2500m the distributions are even less variable.

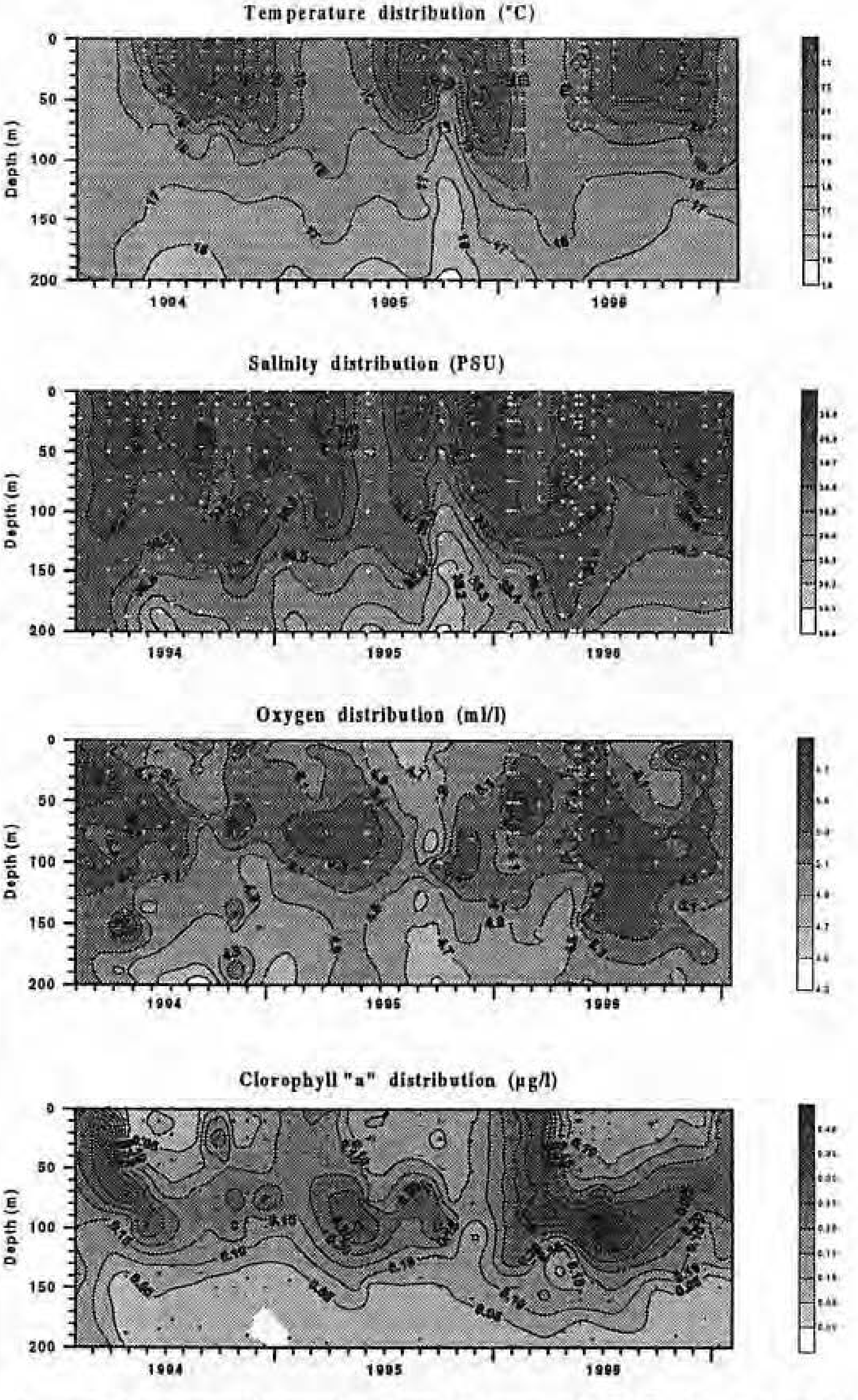

Figure 9. Variation of the monthly parameters taken at ESTOC from 1994 to 1996 (down to 200m).

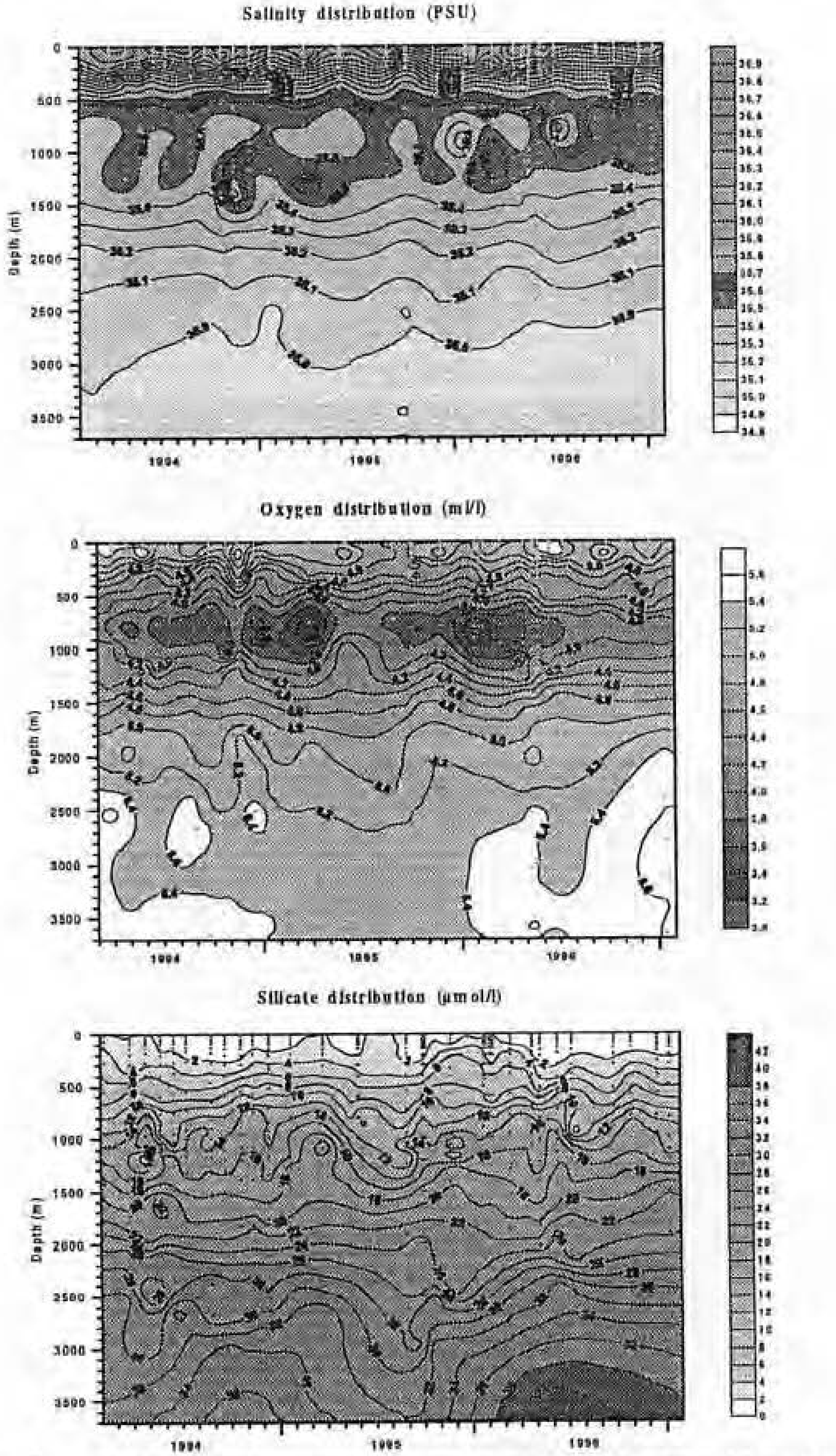

Figure 10. Variation of some monthly parameters taken at ESTOC from 1994 to 1996

4.1.1.2 CO_2 System
(M. González-Dávila, M. Santana-Casiano)

From October 95 to December 96, the Total Alkalinity A_T (µmol/kg) and pH (mol/kg seawater) in the total scale at 25°C were determined on board BO "Taliarte" and FS "Poseidon" 212/3 (October 1995), FS "Poseidon" 219 (May, 1996) and FS "Victor Hensen" 96 (February 1996). Values of A_T (Figure 12) and fCO_2 (Figure 13) computed from the data of pH and A_T and temperature/salinity data are presented here.

The distribution of A_T has the highest values in the surface waters (2412.1 ± 5.5 µmol kg^{-1}) with a surface distribution similar to that of salinity. A minimum surface value of alkalinity in March 96 corresponded to a minimum of salinity, to the lowest sea surface temperatures, the highest values of pH_t and the lowest values of fCO_2. The pH and total alkalinity values exhibit a sharp decrease with depth to approximately 800-1000 m, coincident with a minimum in O_2 and a maximum in fCO_2. The strong gradients in the NACW are also seen in the temperature and nutrient distributions. A more pronounced minimum between November 95 and March 96 seems to be related to the minimum associated with the Antarctic Intermediate Water (AAIW). Between 1000-1550 m the slight maximum in Total Alkalinity and pH is the signature of Mediterranean Water (MW). The water below 1500 m shows increasing values of alkalinity towards the bottom due to the dissolution of calcium carbonate.

We computed the values of fCO_2 at ESTOC during October 95 to December 96 using the pH_T-25°C and A_T. They are presented in Figure 13. The vertical straight line represents an average atmospheric value of 357 µatm from values determined during cruises in 1997 and 1998. The insert figure represents the values of fCO_2 in the last 100 meters for each month which was sampled. It can be concluded that the area is acting as a source of CO_2 from July to November, while from January to May the system is gaining CO_2 from the atmosphere and acting as a sink. In June and December 1996 the system was almost in equilibrium.

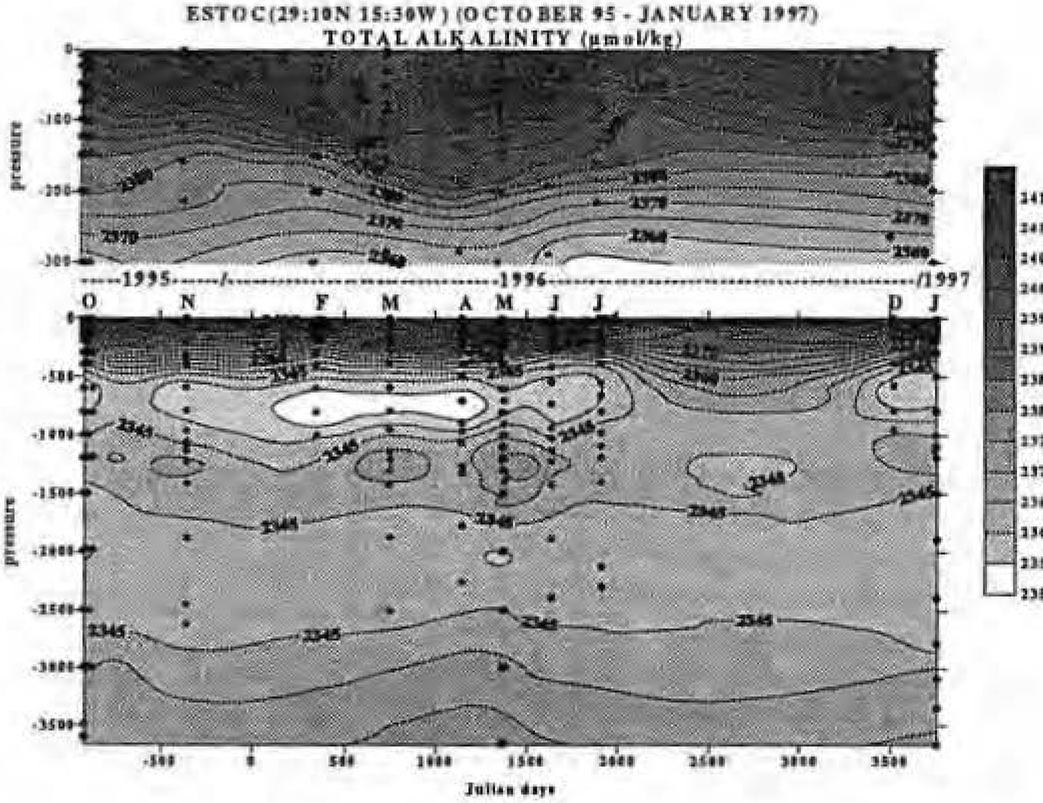

Figure 11. Total alkalinity on ESTOC station measured from BO "Taliarte", FS "Poseidon" P212/3 and P219 and FS "Victor Hensen" VH-96.

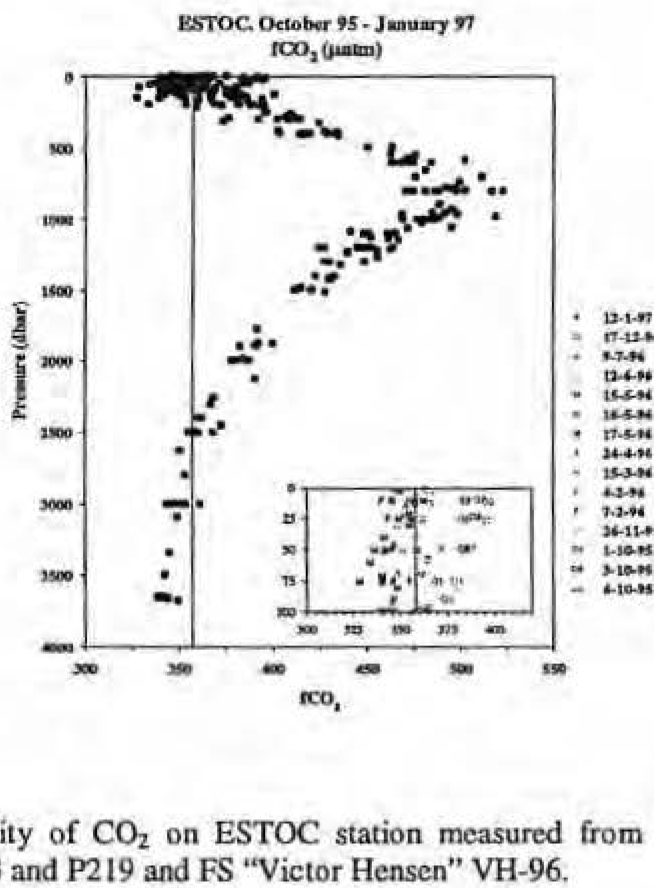

Figure 12. Fugacity of CO_2 on ESTOC station measured from BO "Taliarte", FS "Poseidon" P212/3 and P219 and FS "Victor Hensen" VH-96.

4.1.2 Drifting Particle Collector Studies
(S. Neuer)

During FS "Poseidon" cruise 212 in 1995, the particle traps were deployed twice for three days. Total flux amounted to 32 and 39 $mgm^{-2}d^{-1}$, with POC contributing about 10% (Figure 33).

During the three deployment periods in 1996 (Figure 33), total particle flux varied greatly with maximum values obtained in February and smallest in October. POC flux contributed from 11 to 19 % of total flux.

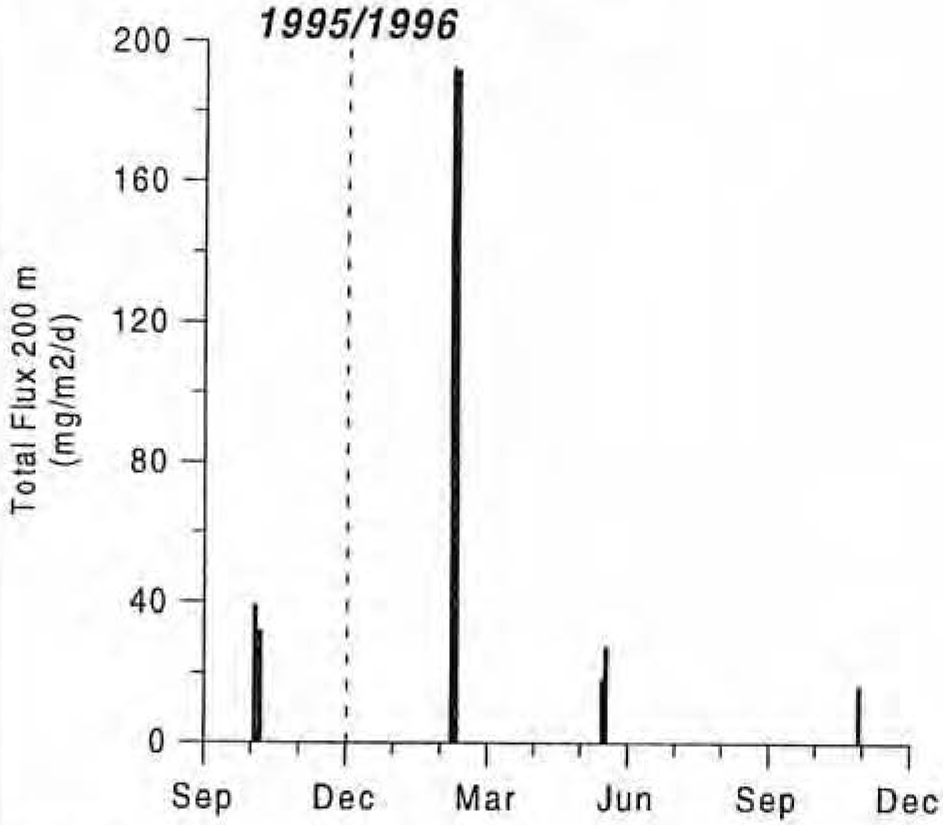

Figure 13. Flux rates obtained with drifting traps in 200 m depth during the deployment periods on FS "Poseidon" 212 (October 95), FS "Victor Hensen" 96/1(February 96), FS "Poseidon" 219(May 96) and BO "Taliarte" 10/96 (October 96) (see also Table 4).

4.1.3 Moorings
4.1.3.1 Current Meter Moorings
(G. Siedler)

The vector plot of the time series of direct current measurements during two consecutive periods is presented in Figure 14. As found elsewhere in the region before, the mean flow component is much smaller than the variable components. The strongest events have typical time scales of 2-3 months. Usually the directions of currents are similar from surface to bottom in these events, indicating considerable barotropic components. The two strong-current events in February 1995 and in January 1996, with maximal current velocities at 1200m depth, i.e. at Mediterranean Water levels, correspond well to the salinity maxima in that depth range in Figure 11 and thus indicate the occurrence of Meddies during these periods.

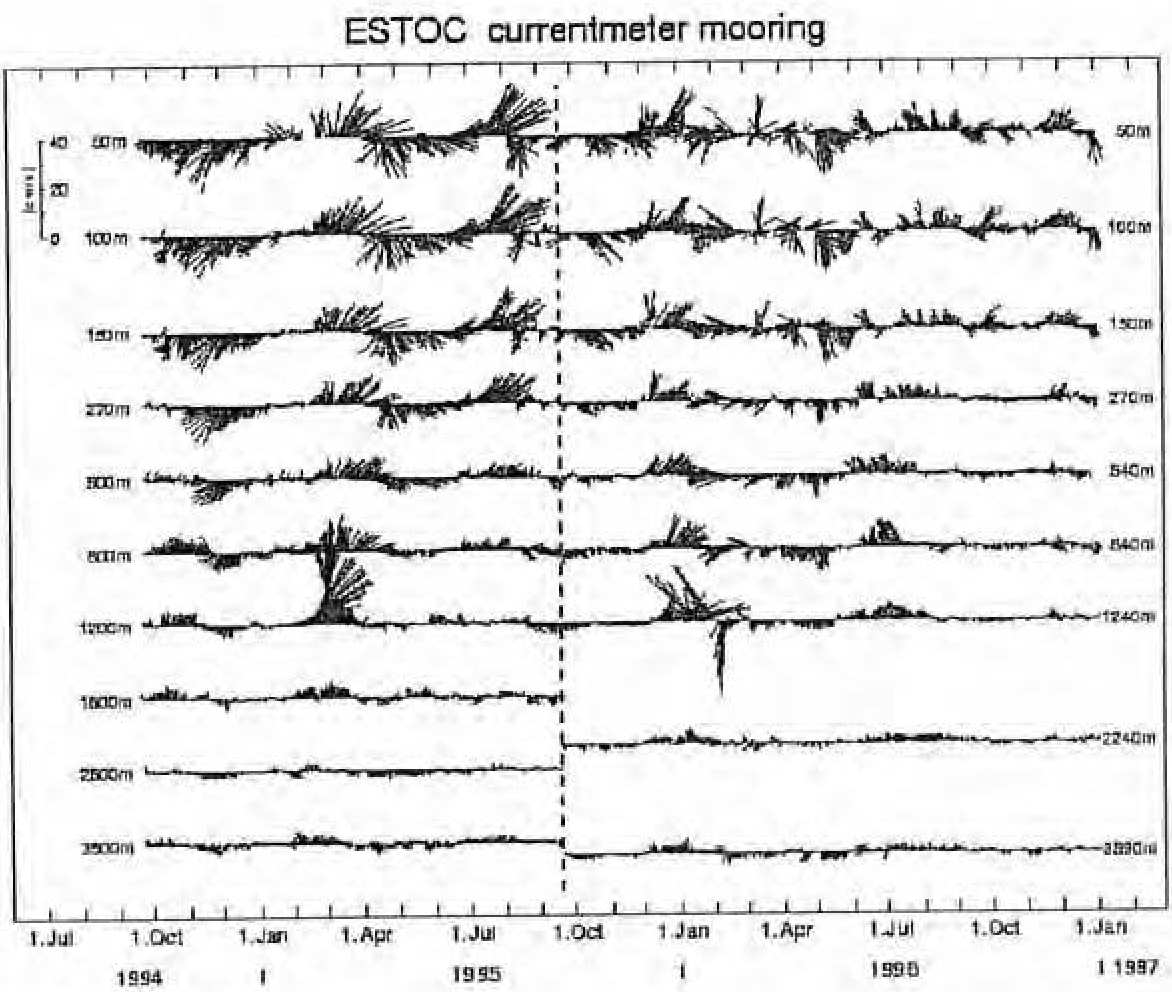

Figure 14. Vector diagram from currentmeters at ESTOC (1994-1996).

4.1.3.2 Sediment Trap Moorings
(S. Neuer)

Particle flux was highly seasonal, with the largest amount of particles collected at the end of February/beginning of March. In addition, smaller peaks occurred during summer and fall. Particle sedimentation was always higher in the 1km traps compared to the 3 km traps, but sedimentation peaks occurred mostly during the same collection interval (Figure 15).

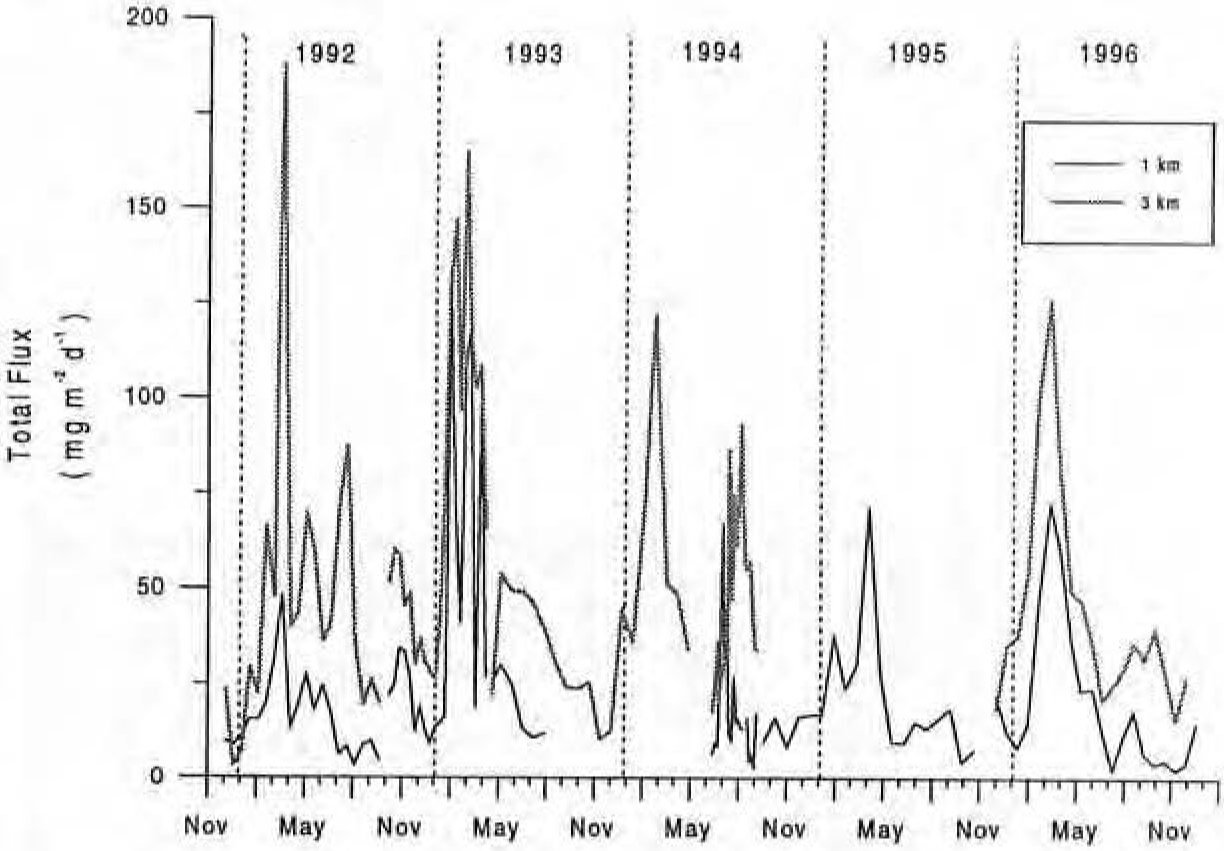

Figure 15. Total particle flux at ESTOC determined with particle traps at 1 km (thin line) and 3 km depth (thick line).

4.1.4 XBT Sections
(E. Pérez-Martell, A. Cianca)

The complementary XBT observational program was described in section 2.1.3 (see Figure 3). In Figure 16 we present the example of a temperature section between ESTOC and Gran Canaria (below) and the corresponding vertical temperature profile at ESTOC taken in July 96 (above left). The T/S diagram from the corresponding ESTOC CTD measurement (above right) indicates a strong Mediterranean Water maximum which is also apparent through the temperature maximum in the vertical profile between 750 and 950m.

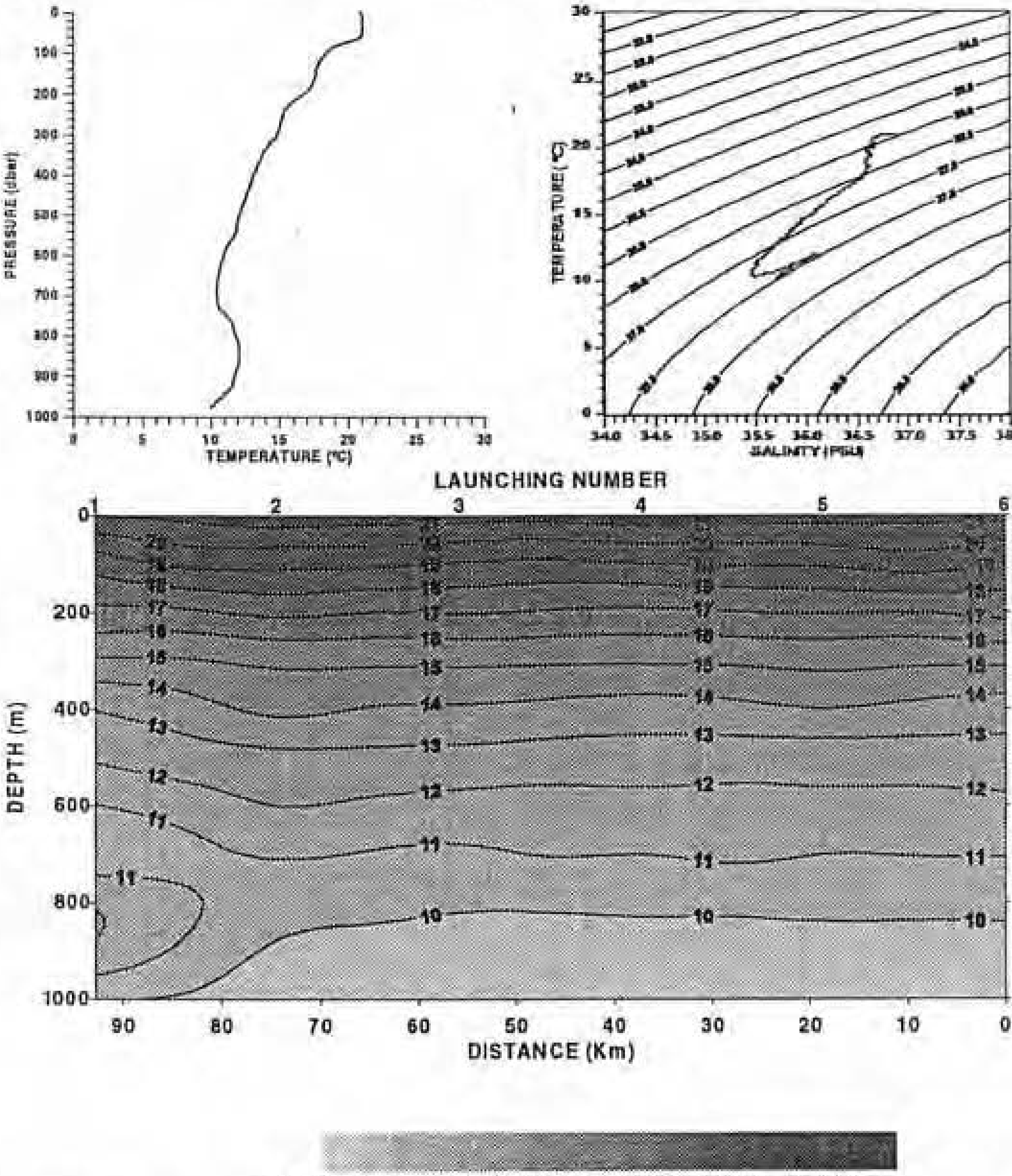

Figure 16. Section of XBT temperatures between ESTOC and Gran Canaria in 07/96 (below, launching #1=ESTOC, #6=sampled point nearest to Gran Canaria), corresponding vertical temperature profile (above left) and temperature/salinity diagram (above right) from the ESTOC CTD measurement.

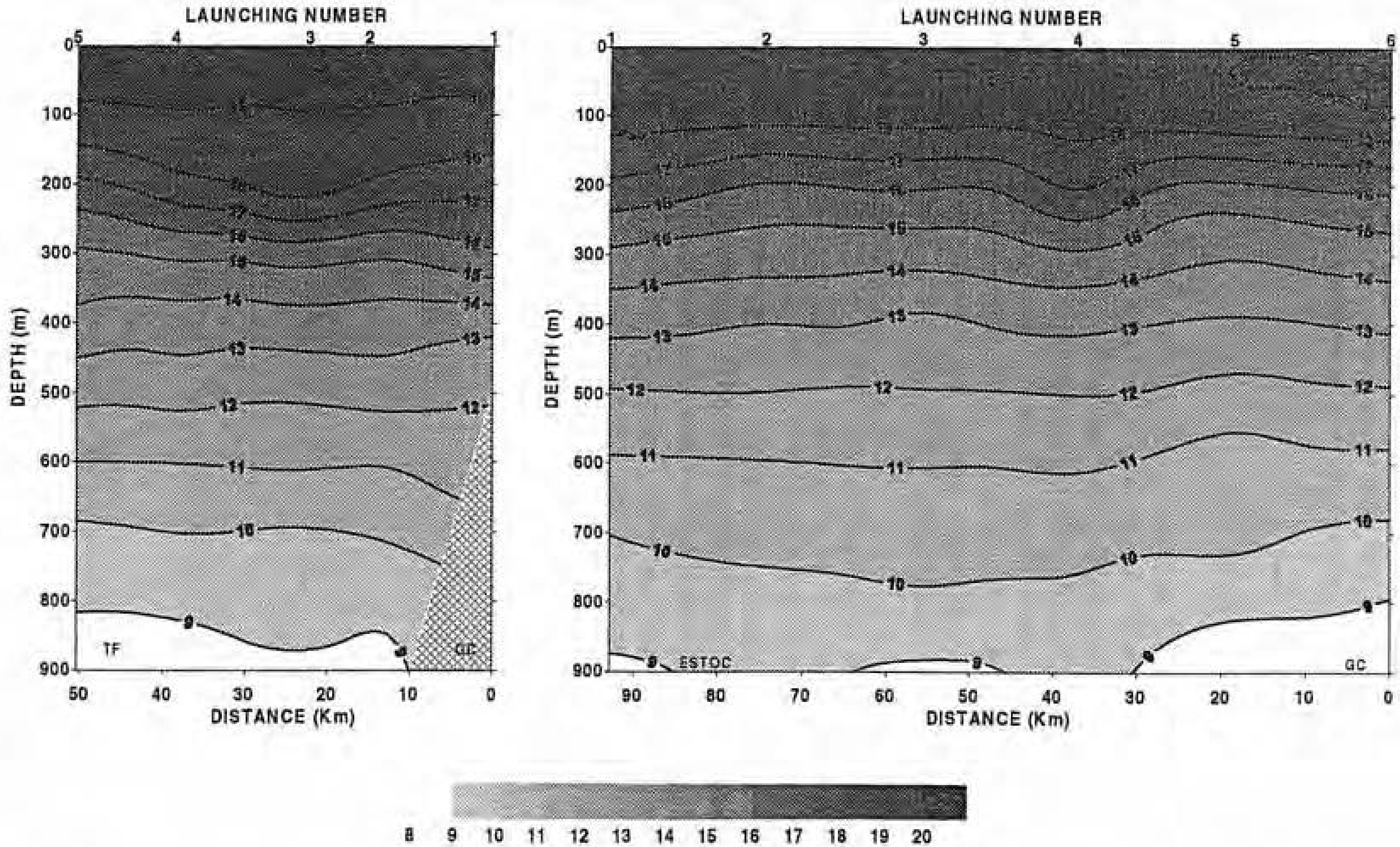

Figure 17. Distributions of XBT temperatures at the seasonal SST minimum for ESTOC 03/96 for the sections between Tenerife and Gran Canaria (left) and between ESTOC and Gran Canaria (right).

In Figure 17 we show two examples which correspond to the seasonal minimum of SST in each of the two sections, with the meridional change of about 1°C present in the surface waters of the section between ESTOC and Gran Canaria (right. At depths between 800 and 1000m we again encounter signals in the isotherm distributions which are related to the presence of AAIW.

4.1.5 Remote Sensing
(J. Pérez-Marrero, O. Llinás)

According to the time window given by the "Poseidon" P212 cruise in September/October 1995 a search was made for AVHRR and ATSR images in the ESA archives. Figure 19 shows the AVHRR image corresponding to the noon overpass of NOAA-14 on 26 September 1995, overplotting the positions of the 86 CTD stations made during the cruise. This scene was atmospherically corrected data using the STRONG & MCCLAIN (1984) algorithm that showed the best agreement with both in situ surface temperatures and with SST derived from ATSR (algorithm from ZÁDOVY *et al.*,1995).

During this campaign there were images avaliable from 26 to 28 of September 1995. While stations 42 to 55 were sampled, little amount of cloud contamination was found and therefore 13 usable pairs of satellite and in situ data sets were obtained within a time period of 24 hours. Correlation analysis was performed between satellite derived SST and temperature obtained by the CTD at depths ranging from 0 to 10 meters. The results in the form of linear correlation coefficient profiles are given in Figure 18. Good linearity between both methodologies was found even for time lags of the order of 48 hours for the depth range from 0 to 4m, however, at larger depths linearity decreases sharply with depth; the minimun of the mean difference (0.21±0.2°C) is located at 4m.

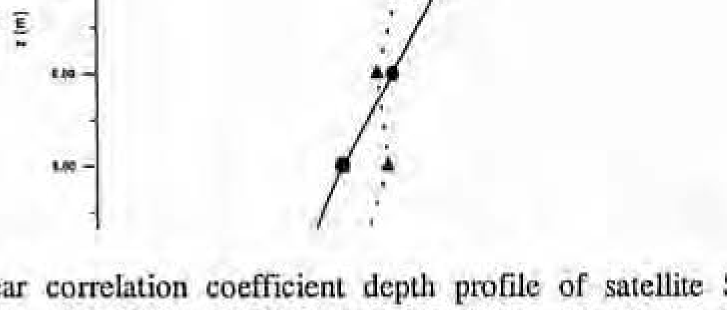

Figure 18. Linear correlation coefficient depth profile of satellite SST and CTD temperatures. Dots result from time differences between measurements up to 24 hours; triangles from up to 48 hours.

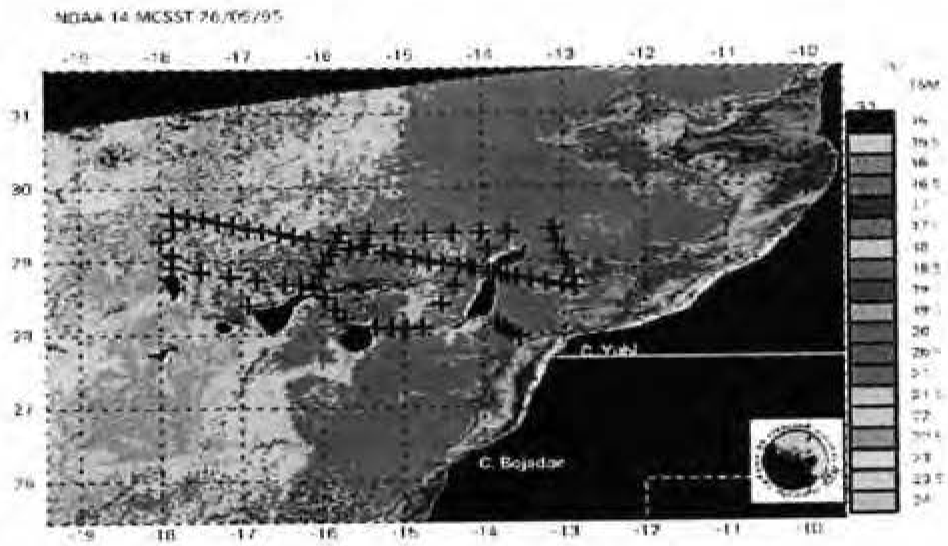

Figure 19. NOAA-14 MCSST image for 26[th] of September 1995, color-coded each 0.5°C in Mercator projection with a spatial resolution of aprox. 2 km. The crosses represent the hydrographic stations made during FS "Poseidon" 212/3 cruise.

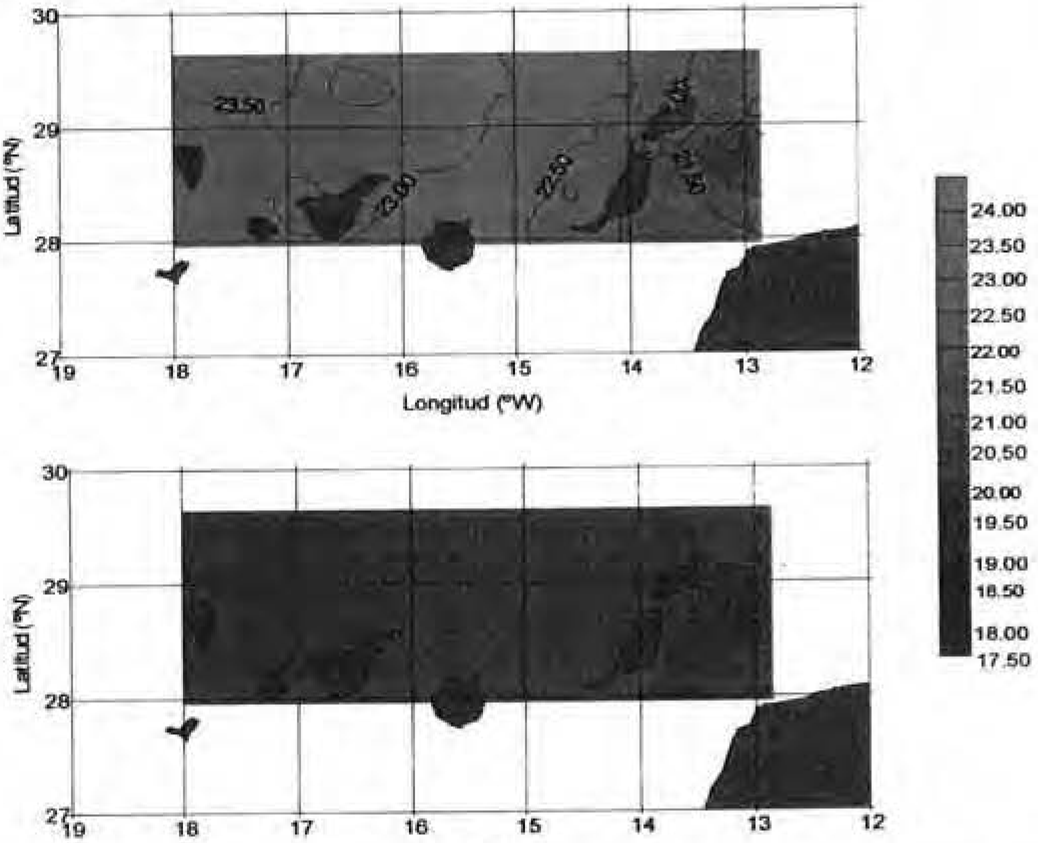

Figure 20. Horizontal temperature distributions at 0m and 10m; both samples taken in situ during cruise P212.

In Figure 20, the horizontal temperature distributions as seen by the vessel (vessel synoptic scale) at 0 and 10m depths are presented. The pattern found in the surface temperature distributions is very well correlated with the satellite SST image shown, nevertheless, features at 10m are quite homogeneous with the exception of the upwelling plume at the west side of Lanzarote and Fuerteventura Islands.

4.2 Related Process Studies
4.2.1 "Victor Hensen" Cruise VH 95

Nutrient and chlorophyll "a" profiles from that cruise are shown in Figures B1-1 to B1-4 of the Appendix B1.

4.2.2 "Poseidon" Cruise P212
4.2.2.1 Chemical and Biological Distributions
(O. Llinás, M.J. Rueda)

In Figures 21 to 26 we present physical, chemical and biological properties on three sections obtained during FS "Poseidon" cruise P212 for full depth and for the upper 200m. The water mass characteristics observed during cruise "Poseidon" 212 can be considered typical for the beginning of autumn: high temperatures at the surface and a well-developed thermocline, apparent in Figures 22a, 24a and 26a. The sections also show the presence of slightly colder and less saline waters near the coast as a consequence of the Canary Current transport. The nutrient concentrations in Figures 22, 24 and 26 (c and d) show an increase in the nitrate+nitrite and in silicate concentrations, with patterns corresponding to the thermohaline variations.

The silicate concentrations have a complex pattern, with relatively high values near the surface and a subsurface gradient to a variable layer with relative minima ; this supports the hypothesis of an atmospheric input as a consequence of the eolian transport from the African coast.

The chlorophyll concentrations in Figures 22, 24 and 26 (f) have absolute maxima just below the thermocline, but relative maxima occur also closer to the surface, probably as a consequence of the complex distribution of the organisms in the upper layers. The oxygen distributions are coherent with the chlorophyll distributions.

At greater depths, a complex structure is found in the range corresponding to the intermediate waters, approximately between 800 and 1500m, as can be seen in Figures 21, 23 and 25. The Mediterranean Water (MW) can be identified there in the northwest corner of the sampled polygon as shown by the values of stations 851, 854 and 855. Salinity values are higher than 35.5 and the concentration values of nitrites+ nitrates are relatively low; other stations have lower salinity and oxygen and slightly higher nutrients concentrations (nitrates+nitrites, phosphate and silicate) due to the influence of the AAIW which has a larger nutrient concentration than the MW.

4.2.2.2 Temperature/Salinity distributions
(J. Reppin)

The CTD/NB1 used for the basic observations carried a fluorescence sensor and an ADCP which both had a depth limit of 3000 m. The CTD casts were therefore done to a maximum depth of 3000 m where bottom depth allowed, except for those cases where shallower depths were required for specific experiments. The profiles usually covered the range of surface water, Central Water, Intermediate Water, and the Upper and Middle North Atlantic Deep Water including a major contribution from the Mediterranean. Large regional differences occurred particularly at the Mediterranean Water level, and in two cases high salinities indicated the existence of Mediterranean Water lenses (MEDDYs).

Changes in the structure of the profiles at the ESTOC position are most noticeable in the upper part of the Central Water, and the investigation of the cause for these variations are an important part of the future analysis. Thermohaline staircases were quite common throughout the area and existed more frequently than had been expected, thus suggesting an important role of double diffusive mixing in the central and the upper deep waters.

The station pattern had been designed to allow for an analysis of several closed boxes. This will facilitate the study of property gradients and budgets in the area near the ESTOC position and in the neighbourhood. The three sections east of Lanzarote will provide a good estimate of the Canary Current structure and transports in that area. The CTD measurements done by the IFM group provide, together with the water sampling performed jointly by the German and Spanish groups, the basic data set for all participating groups.

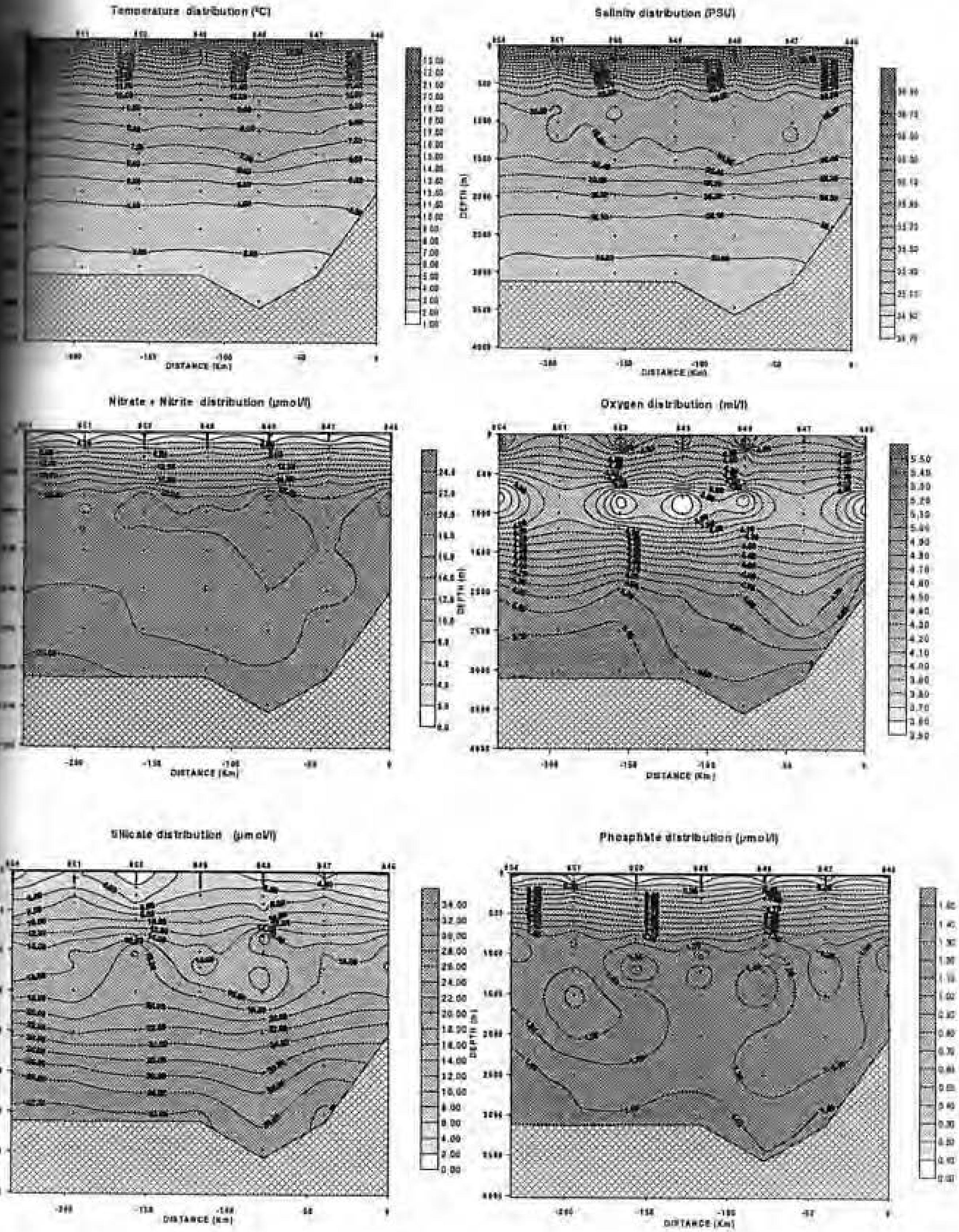

Figure 21. Distribution of the indicated parameters from surface to bottom taken along the P212/3 section from the northern tip of Lanzarote to ESTOC (stations 846-854).

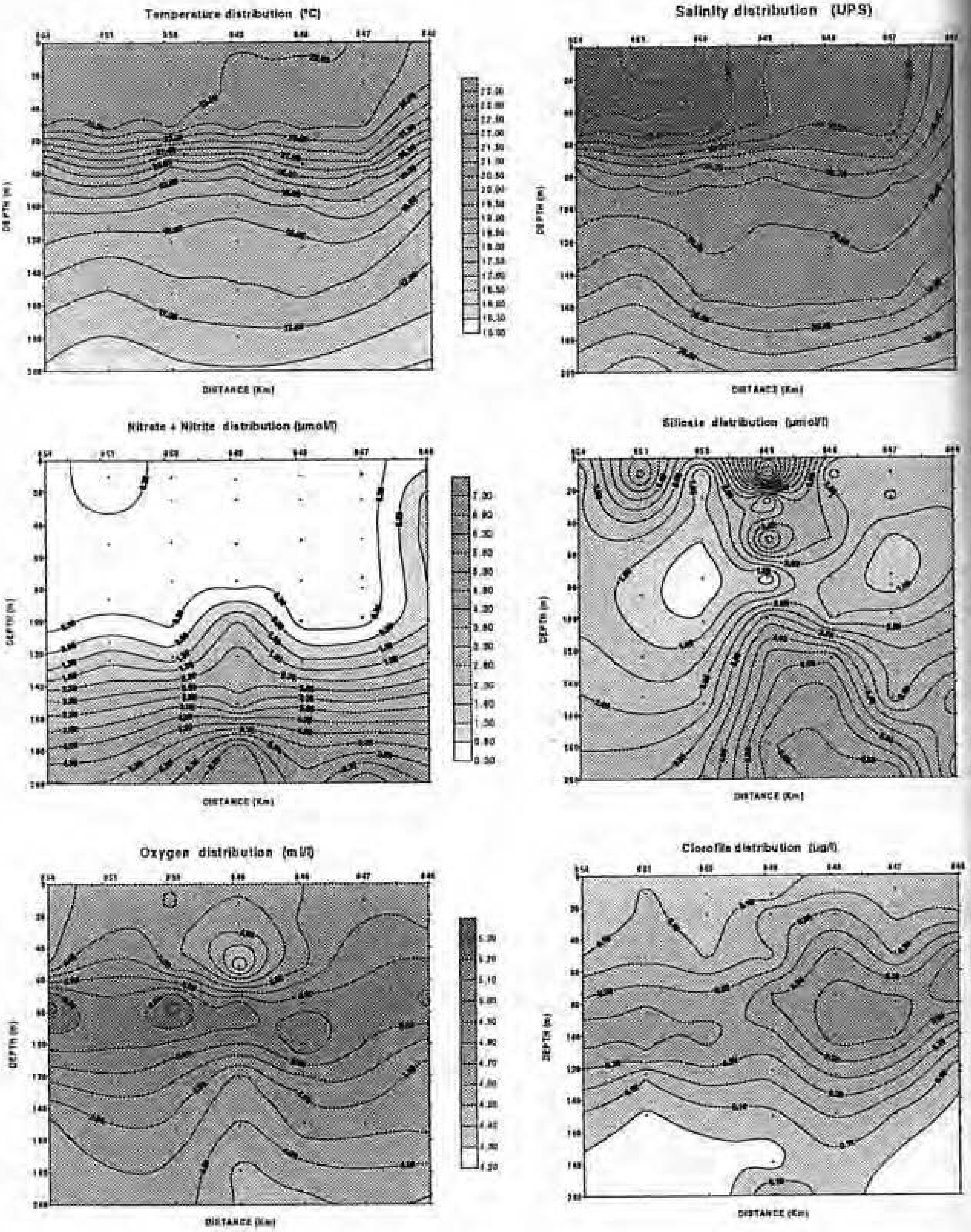

Figure 22. Distribution of the indicated parameters from surface to 200m taken along the P212/3 section from the northern tip of Lanzarote to ESTOC (stations 846-854).

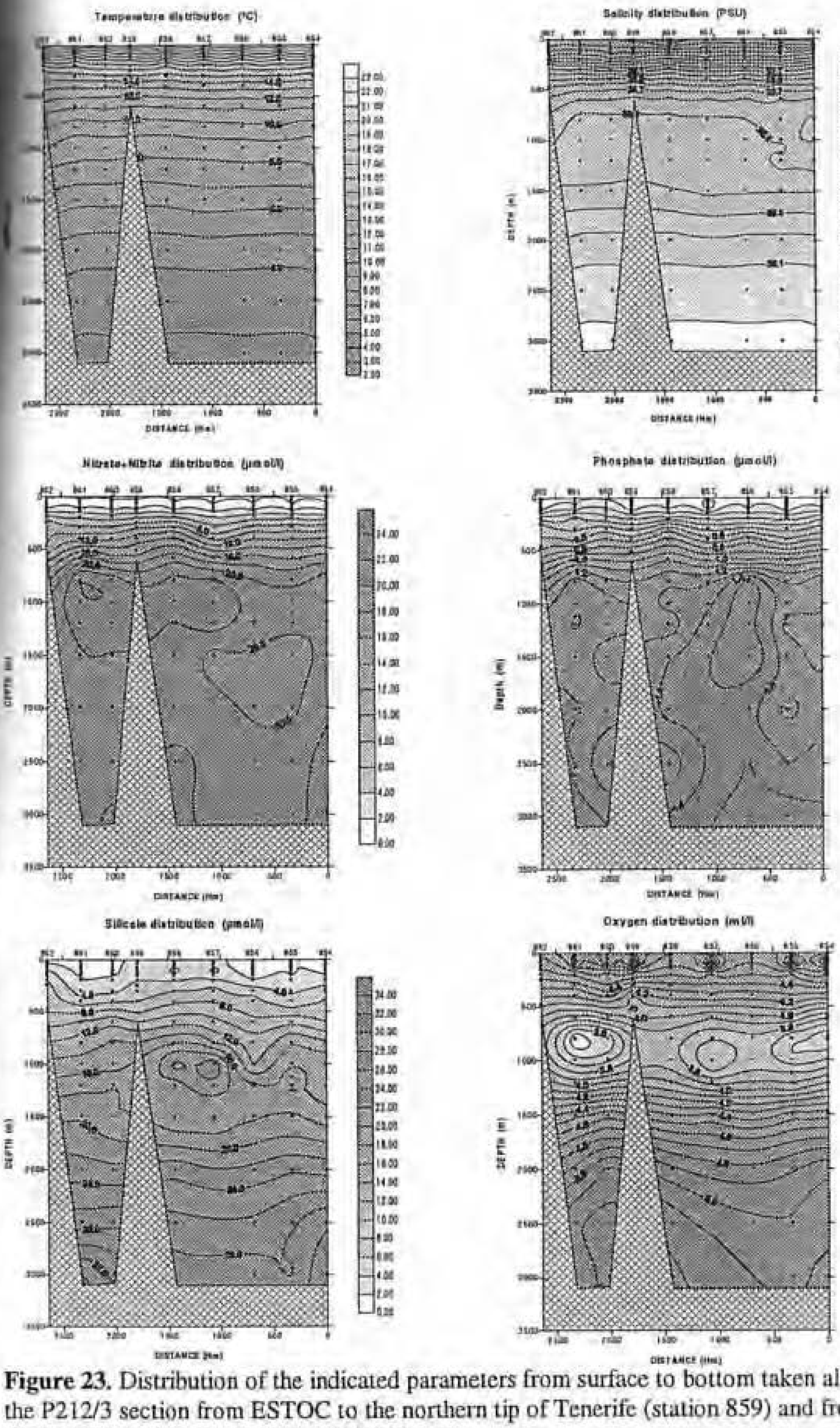

Figure 23. Distribution of the indicated parameters from surface to bottom taken along the P212/3 section from ESTOC to the northern tip of Tenerife (station 859) and from there to Gran Canaria (stations 854-862).

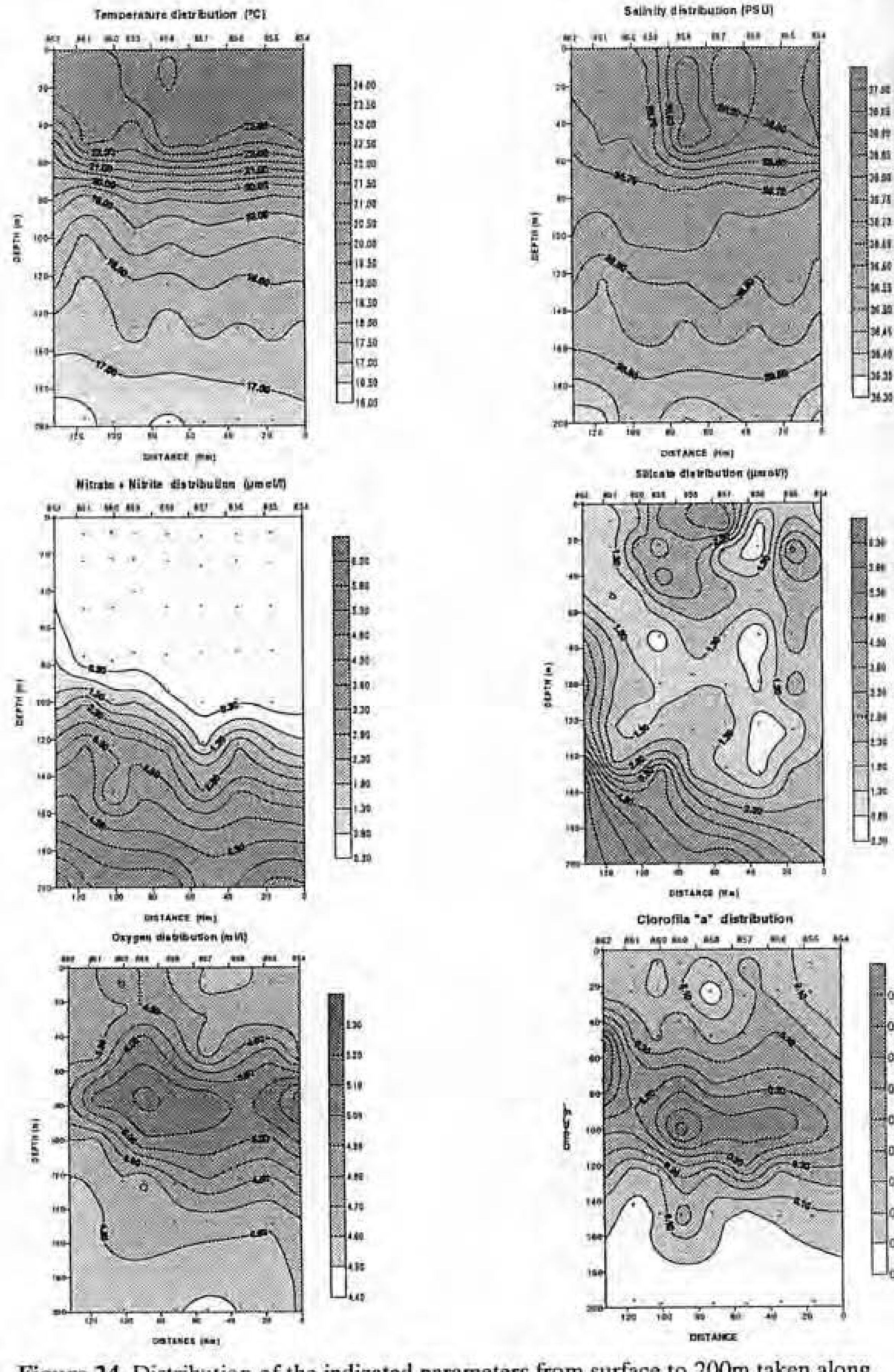

Figure 24. Distribution of the indicated parameters from surface to 200m taken along the P212/3 section from ESTOC to the northern tip of Tenerife (station 859) and from there to Gran Canaria (stations 854-862).

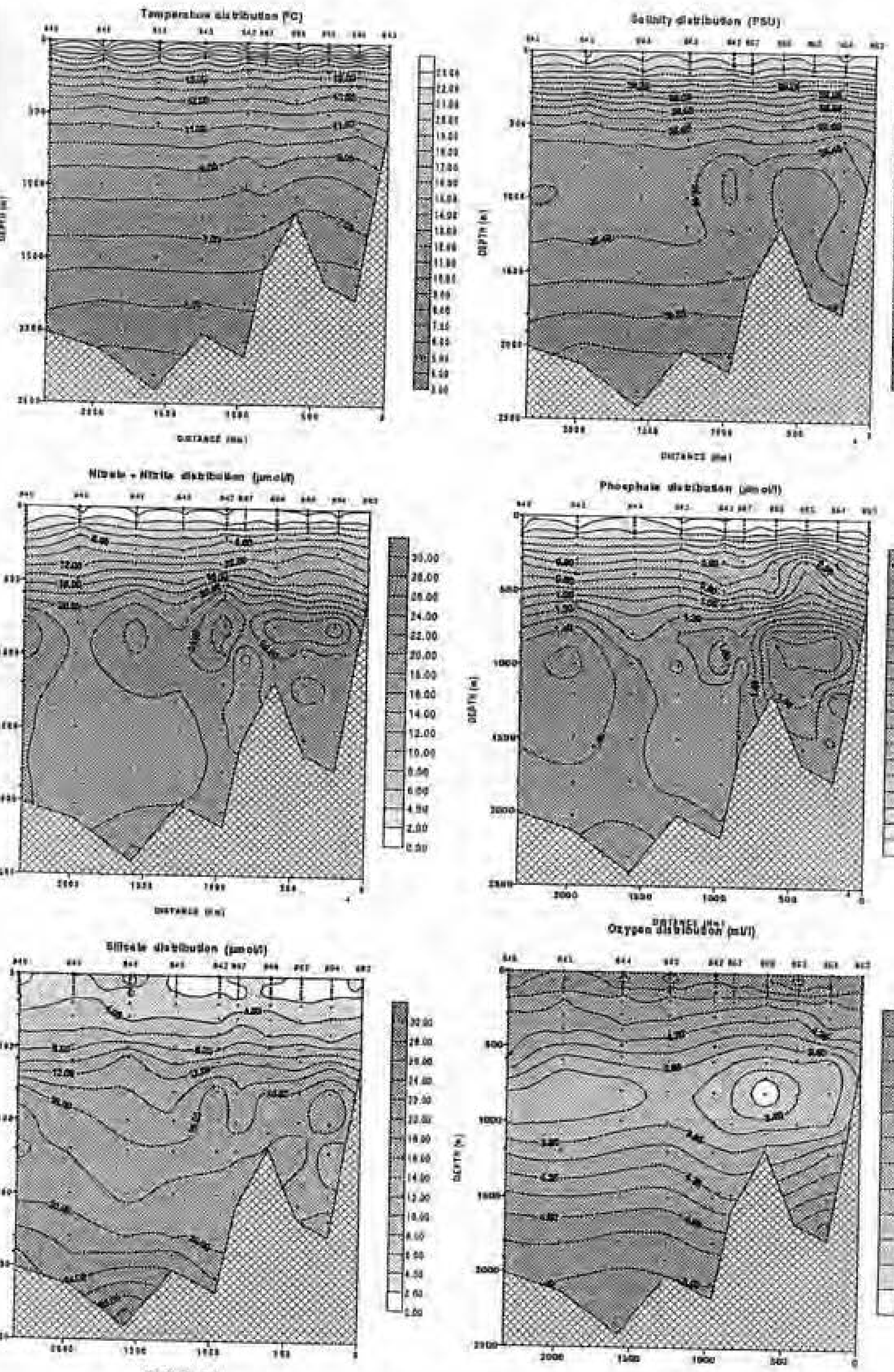

Figure 25. Distribution of the indicated parameters from surface to bottom taken along the P212/3 section along the western slope of Lanzarote and Fuerteventura and to Gran Canaria (stations 846-863).

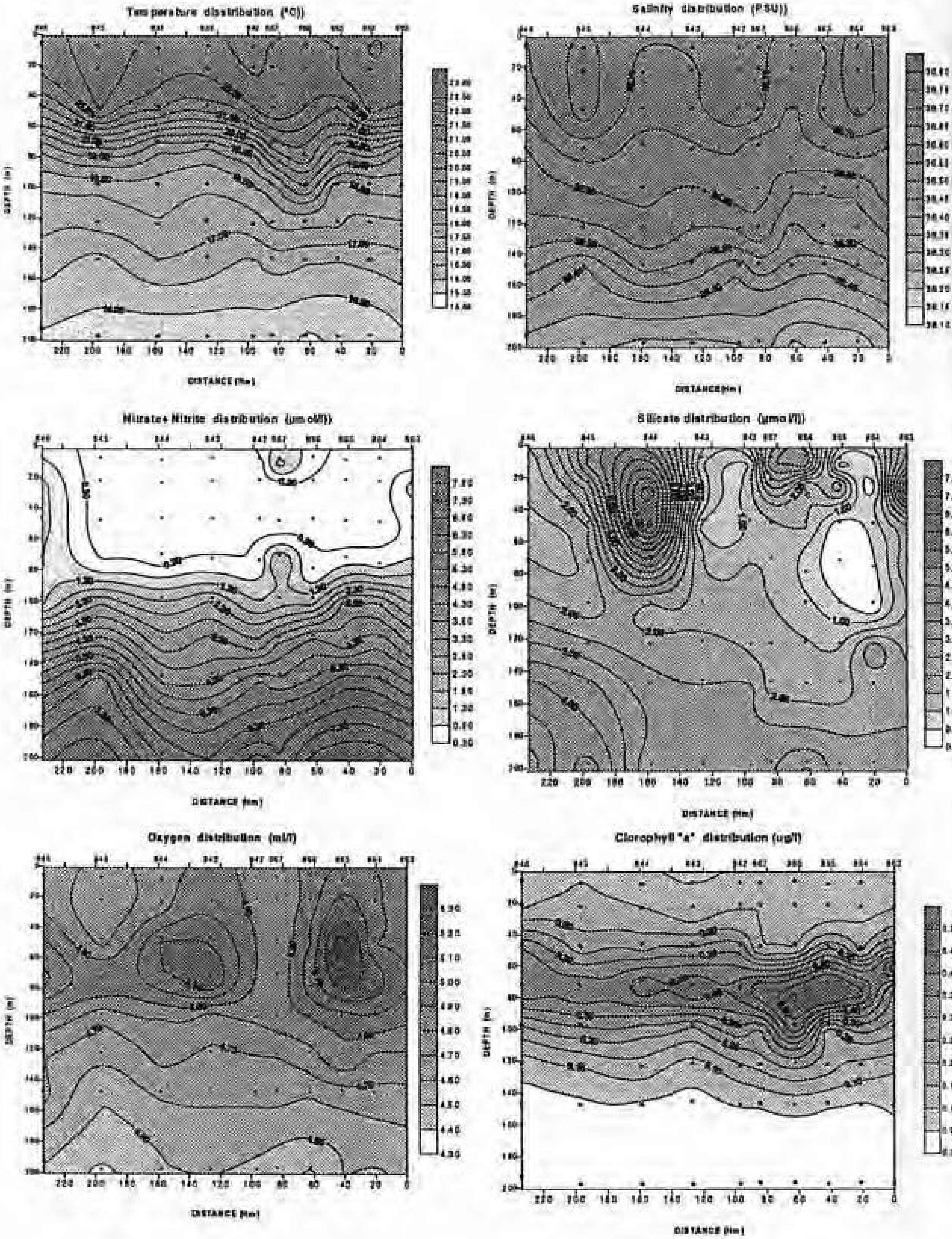

Figure 26. Distribution of the indicated parameters from surface to 200m taken along the P212/3 section along the western slope of Lanzarote and Fuerteventura and to Gran Canaria (stations 846-863).

4.2.2.3 CO_2 System
(M. González-Dávila, M. Santana-Casiano)

During the cruise "Poseidon" 212/3 (30.09.95 – 08.10.95) a determination of carbon system variables was performed along a section between La Palma and the north of Lanzarote (La Graciosa), visiting the ESTOC station three times. One of the main objectives of this cruise was to study the carbon cycle for the first time in this area and to evaluate the potential of this area for removing anthropogenic carbon dioxide from the atmosphere. Total alkalinity and pH in the total scale at 25°C were determined on 24 stations from surface to bottom. Values of total dissolved inorganic carbon (C_T) and the fugacity of carbon dioxide were computed by using thermodynamic relations and the Roy et al. (1993) constant. We show here the variable distribution observed in the carbon system in the section from La Palma (station 870) to La Graciosa (station 846).

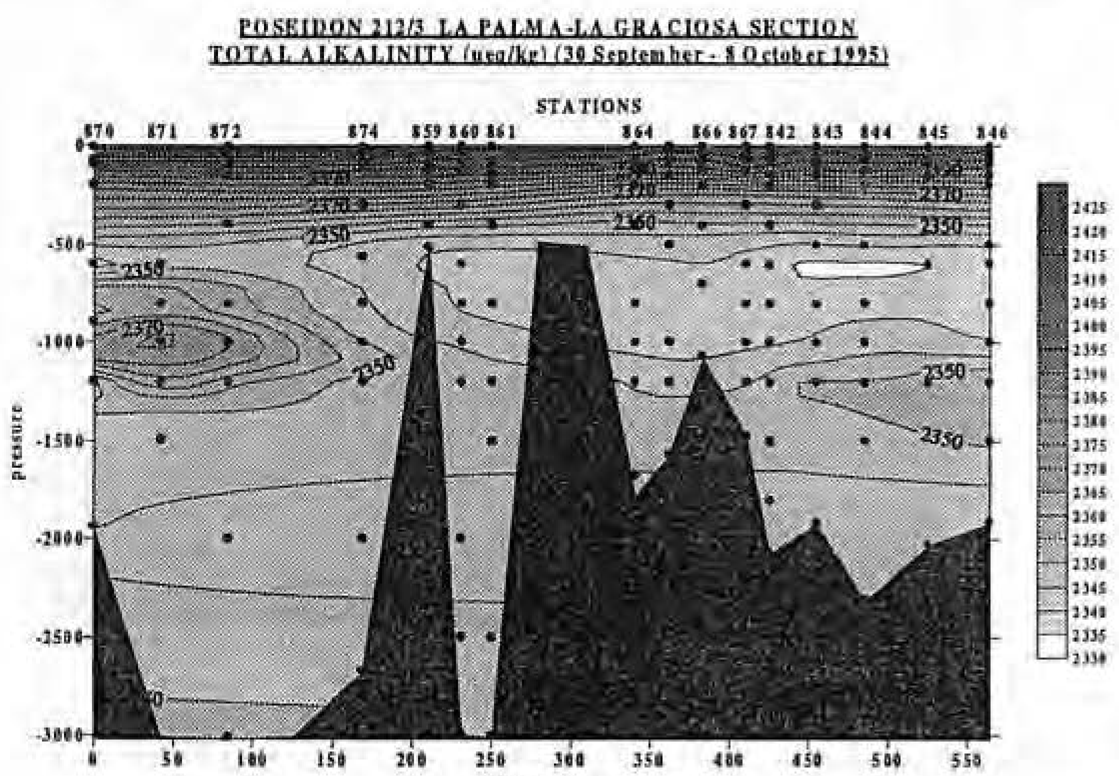

Figure 27. Alkalinity distribution from the 16 stations where sampling took place along P212/3.

Figure 27 displays the variability of alkalinity along the 16 stations analysed. The distribution has a pattern which is well related to the salinity distribution. The presence of North Atlantic Central Water (NACW) between 100 and 800 m is indicated by a strong gradient of alkalinity and pH_T which corresponds to the temperature and nutrient distributions. In the intermediate water from 800 to 1500 m both the influence of Mediterranean Water (MW) and Antarctic Intermediate Water (AAIW) are clearly observed. The minimum of salinity in the

AAIW corresponds to a layer of minimum pH, minimum alkalinity (Figure 27) and maximum fCO_2 (Figure 28) between the stations 864-866 and indicates the inflow of AAIW through the strait between Gran Canaria and Fuerteventura. This maximum of fugacity is also observed at station 846 (La Graciosa). The Mediterranean Water with a salinity maximum at about 1200 m is related to high values of alkalinity and total dissolved inorganic carbon. At station 871 a strong salinity maximum denotes the presence of a Meddy which is also recognized by a maximum of pH and a strong increase of alkalinity. The surface values of the computed fCO_2 during this time of the year are evidence for the fact that this area is acting as a source of CO_2. Assuming an atmospheric mean value of fCO_2 of 360 µatm and with surface values between 385 to 398 µatm, we conclude that during this cruise this oceanic area tended to lose CO_2 to the atmosphere.

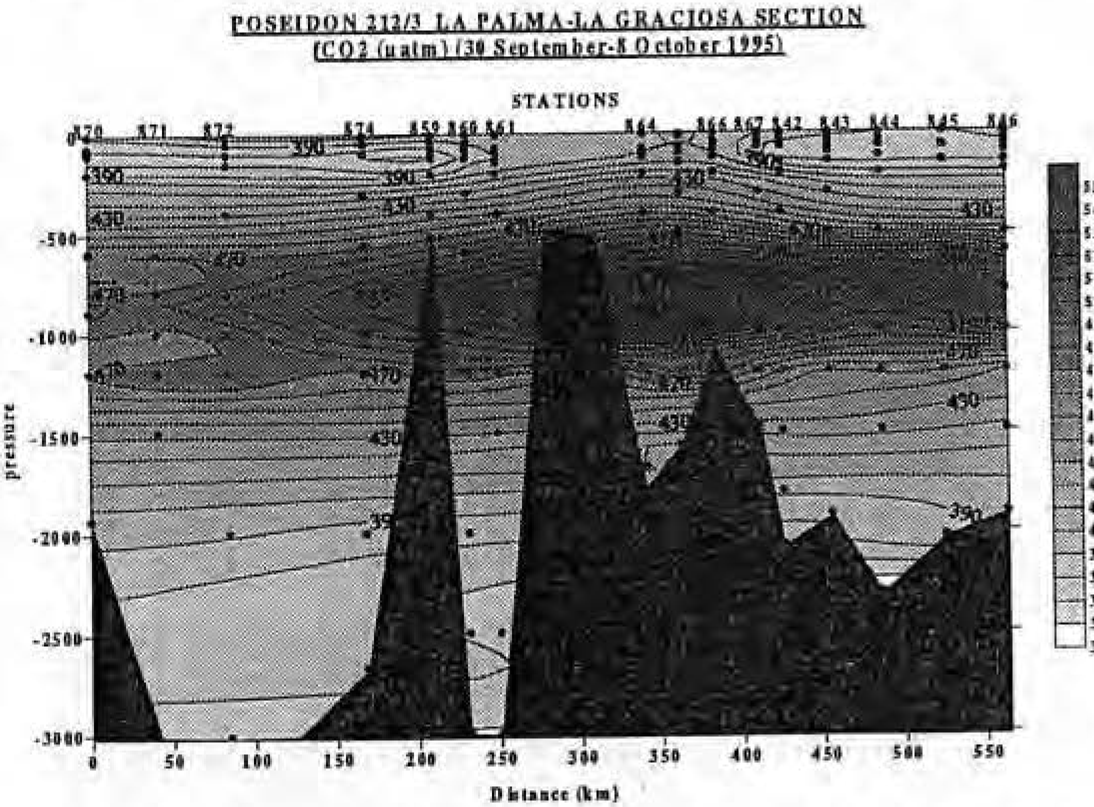

Figure 28. Fugacity of CO_2 distribution along the 16 stations were sampling was perfomed during P212/3.

4.2.3 "Victor Hensen" Cruise VH 96
4.2.3.1 Chemical and Biological Parameters
(O. Llinás, M.J. Rueda)

The surface conditions encountered during this cruise were characteristic of winter conditions with chlorophyll maxima in the surface water always above the thermocline while the deep maximum generally found in the area during the rest of the year had disappeared. The nitrate+nitrite and phosphate values were found either below or very near the detection limit of the applied methodology, but the phosphates have values that are systematically coincident with the minimum temperature zone of the surface layer. The silicate structure indicates the eolian input (Figure 29c, d and e).

(a)

(b)

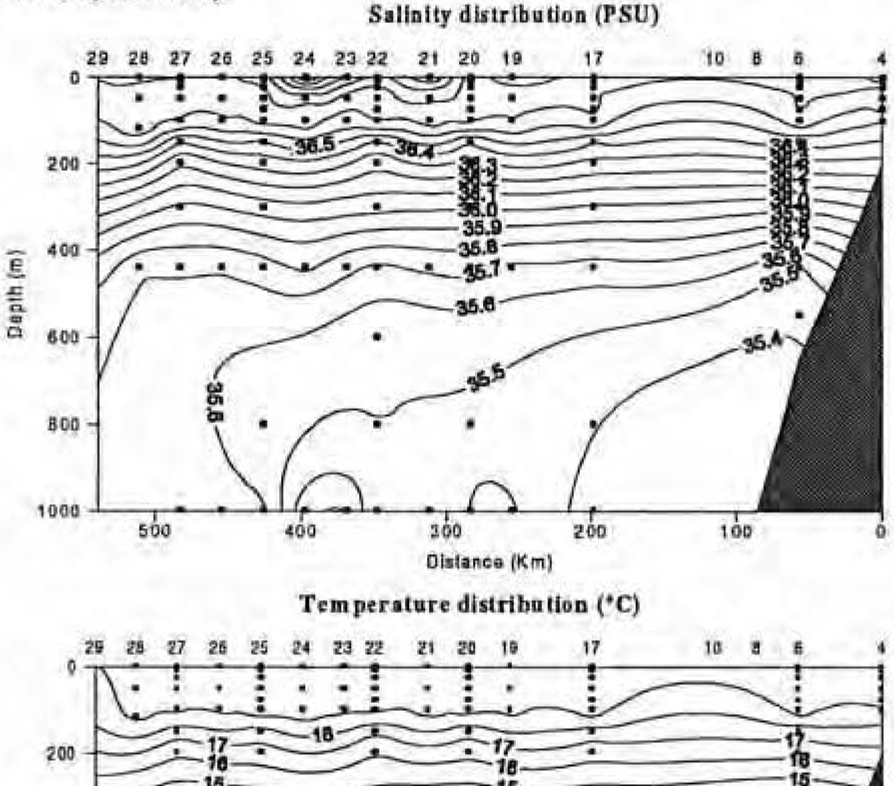

Figure 29 (a,b). Distributions of salinity and temperature during FS "Victor Hensen" cruise VH 96-1 on the zonal section at about 29°N.

Since it was only possible to sample down to 1000m depth during this cruise, the main signal is provided by the salinity minimum centered on the slope and at 800m towards the west. The nitrate+nitrite concentrations have relatively high values although they might not suffice to identify the AAIW (see Figure 29).

(c)

(d)

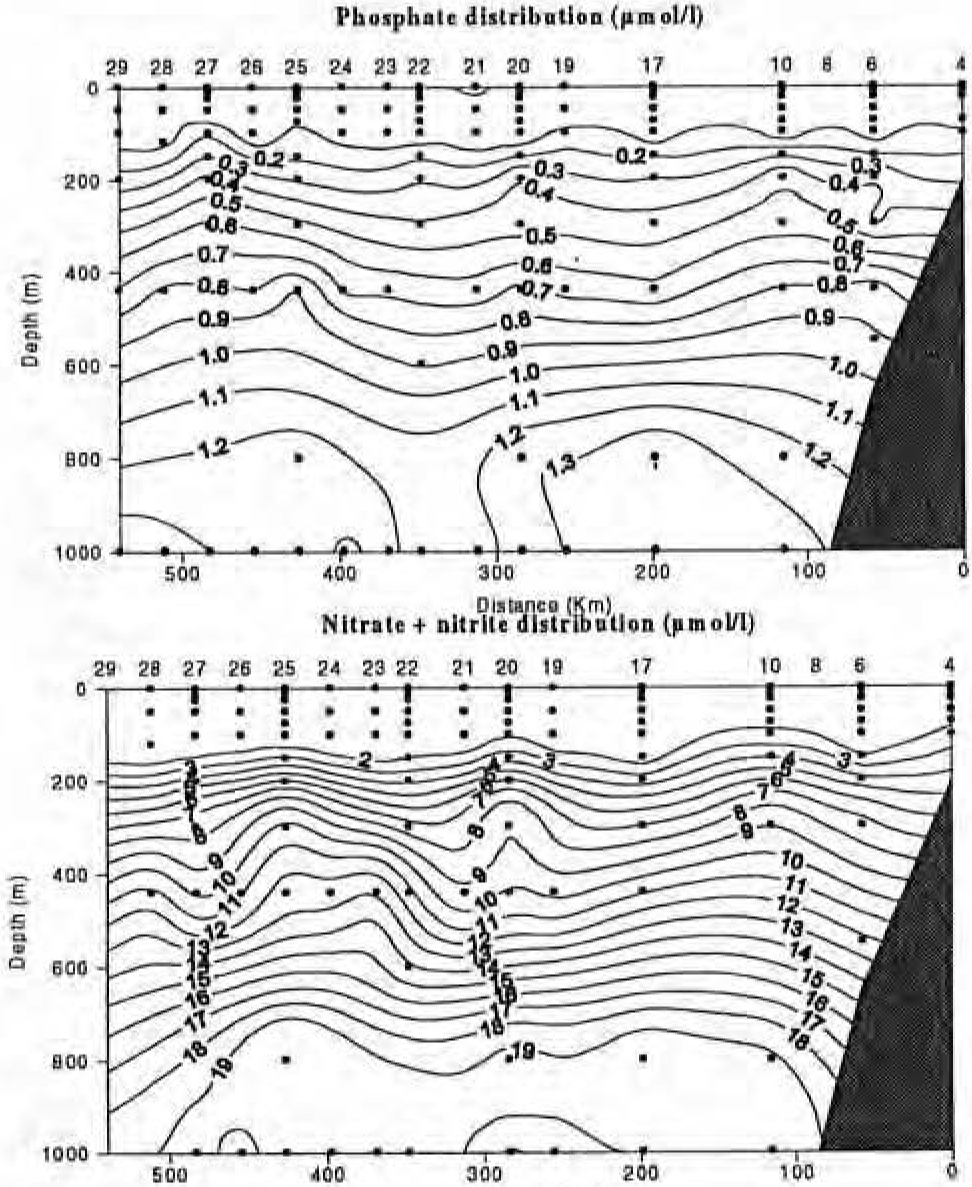

Figure 29 (c,d). Distributions of phosphates and nitrate+nitrite during FS "Victor Hensen" cruise VH 96-1 on the zonal section at about 29°N.

(e)

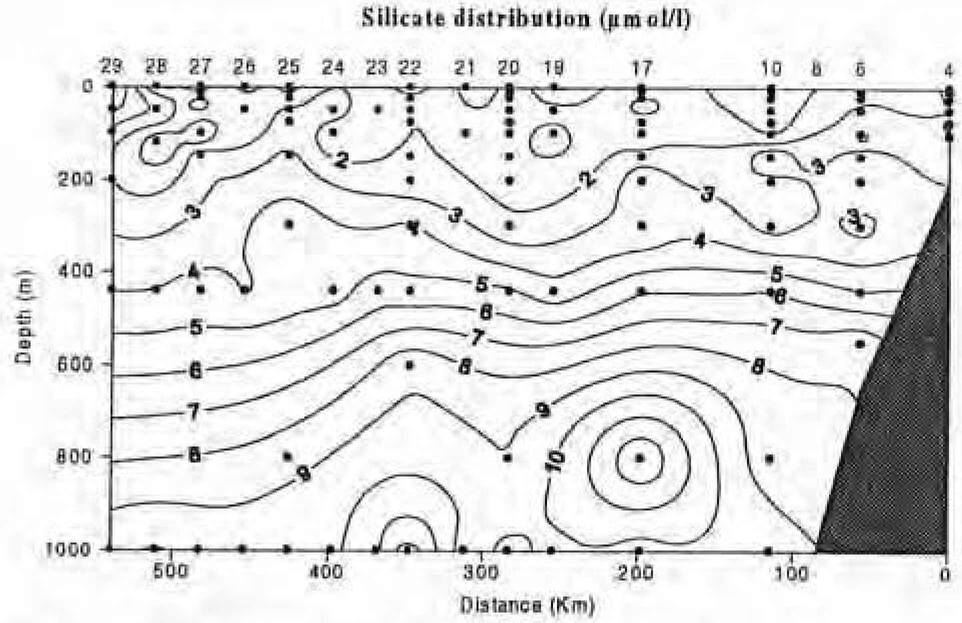

Figure 29 (e). Distributions of silicates during FS "Victor Hensen" cruise VH 96-1 on the zonal section at about 29ºN.

4.2.3.2 CO_2 System
(M. González-Dávila, M. Santana-Casiano)

On February 2 to 12, 1996, the carbonate system variables Total Alkalinity (µmol kg^{-1}) and pH (mol/kg seawater) in the total scale at 25ºC were determined on board FS "Victor Hensen" in the area between 16º - 12ºW and 28º - 30ºN, north of the Canary Islands and on the continental slope. In Figure 30, the spatial variability of pHt is presented down to 1000 m for the section between station 35 and the station ESTOC. The most important feature is the presence of a minimum of pH as low as 7.65 and minimum of A_T of 2325.7 µmol kg^{-1} (high C_T to A_T ratio) which is typical for the presence of Antarctic Intermediate Water (AAIW) at about 800m depth. From nutrients, pH and AOU distributions we find AAIW to be the oldest water. As we go to ESTOC, the minimum of pH and alkalinity moves down to about 900m, related to the salinity minimum of the North Atlantic Central Water (NACW).

At this time of the year, with a mean sea surface temperature of 19.2 ºC, the computed values of fugacity of CO_2 are 342 ± 5 µatm, showing a ΔfCO_2 = -18 µatm (considering an atmospheric fCO2 of 360 µatm). These values indicate that during this time this part of the ocean was acting as a sink of CO_2. The highest values of fCO_2 are observed on the shelf (station 35) where the environmental conditions during late autumn and early winter are favorable for the absorption of CO_2 by the ocean, mainly in an area that is affected by upwelled water.

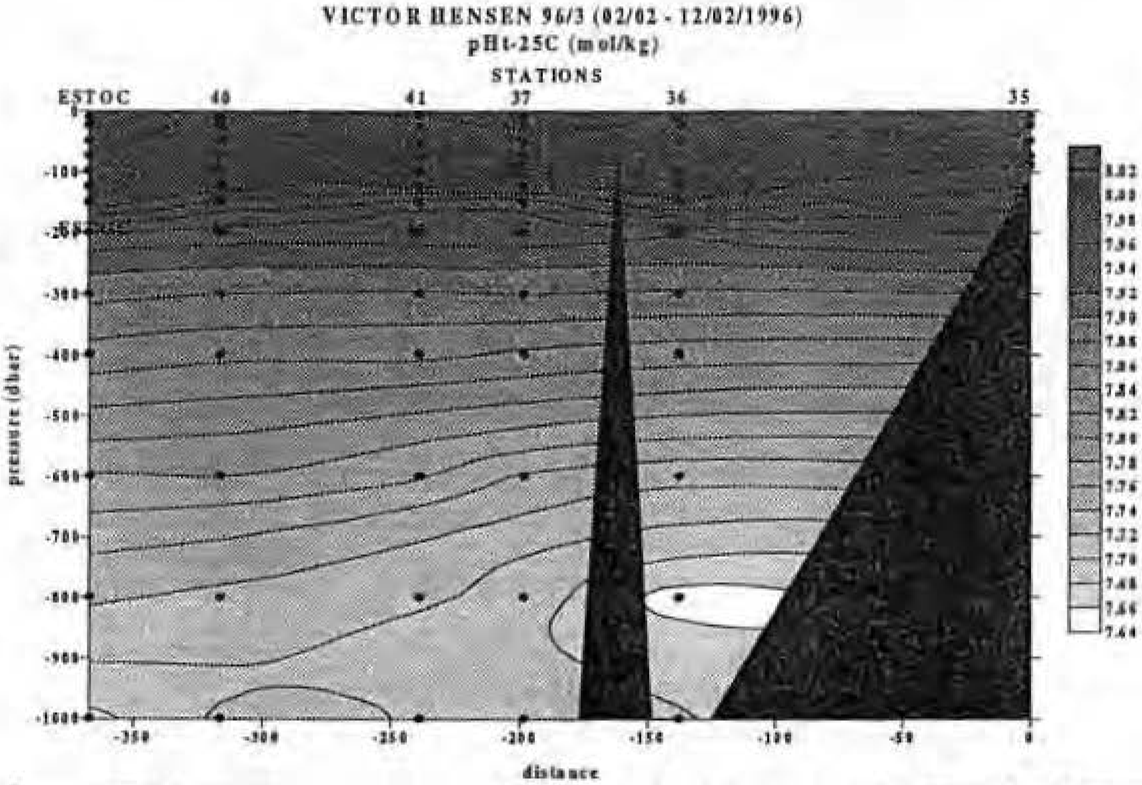

Figure 30. Spatial variability of the pHt in the section between station 35 on the Moroccan continental slope and ESTOC.

4.2.4 "Poseidon" Cruise P 219
(O. Llinás, A. Spitzy)

During this cruise in the beginning of summer samples were taken along 30ºN in the inmediate station sorroundings in order to test the homogeneity of the area north of ESTOC. In Figures 31 and 32 we represent the distributions of several parameters sampled during the cruise. It can be seen that the temperature, phosphate and nitrate+nitrite distributions are well correlated. The isoline deviations have horizontal scales of about 100km which are commensurate with eddies. Silicate has similar distributions, with increasing concentrations towards greater depth, but also has a maximum at the surface, probably due to Saharan dust input. Both processes can contribute to the nutrient supply of the near-surface layer in this area.

SECTION 30°N

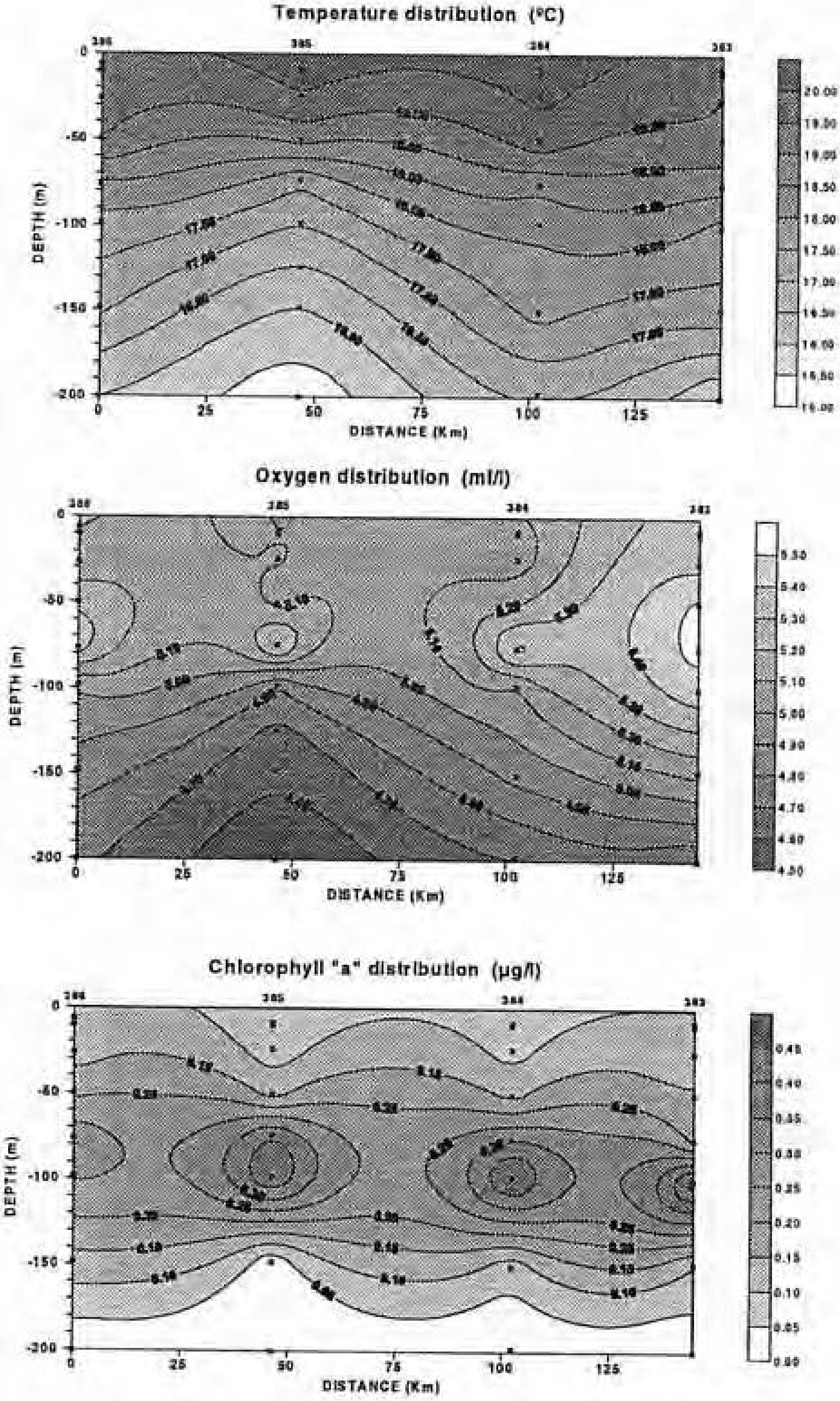

Figure 31. Temperature, oxygen and chlorophyll "a" distributions from the FS "Poseidon" P219 zonal section north of the Canary archipelago.

SECTION 30°N

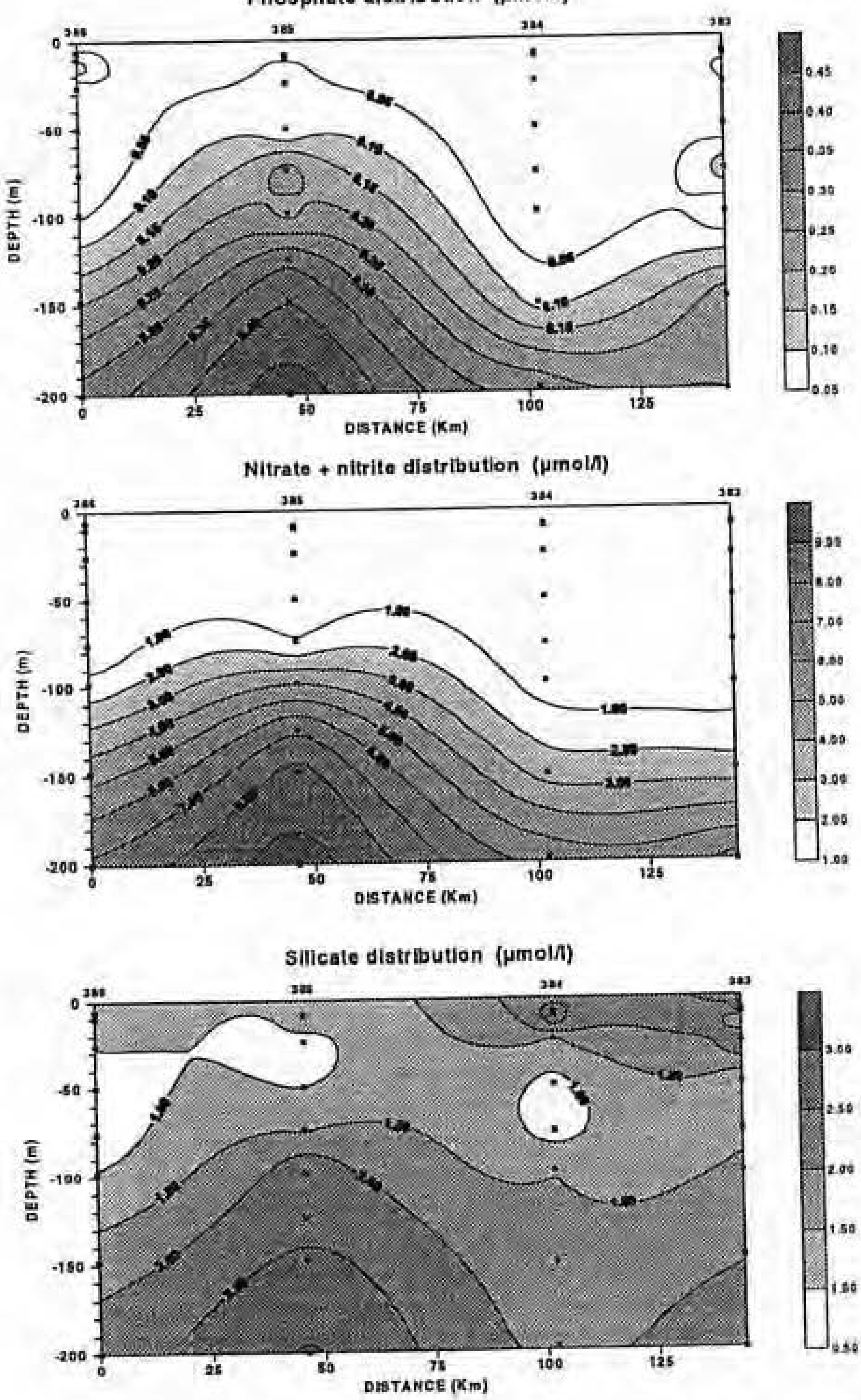

Figure 32. Phosphate, nitrate+nitrite and silicate distributions from from the FS "Poseidon" P219 zonal section north of the Canary archipelago.

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6 ESTOC PROGRAMME PRESENTATIONS AND PUBLICATIONS

Talks and Posters at Meetings and Workshops

1994:

AGU/ASLO, San Diego, U.S.A., 21.-25.02.1994

- Fischer, G., S. Neuer, G. Krause, G. Wefer: Deep water chlorophyll and particle flux recorded north of Gran Canaria (Canary Islands).

First Meeting of the ESTOC-Project, Telde, Gran Canaria, 13.-14.10.1994

- Llinás, O.: Introduction to ESTOC, Relationship to WOCE and JGOFS.
- Siedler, G.: Introduction to ESTOC, Relationship to WOCE and JGOFS.
- Wefer, G.: Introduction to ESTOC, Relationship to WOCE and JGOFS.
- Gonzales, A.: Short-term variations of the upwelling in the NW Africa (20°N-26°N).
- Davenport, R.: Application of remote sensing ocean pigment data to the Canary region.
- Gnade, O.: Ocean surface dynamics of the Canary Current region as observed by ERS-1 altimetry.
- Pérez-Marrero, J.: Infrared observations of upwelling phenomena in relation to other data.
- Knoll, M.: Preliminary Results of the Poseidon Cruise 202/1c.
- Zenk, W.: Circulation patterns in the deep and bottom waters of the Eastern North Atlantic.
- Rodríguez, I: A prognostic upwelling model off NW Africa.
- Neuer, S.: Particle flux recorded at the ESTOC Site using moored sediment traps from 1991 till 1993.
- de Armas, D.: Data management for ESTOC (EDAM).

Third JGOFS-Workshop, Universität Bremen, 05.-06.12.1994

- Siedler, G.: Stand der Arbeiten bei ESTOC.
- Neuer, S.: Partikelsedimentation an der ESTOC-Station: Saisonalität und biologische Komponenten.
- Knoll, M., C. Haag und S. Neuer: Erste Ergebnisse der Poseidon-Fahrt im Herbst 1994.
- Haag, C., M. Knoll, G. Siedler, S. Neuer, G. Wefer, E. Delgado, O. Llinás, C. Rodríguez, M.-J. Rueda, R. Santana, J. Escánez, A. Rodríguez: Joint investigation of the Canary Island Region during POSEIDON Cruise 202/1c (OCT.'94): Preliminary Results.

1995:

First JGOFS International Scientific Symposium, Villefranche-sur-Mer, 8.-12.05.1995

- Neuer,S. et al: First results from ESTOC, a Spanish-German time-series station north of the Canary Islands.

Second ESTOC Workshop, Sta Cruz, Tenerife, 09.-10.10.1995

- López, F.: Activity and results from IEO in the ESTOC-Station 1994-1995.
- Llinás, O.: Activity, Operations and Results from ICCM in the ESTOC-Station, 1994-1995.
- Neuer, S.: Particle flux at the ESTOC-Station and the role of deep advection.
- Siedler, G.: First Results from POSEIDON cruise 212 in September/October 1995.
- Steinberg, D.: An overview of Bermuda Atlantic Time-series Study.
- Müller, T.J.: Current variability in the Canary-Azores region.
- Knoll, M. und C. Haag: Water masses and transport in the Canary Islands region.
- Lavin, A.: Decadal changes in water mass characteristics at 24°N in the subtropical North Atlantic Ocean.
- Davenport, R.: Historical C.Z.C.S. data for the Canary Islands.
- Arvelo, M.: Optimized algorithm for determination for sea surface temperature from satellites in Canary Islands.
- Willkomm, R.: Remote sensing of yellow substance and chlorophyll by fluorescence technique from board aircraft in the region of the Canary Islands.
- Spiedt, A.: Planktonic foraminifera and their role as environmental indicators.
- Hernández-Brito, J.: Aluminium variability in the ESTOC-Station.
- Braun, J.G.: Variability in oxygen and nutrients in the transition zone of the eastern boundary current in the Canary Islands.

Fourth JGOFS Workshop, Universität Bremen, 20.-21.11.1995

- Siedler, G., C. Haag, M. Knoll, S. Neuer und G. Wefer: ESTOC-Station bei den Kanarischen Inseln.
- Davenport, R, S. Neuer, G. Fischer, G. Wefer: Analysis of historical CZCS data to determine seasonal and annual chlorophyll-like pigment levels in the region of the Canary Islands and comparison with data from the present European ESTOC Time Series Station.
- Knoll, M., C. Haag: Wassermassen und Transporte in der Kanaren-Region.
- Haag, C., M. Knoll, M. Busse, G. Siedler, S. Neuer, A. Spiedt, R. Davenport, G. Wefer, M.-J. Rueda, E. Delgado, C. Rodríguez, R. Santana, O. Llinás, F. López, J. Escánez, J.-M. Rodríguez, C. Garcia, A. Rodríguez, R. Willkomm, H. Barth, R. Heuermann, R. Reuter, J. Hernández, M. González: ESTOC and related Process Studies (1994-1995).

1996:

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- Knoll, M., C. Haag: The Eastern Boundary Current System in the Canary Islands Region.

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- S. Neuer, R. Davenport, V. Rathmeyer, G. Fischer, F. Abrantes, S. Nave, G. Wefer: Importance of lateral advection for the particle flux recorded at the ESTOC time-series station.

Fifth JGOFS-Workshop, Universität Bremen, 27.-28. 11.1996

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- Knoll, M., T. Müller, J. Reppin, M. Busse, G. Siedler, S. Neuer, R. Davenport, V. Rathmeyer, A. Spiedt, G. Fischer, G. Wefer, M.-J. Rueda, E. Delgado, C. Rodríguez, R. Santana, O. Llinás, J. Escánez, C. Garcia Ramos, J.-M. Rodríguez, A. Rodríguez, F. López: ESTOC-Observations.
- Neuer, S., P. Müller, G. Ruhland, G. Wefer: Untersuchungen mit freitreibenden Partikelfallen an der ESTOC Station.
- Neuer, S., R. Davenport, V. Rathmeyer, G. Fischer, G. Wefer, M. Knoll, G. Siedler, M.-J. Rueda, O. Llinás: Seasonality of biogenic and lihogenic particle flux at the ESTOC time-series station: Comparison with upper water column processes and long-term satellite derived pigment data.

University of Las Palmas, Gran Canaria, 03.12.1996

- Knoll, M.: The Canary Current and the Eastern Boundary Current System.

1997:

ICCM, Telde, Gran Canaria, 23.01.1997

- Müller, T.J.: Variability of flow in the subtropical Eastern Atlantic.

University of Las Palmas, Gran Canaria, 24.01.1997

- Müller, T.J.: Variability of flow in the subtropical Eastern Atlantic.

ICCM, Telde, Gran Canaria, 07.03.1997

- Siedler, G.: The North and the South Atlantic - similarities and differences.

EUG, Strasbourg, March 1997

- Neuer, S., B. Davenport, V. Ratmeyer, G. Fisher, S. Nave, F. Abrantes: Importance of lateral advection for the particle flux record at the ESTOC time-series station.

ICCM, Telde, Gran Canaria, 11.04.1997

- Neuer, S.: Las grandes nevadas en el mar (The great snowfall in the ocean).

Sixth JGOFS workshop Universität Bremen, 04.-05.12.1997

- Determann, S.: Erste Ergebnisse eines hochauflösenden Zirkulationsmodells im Bereich der ESTOC-Station (First results from a high resolution circulation model in the area of the ESTOC station).
- Neuer, S. et al.: Particle flux measurements at ESTOC.
- Neuer, S. et al.: Present status of ESTOC-Observations.
- Pätsch, J., G. Radach: Ein 1D-Ökosystemmodell für die biologischen und chemischen Prozesse in den oberen 3000m des Nordatlantik bei der ESTOC-Station (A 1d-Ecosystem model of the biological and chenical processes in the upper 3000m of the North Atlantic at ESTOC).
- Peeken, I., S. Neuer: Phytoplanktonzusammensetzungen anhand photosynthetischer Pigmente zu verschiedenen Jahreszeiten an der ESTOC-Station (Phytoplankton composition derived through photsyntetic pigments at different saisons at ESTOC).
- Reppin, J., M. Knoll, T.J. Müller, G. Siedler, S. Neuer, B. Davenport, H. Meggers, V. Ratmeyer, A. Spiedt, G. Fischer, G. Wefer, M.-J. Rueda, M. Villagarcía, E. Delgado, C. Rodriguez, R. Santana, O. Llinás, F. López-Laatzen, A. Rodriguez: ESTOC- European Station for Time-Series in the Ocean, Canary Islands.

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EGS XXIII General Assembly, Nice, France, 23.04.1998

- Reppin, J., M. Knoll: Watermasses and currents in the area of the ESTOC time series station.
- Neuer, S., R. Davenport, V. Ratmeyer, G. Fischer, G. Wefer, M.J. Rueda, O. Llinás: Particle flux measurements at ESTOC.
- Rueda, M.J. R. Santana, J. Perez-Marrero, A. Cianca, M.G. Villagarcía, J. Godoy, J. Escánez, O. Llinás: Variability of the nutrients concentration at ESTOC (1994-1997).

AGU Ocean Sciences Meeting, San Diego, February 1998

- Neuer, S., I. Peeken: Investigations with surface-tethered particle traps at the ESTOC (European Station for Time-series in the Ocean).

Sixth International Conference on Paleoceanography, Lisbon, August 1998

- Meggers, H., T. Freudenthal, R. Davenport, S. Neuer, G. Wefer: Particle Flux and Paleoceanography in the Eastern Boundary Current system.
- Nave, S., P. Freitas, F. Abrantes, S. Neuer, G. Wefer: Diatom assemblages in the Canary Islands region: Comparison of a sediment trap time series and the sea floor record.

ESTOC workshop, Hamburg, October 1998.

- Pérez-Marrero, J.: Variability in ESTOC (1994-1997).

Seventh JGOFS workshop, Universität Bremen, 04.-05.12.1998

- Determann, S.: Woher kommt das Wasser an der ESTOC Station? Ergebnisse eines eddy-auflösende Zikulationsmodells (Where does the water at ESTOC come from? First results from an eddy resolving circulation model).
- Kühn, W.: ESTOC - eine 1D-Modellstudie (ESTOC - a 1D-model study).
- Kühn, W.: Biogeochemische Prozesse und Partikelfluß bei ESTOC - Modelle und Daten (Biogeochemical processes and particle flux at ESTOC - models and data).
- Müller, T., O. Llinas, S. Neuer, J. Reppin, M. J. Rueda, G.Siedler and G. Wefer: Die ESTOC-Zeitserienstation nördlich der Kanarischen Inseln (ESTOC timeseries station north of the Canary Islands).
- Neuer, S., R. Davenport, O. Llinas, M-J. Rueda, J. Godoy, and G. Wefer: Estimates of primary and export production at ESTOC.
- Pätsch, J., W. Kühn, S. Determann, K. Herterich, G.Radach, M. Gonzalez-Davila, M. Santana-Casiano: Ergebnisse der Modellieraktivitäten für die ESTOC-Station (Results of modelling activities at ESTOC).
- Rueda, M.J., R. Santana, J. Perez-Marrero, A. Cianca, M.G. Villagarcia, J. Godoy, J. Escánez, O. Llinas: Variability of the nutrients concentration at ESTOC (1994-1997).

Publications:

Davenport, R., S. Neuer, A. Hernandez-Guerra, M[a].-J. Rueda, O. Llinas, G. Fischer and G. Wefer (in press): Seasonal and interannual pigment concentration in the Canary Islands region from CZCS data and comparison with observations from the ESTOC time-series station. *Int. J. Remote Sensing*.

Fischer, G., G. Krause, S. Neuer, and G. Wefer (1996): Short-term sedimentation pulses recorded with a fluorescence sensor and sediment traps in 900 m water depth in the Canary Basin., *Limnol. Oceanogr.*, **41(6)**, 1354-1359.

Llinás,O., A.Rodríguez de Leon, G.Siedler and G.Wefer (1994): The ESTOC Time Series Station Started Operation. *Int. WOCE Newsletter*, 17, Nov.1994

Llinás,O., A.Rodríguez de Leon, G.Siedler and G.Wefer (1997): ESTOC Data Report 1994, *Informes Téchnicos Inst. Canario Cienc. Mar.*, **3**, 80pp.

Neuer, S. and M. Rueda (1997): European Time-Series Station In Operation North of Canary Islands. *U.S. JGOFS Newsletter*, March 1997.

Neuer, S., V. Rathmeyer, R. Davenport, G. Fischer and G. Wefer (1997): Deep water particle flux in the Canary Islands region: seasonal trends in relationship to long-term satellite derived pigment data and lateral sources. *Deep-Sea Res. I*, **44**, 1451-1466.

Ratmeyer, V. and G. Wefer (1996): A high resolution camera system (ParCa) for imaging particles in the ocean: system design and results from profiles and a 3 month deployment. *J. Mar. Res.* **54**, 1-16.

Sprengel, C., K.-H. Baumann and S. Neuer (subm.): Seasonal and interannual variation of coccolithophore fluxes and species composition in sediment traps north of Gran Canaria (29°N 15°W). *Mar. Micropaleonto.*

7 ACKNOWLEDGMENTS

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8 DATA AVAILABILITY AND DISTRIBUTION

The data reports will be published annually or once in two years in the ICCM report series, combining the data sets from the standard station observations and from the special process studies. It is the understanding that in the future the data sets will be made available to other users through the ICCM web server two years after the year of observation, unless the ESTOC Comittee decides that special restrictions apply.

9 APPENDICES

A Monthly Observations

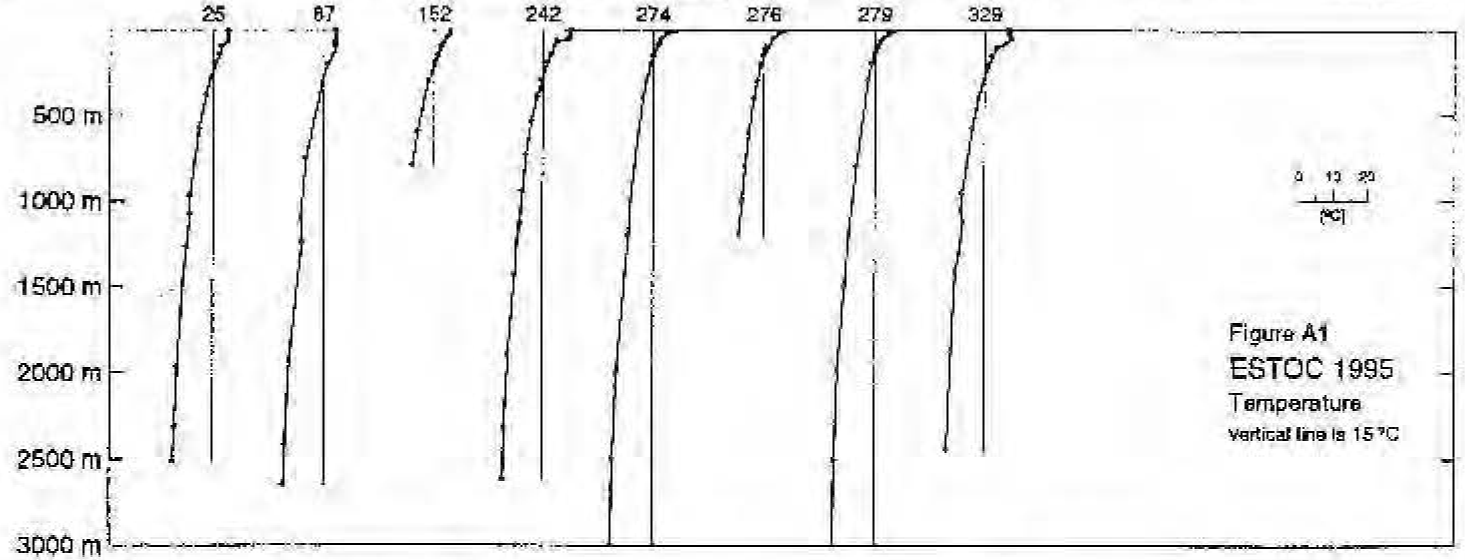


Figure A1
ESTOC 1995
Temperature
vertical line is 15°C

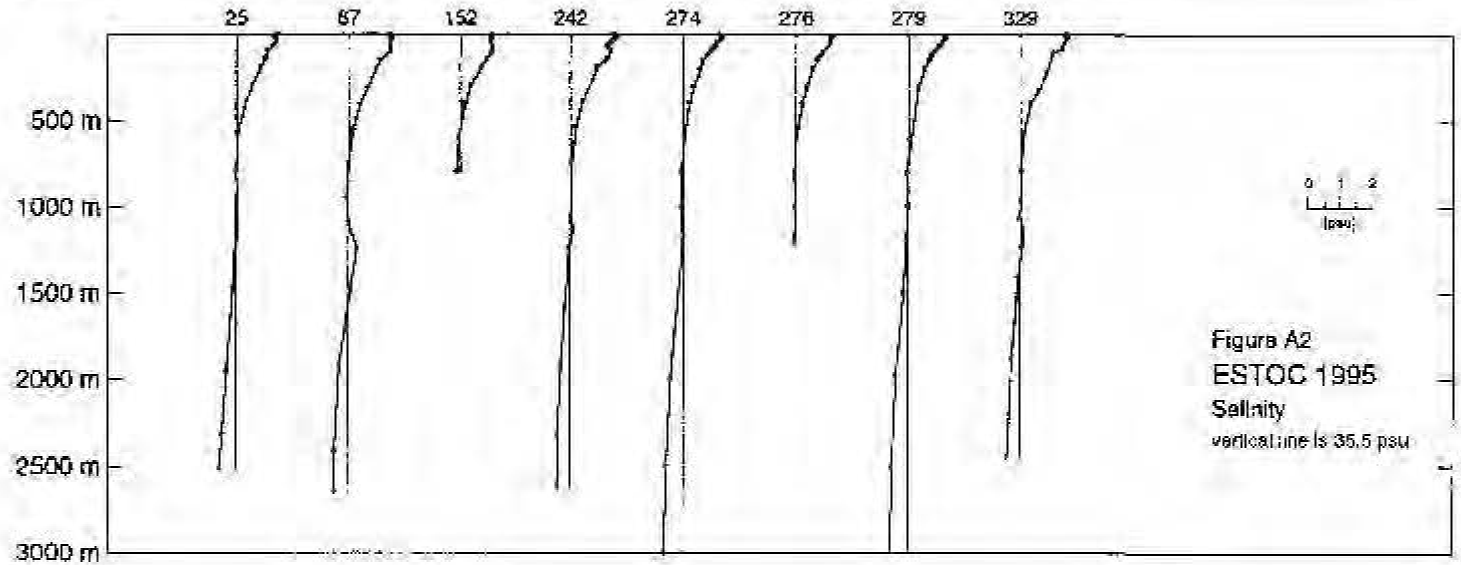


Figure A2
ESTOC 1995
Salinity
vertical line is 35.5 psu

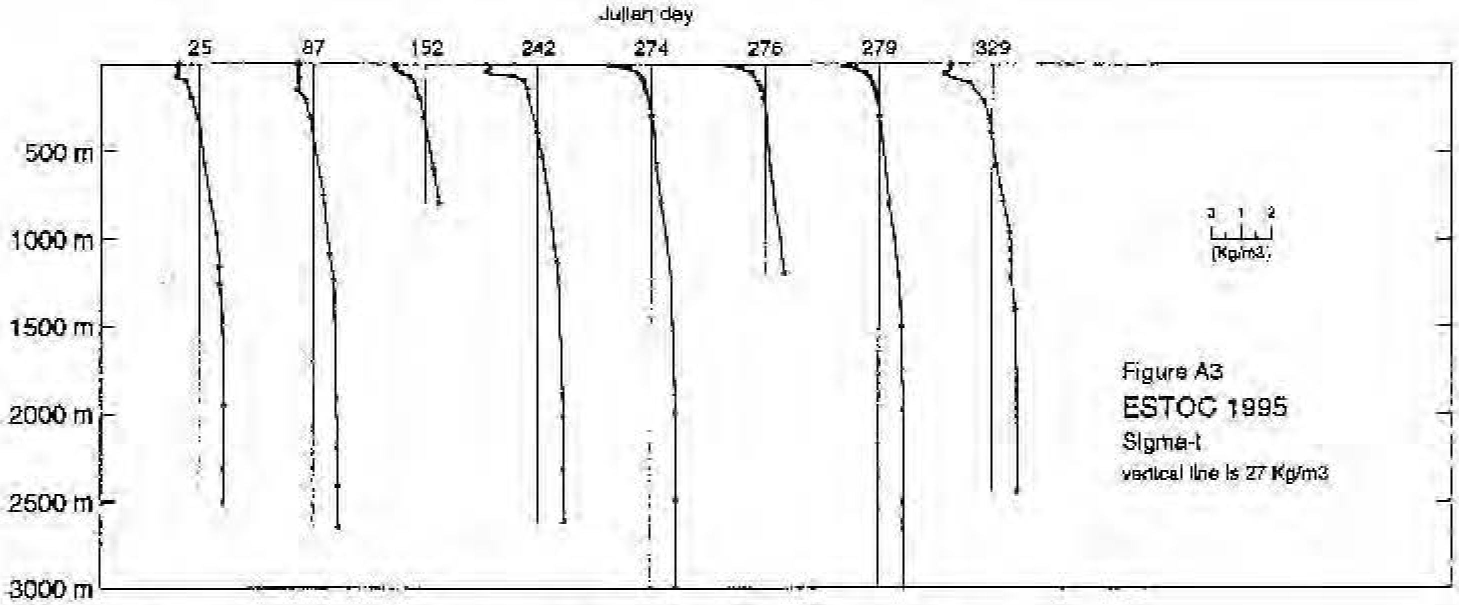


Figure A3
ESTOC 1995
Sigma-t
vertical line is 27 Kg/m3

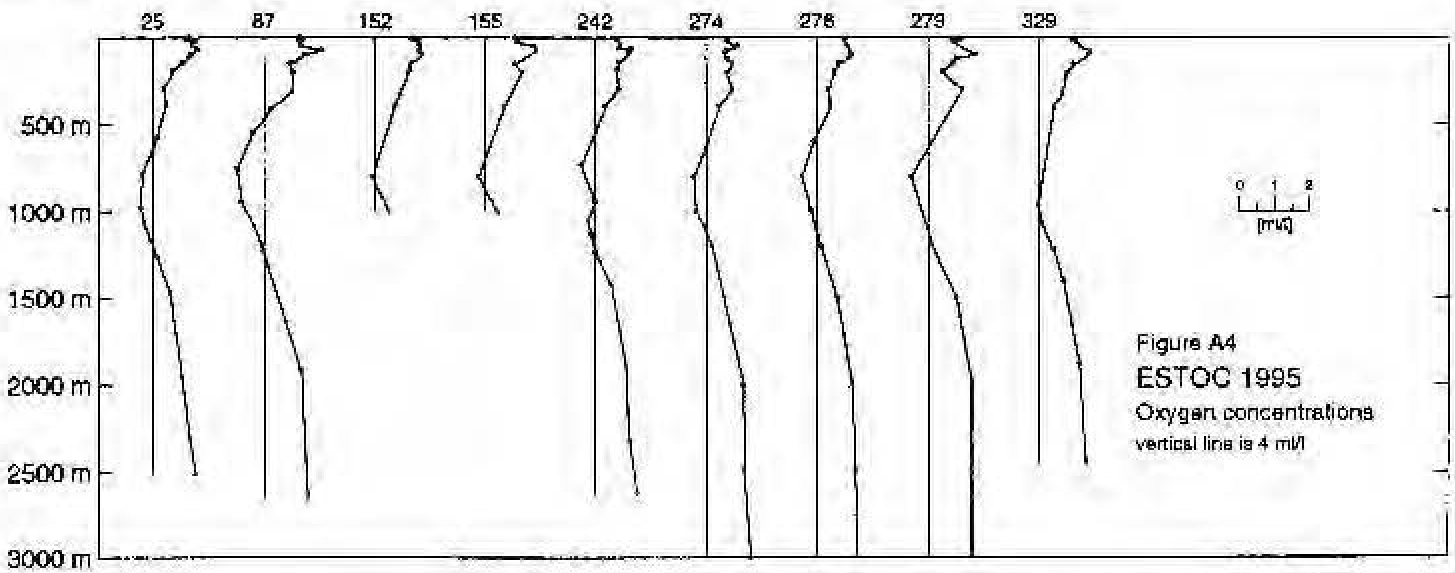


Figure A4
ESTOC 1995
Oxygen concentrations
vertical line is 4 ml/l

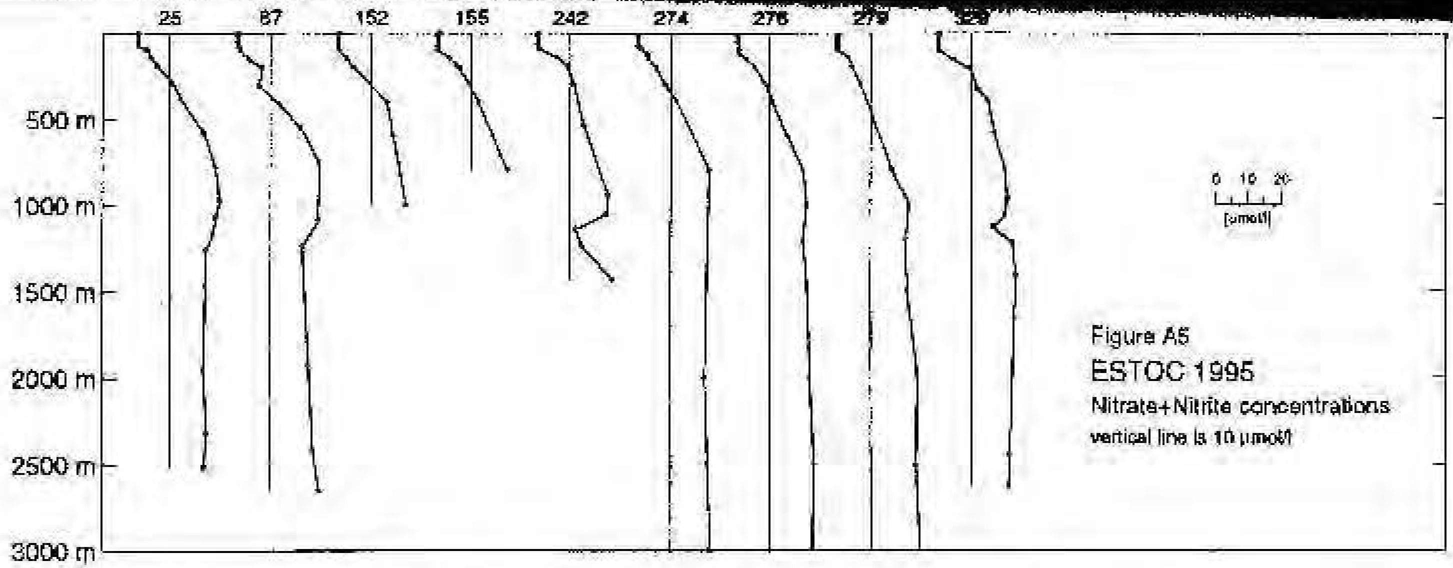


Figure A5
ESTOC 1995
Nitrate+Nitrite concentrations
vertical line is 10 µmol/l

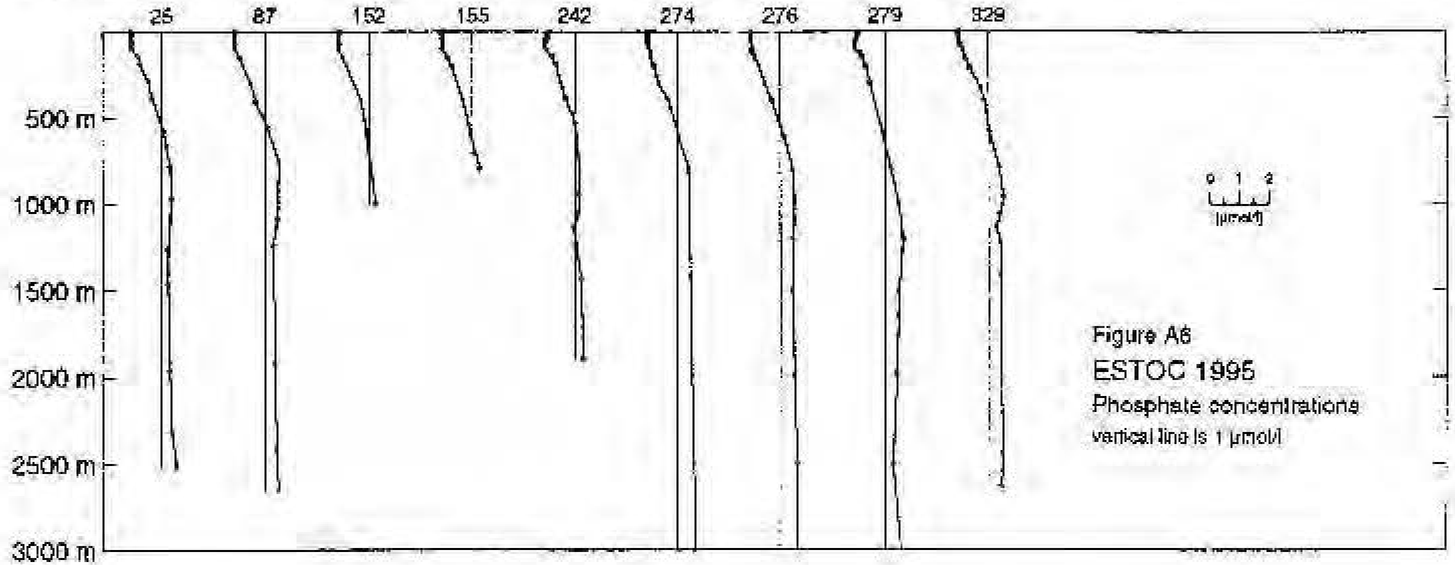


Figure A6
ESTOC 1995
Phosphate concentrations
vertical line is 1 µmol/l

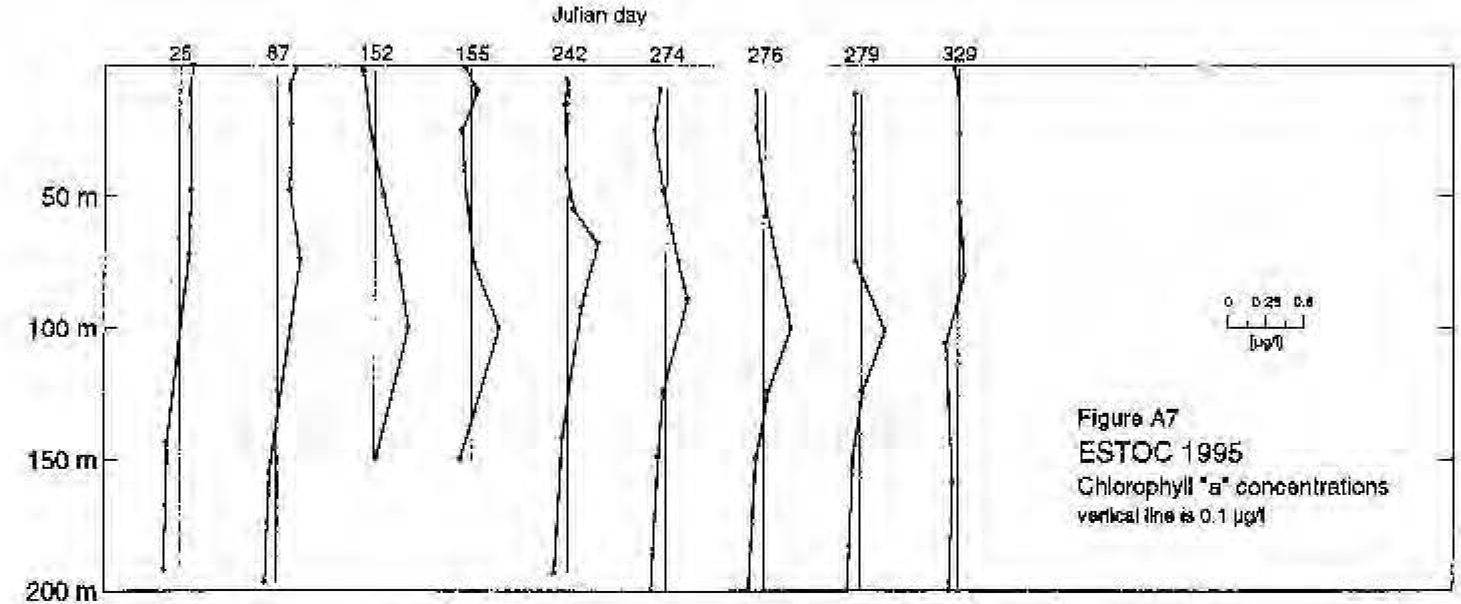


Figure A7
ESTOC 1995
Chlorophyll "a" concentrations
vertical line is 0.1 µg/l

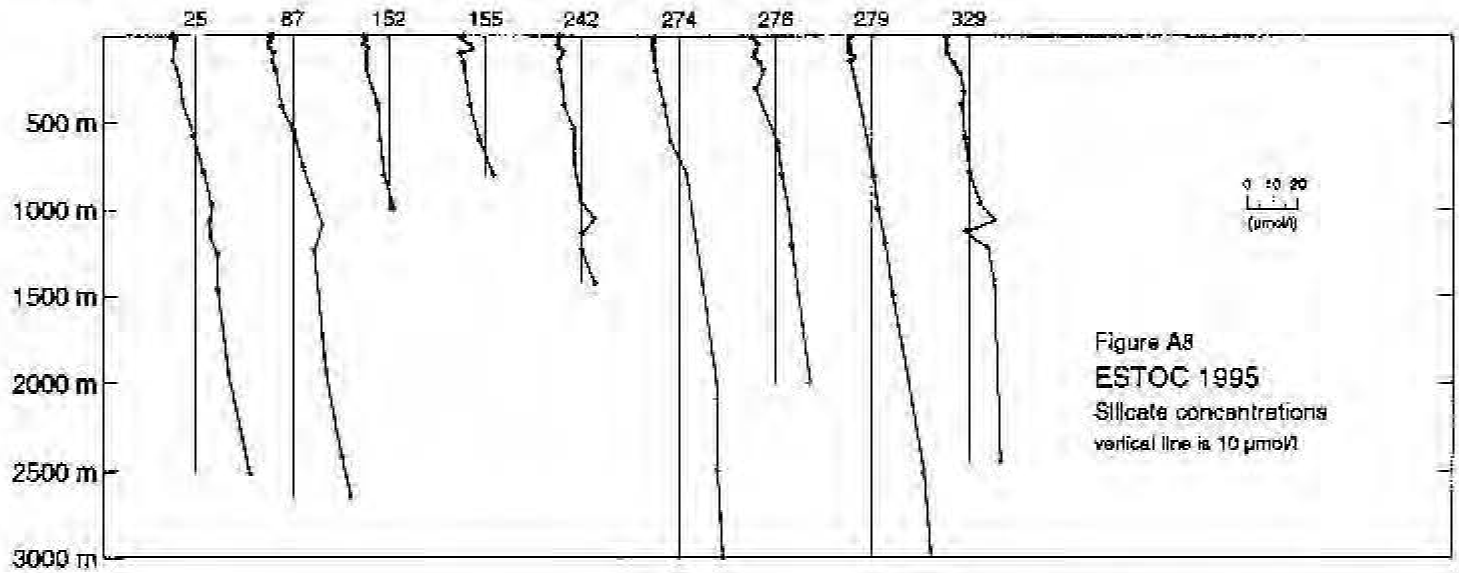


Figure A8
ESTOC 1995
Silicate concentrations
vertical line is 10 µmol/l

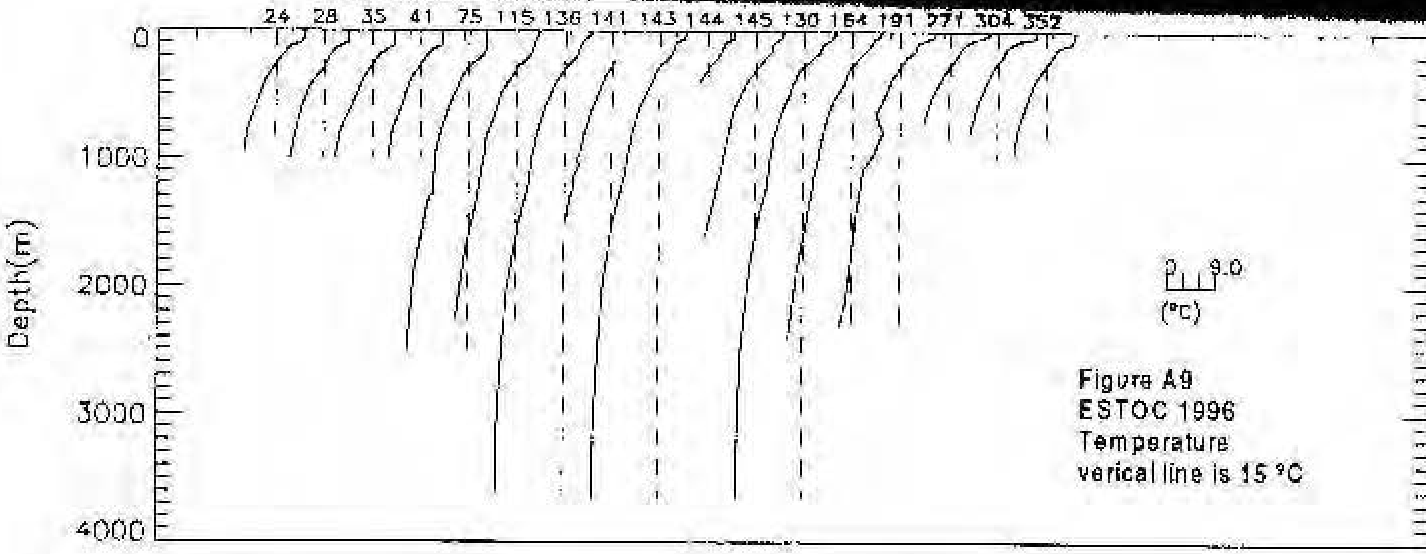


Figure A9
ESTOC 1996
Temperature
verical line is 15 °C

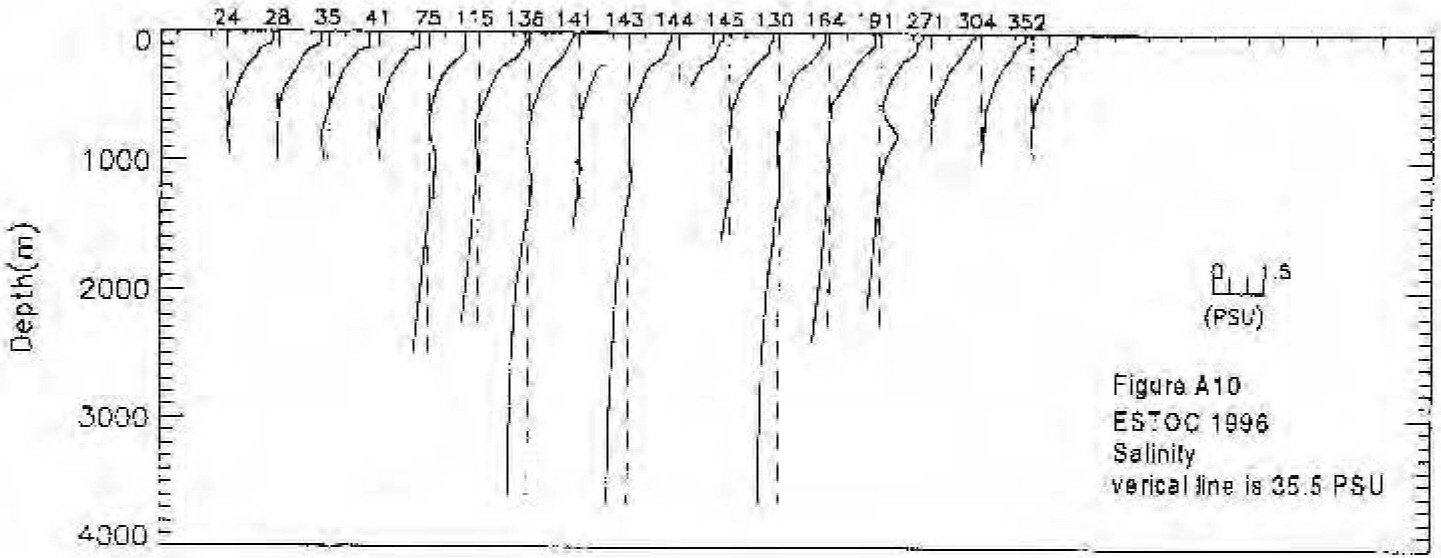


Figure A10
ESTOC 1996
Salinity
verical line is 35.5 PSU

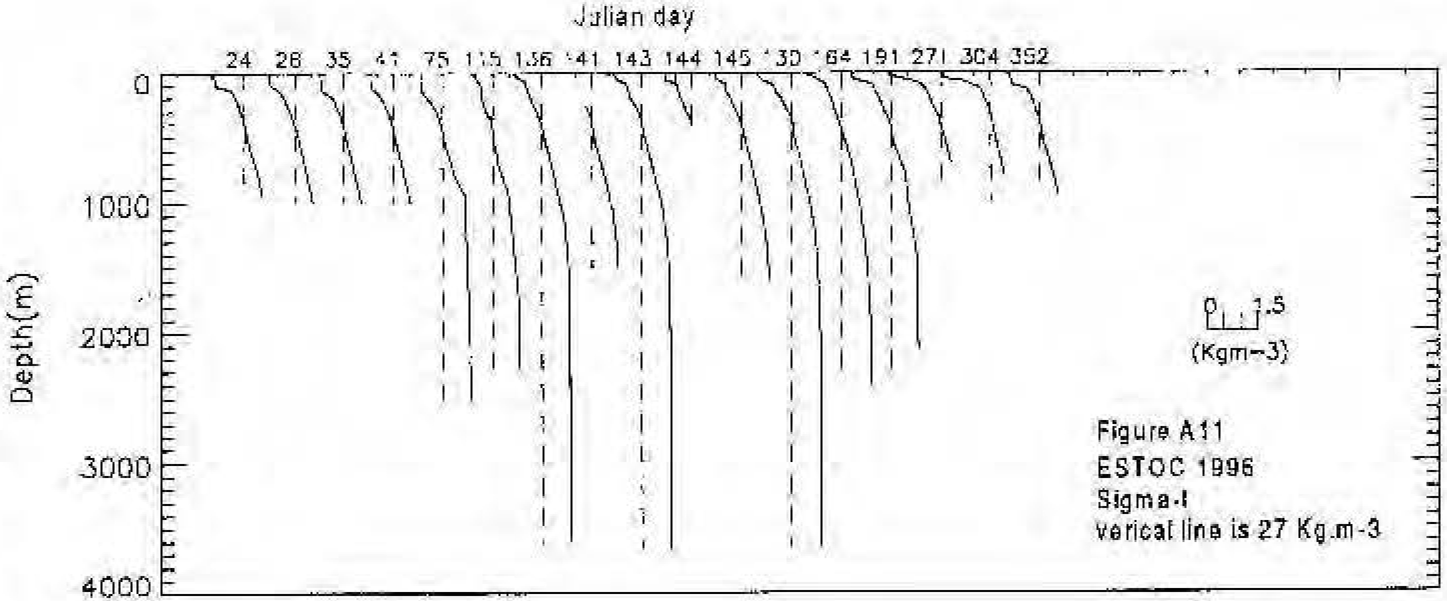


Figure A11
ESTOC 1996
Sigma-t
verical line is 27 Kg.m-3

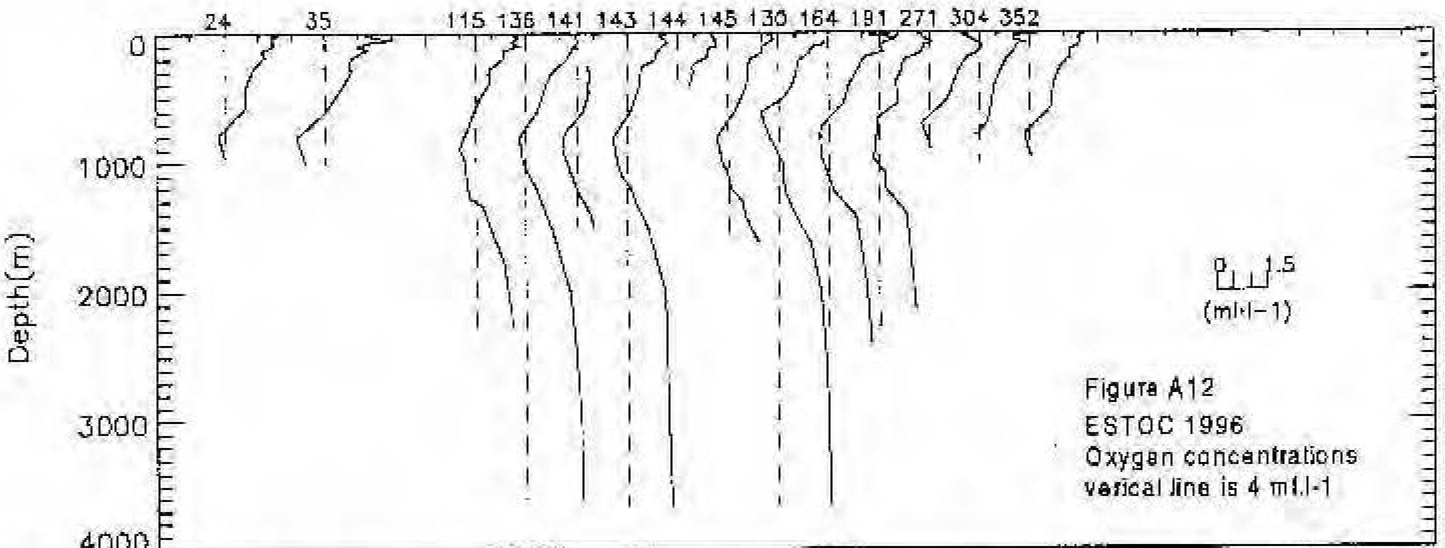


Figure A12
ESTOC 1996
Oxygen concentrations
verical line is 4 ml.l-1

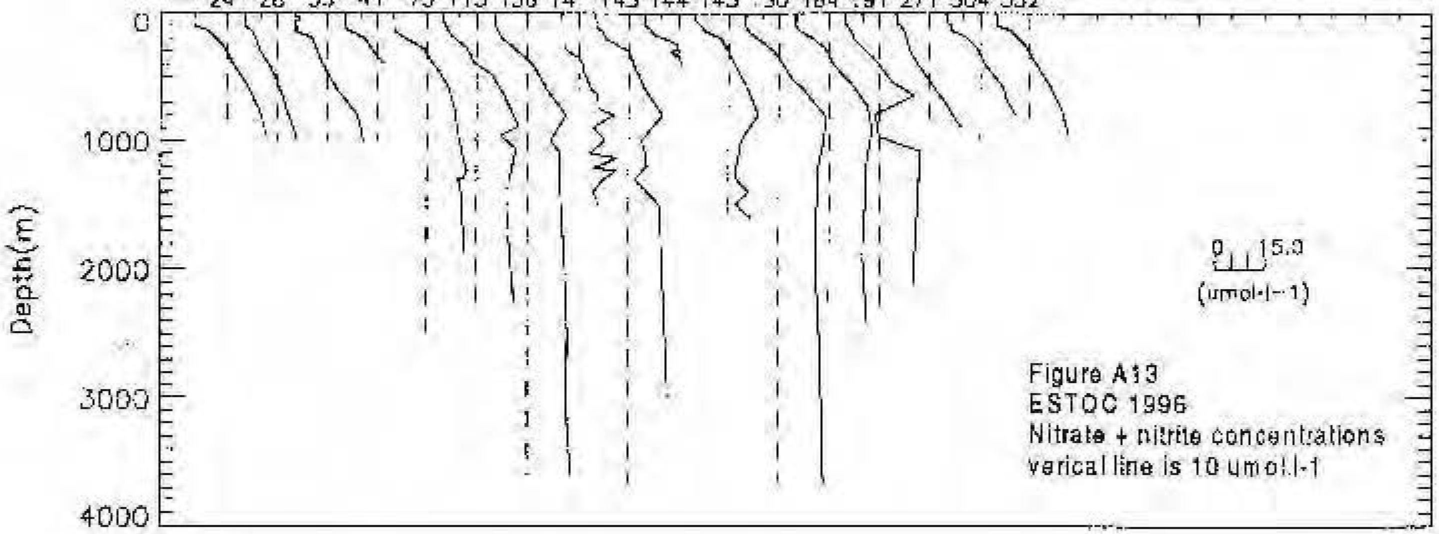


Figure A13
ESTOC 1996
Nitrate + nitrite concentrations
verical line is 10 umol.l-1

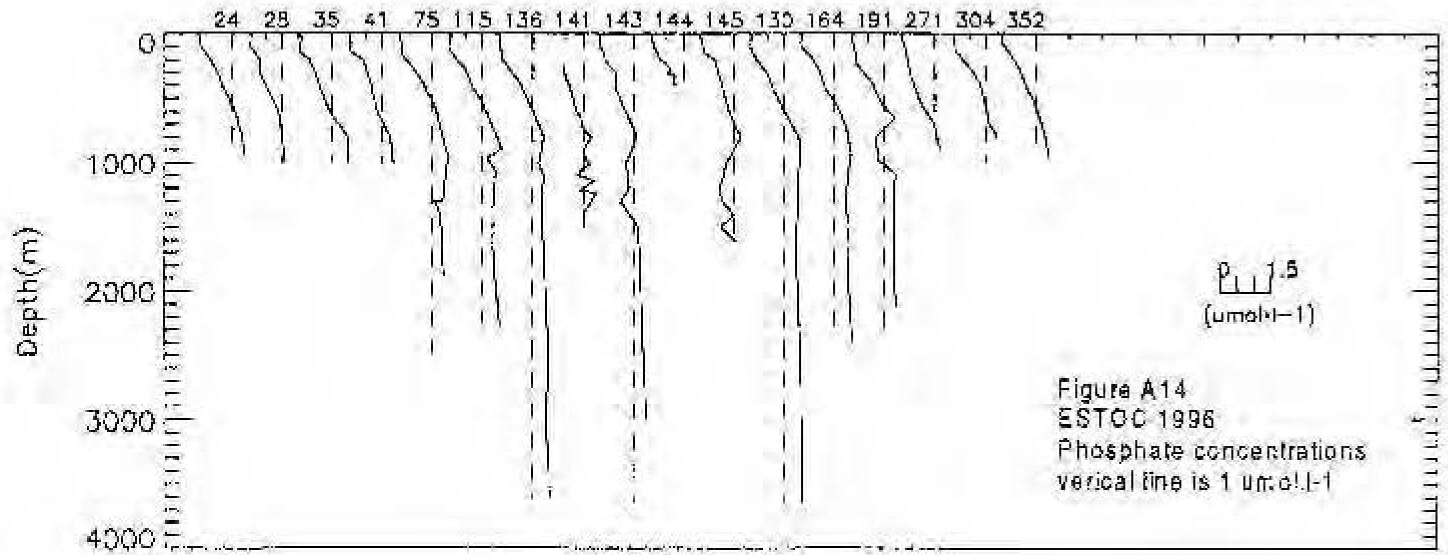


Figure A14
ESTOC 1996
Phosphate concentrations
verical line is 1 umol.l-1

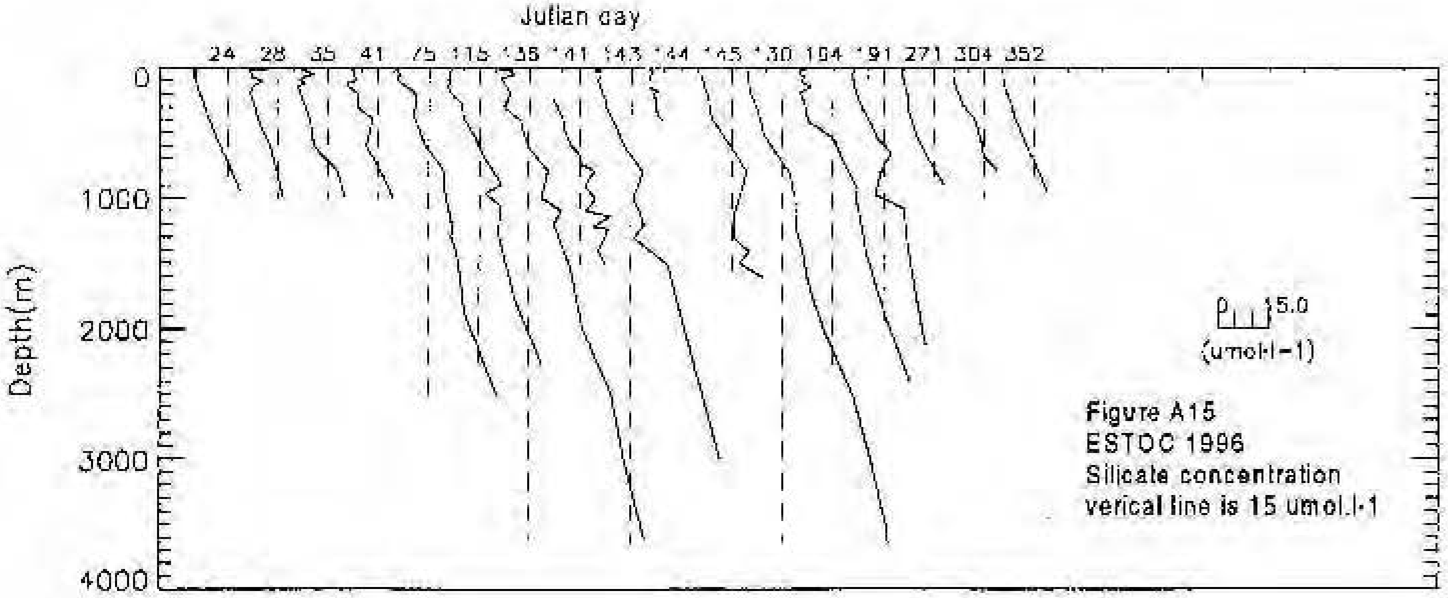


Figure A15
ESTOC 1996
Silicate concentration
verical line is 15 umol.l-1

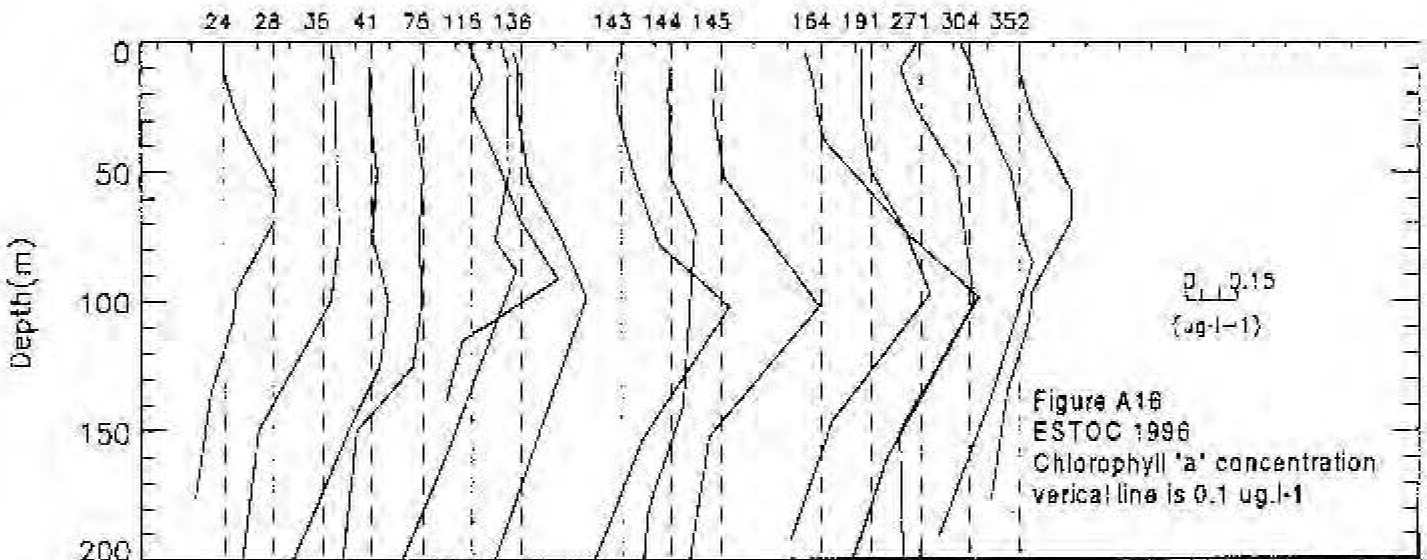


Figure A16
ESTOC 1996
Chlorophyll 'a' concentration
verical line is 0.1 ug.l-1

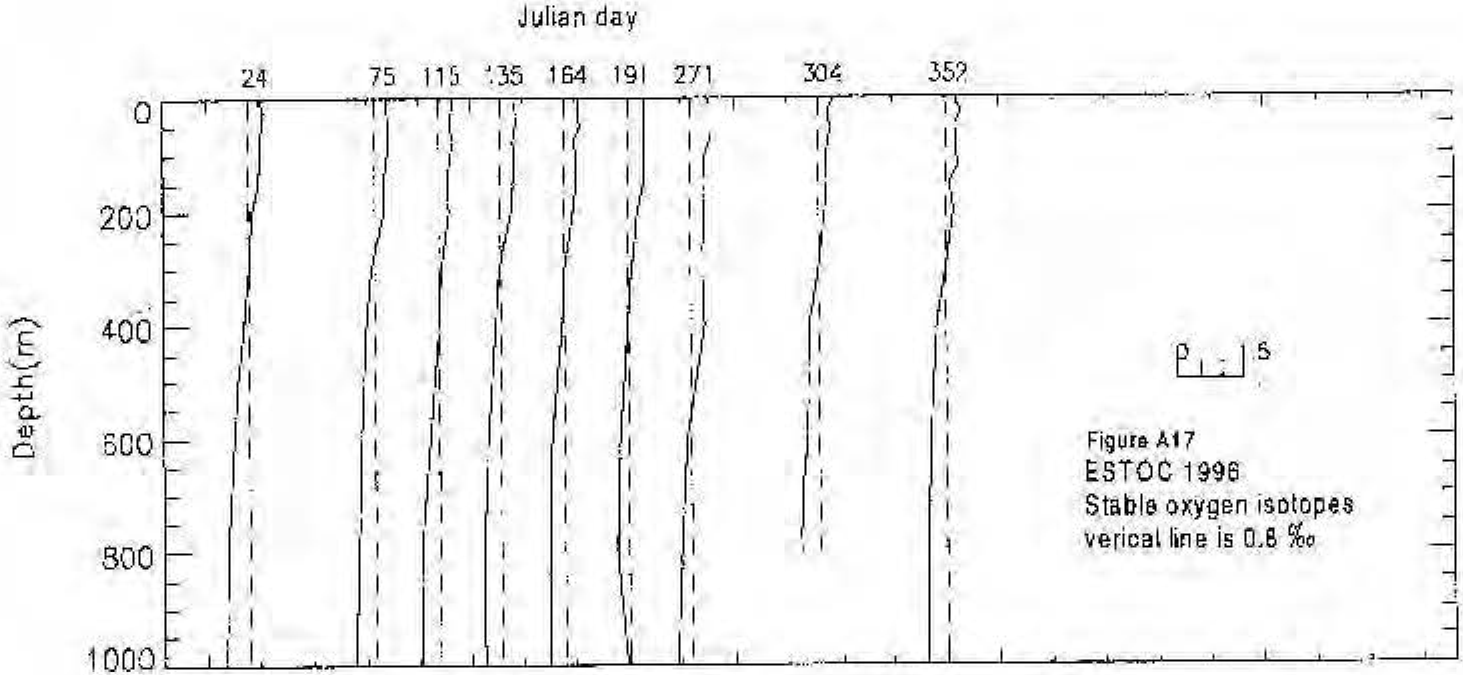


Figure A17
ESTOC 1996
Stable oxygen isotopes
verical line is 0.8 ‰

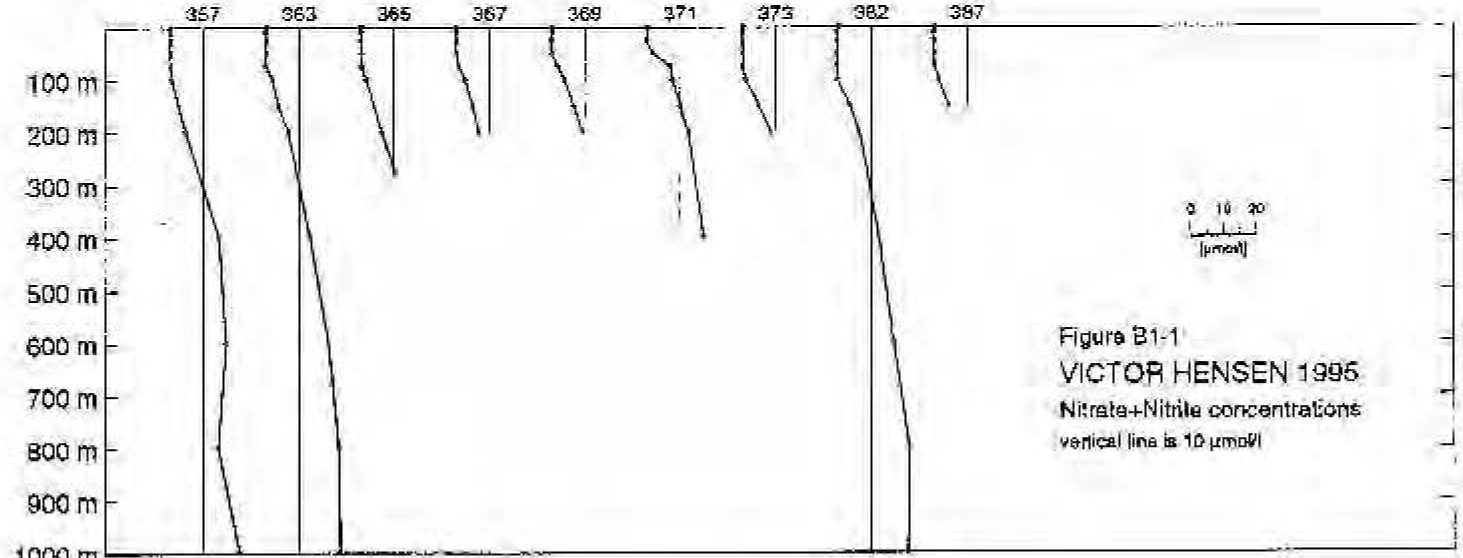


Figure B1-1
VICTOR HENSEN 1995
Nitrate+Nitrite concentrations
vertical line is 10 µmol/l

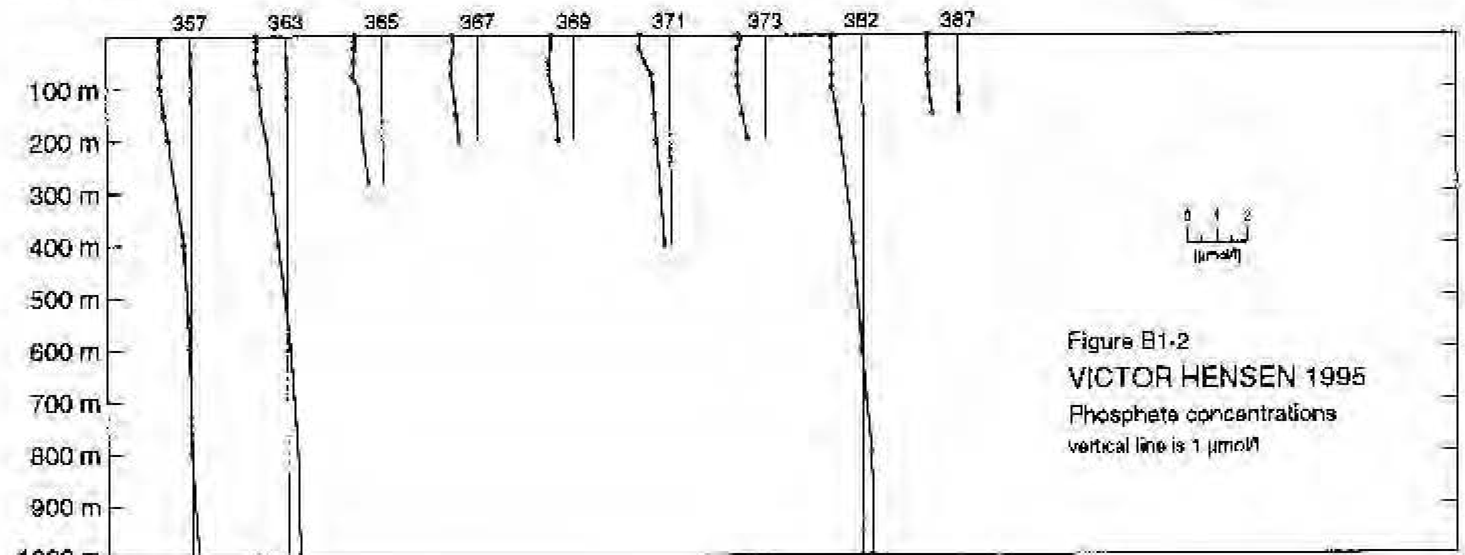


Figure B1-2
VICTOR HENSEN 1995
Phosphate concentrations
vertical line is 1 µmol/l

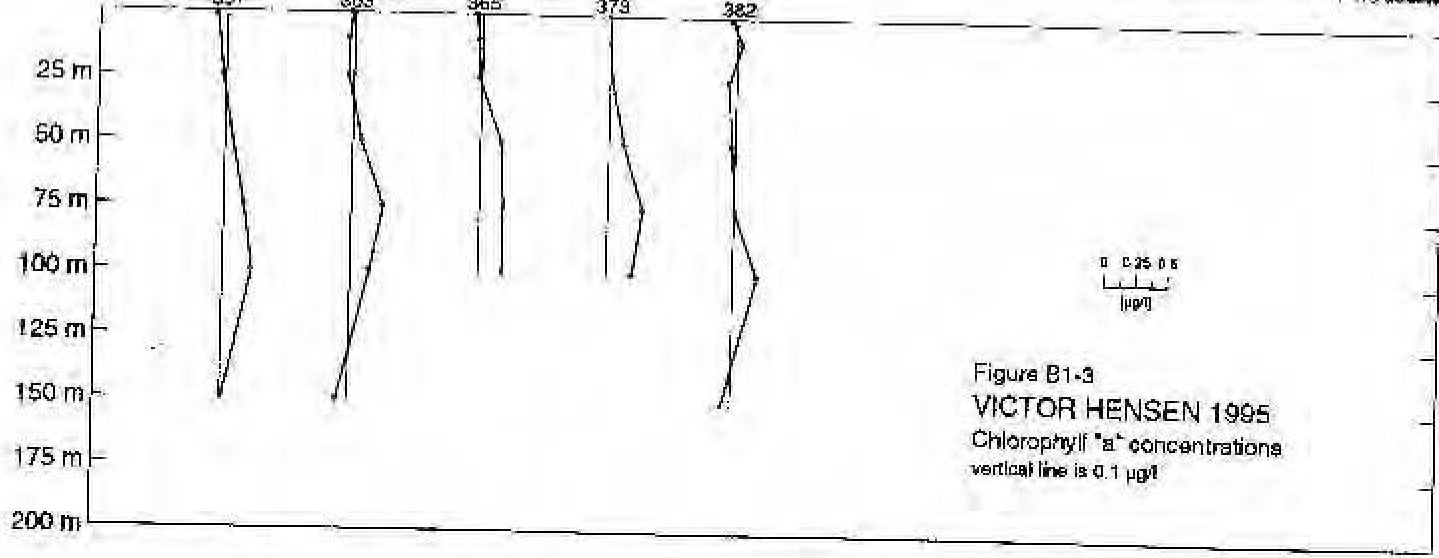


Figure B1-3
VICTOR HENSEN 1995
Chlorophyll "a" concentrations
vertical line is 0.1 µg/l

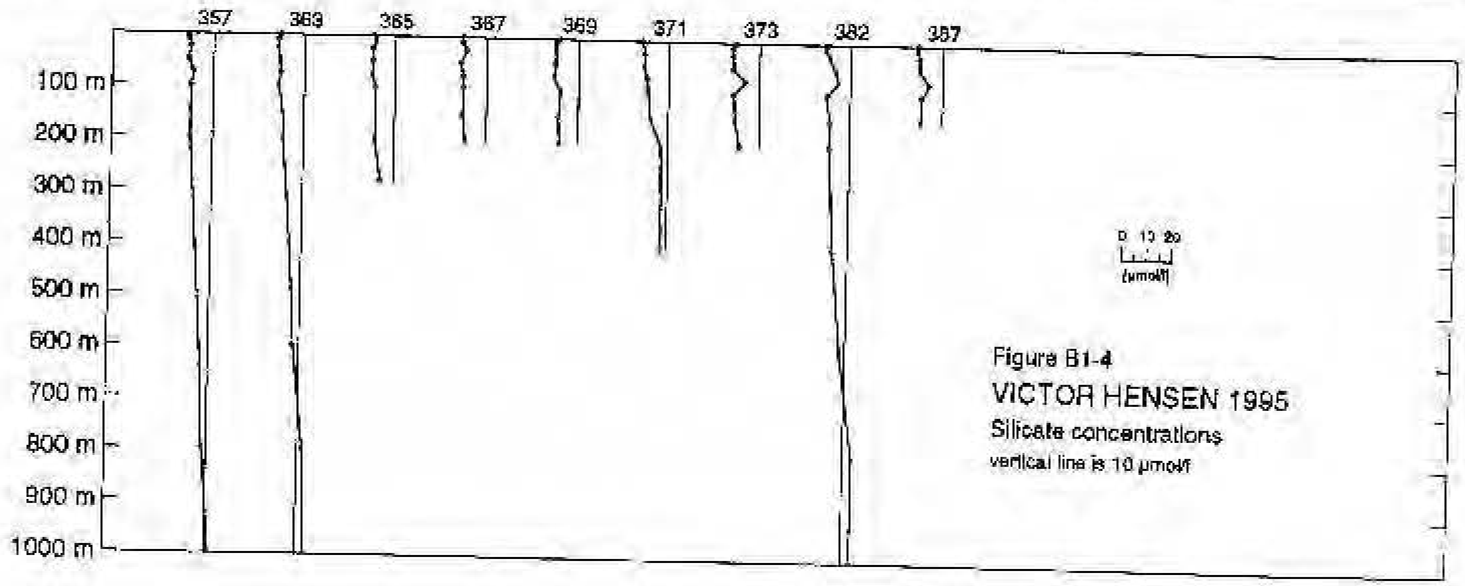
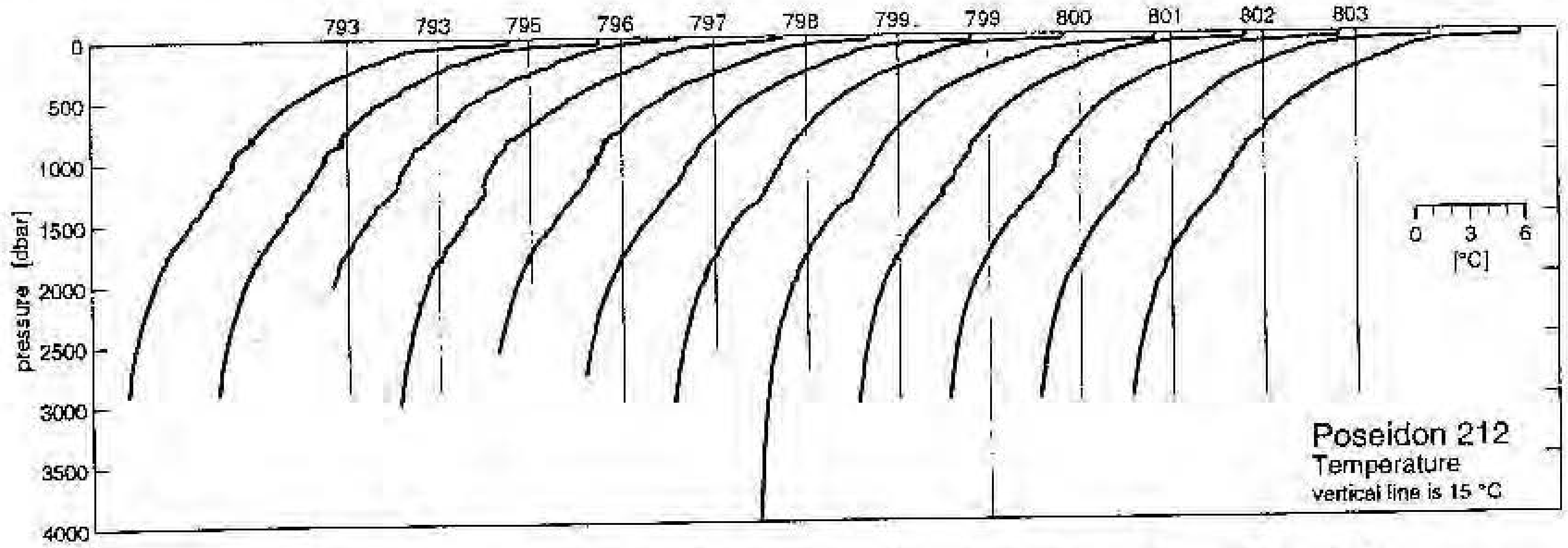
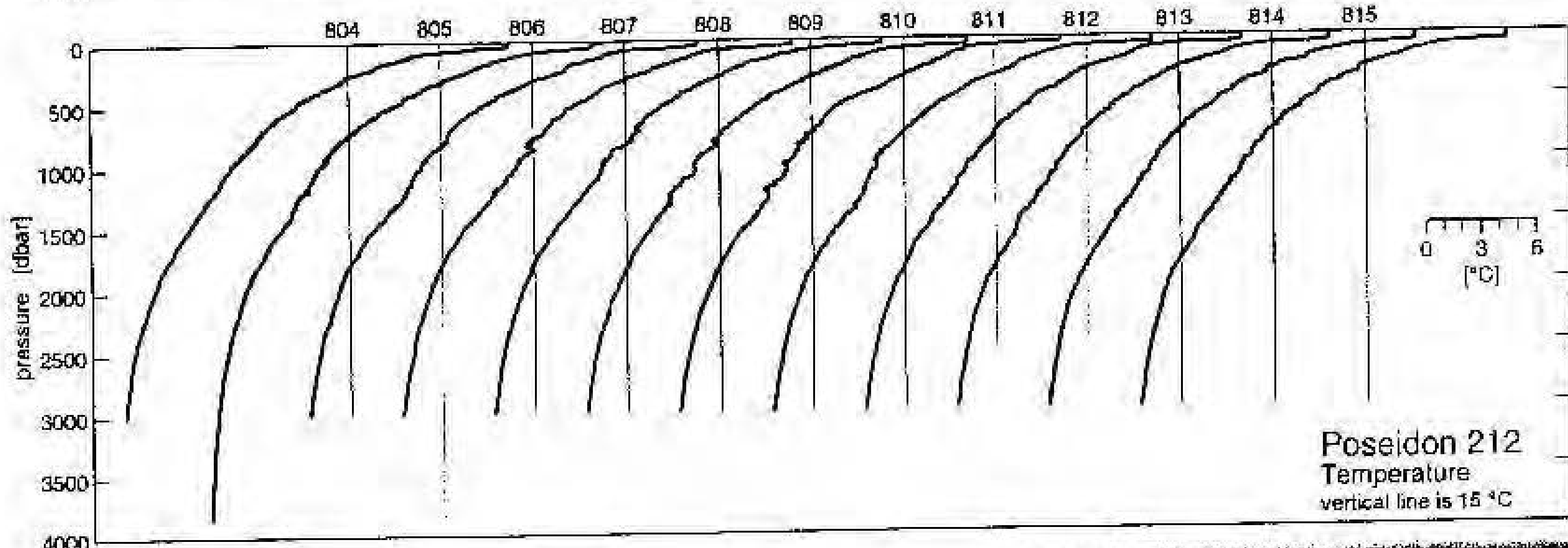
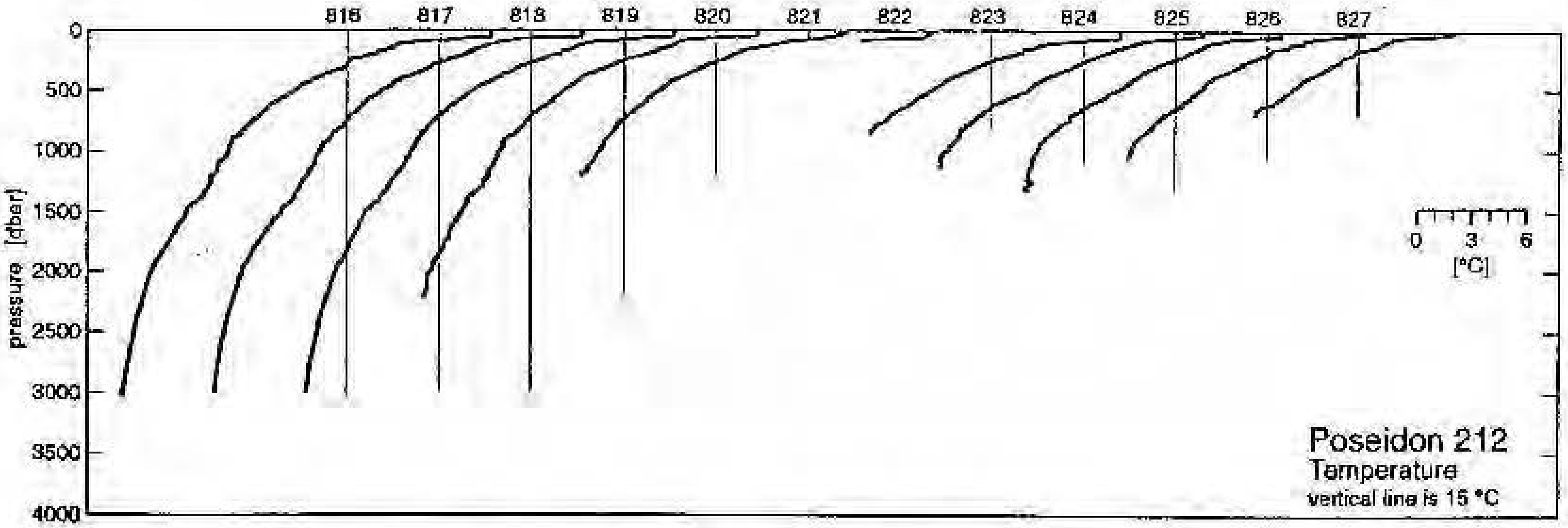
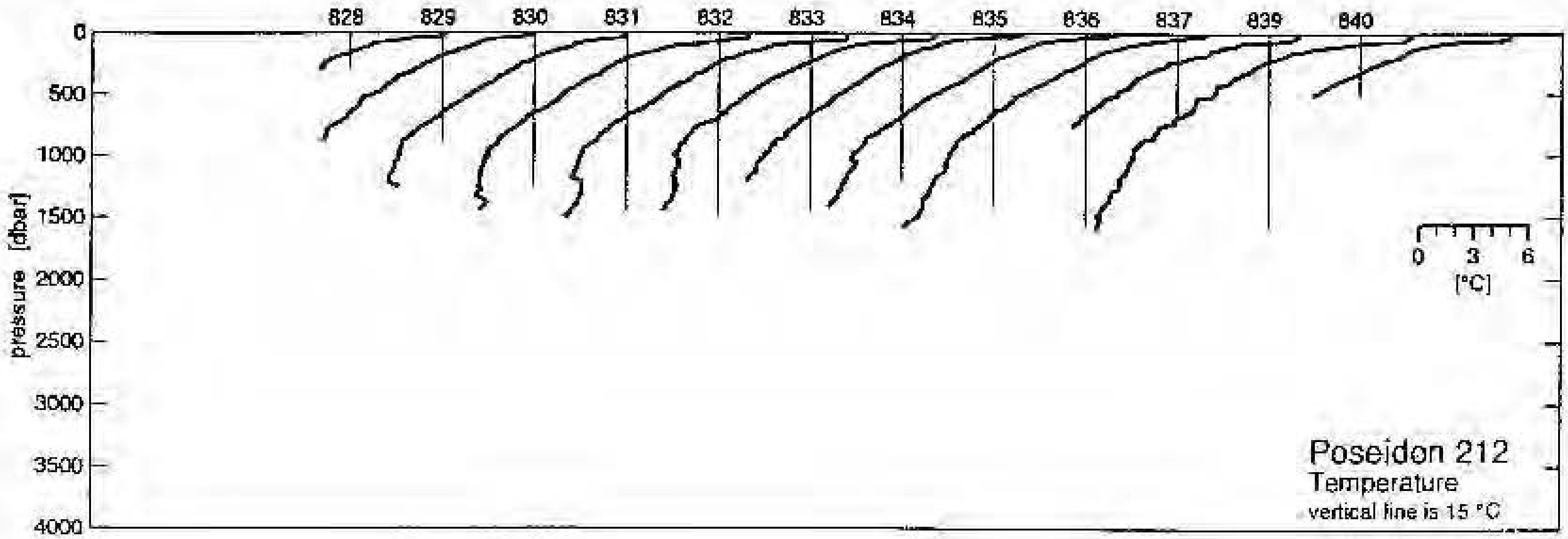


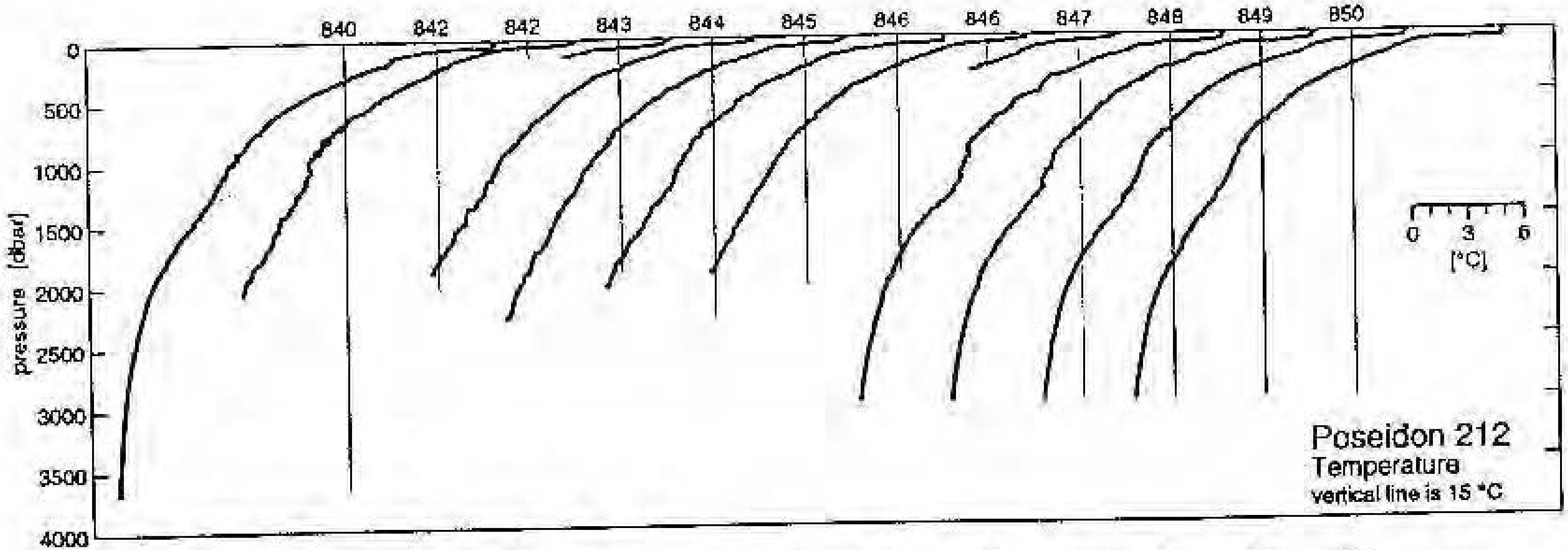
Figure B1-4
VICTOR HENSEN 1995
Silicate concentrations
vertical line is 10 µmol/l

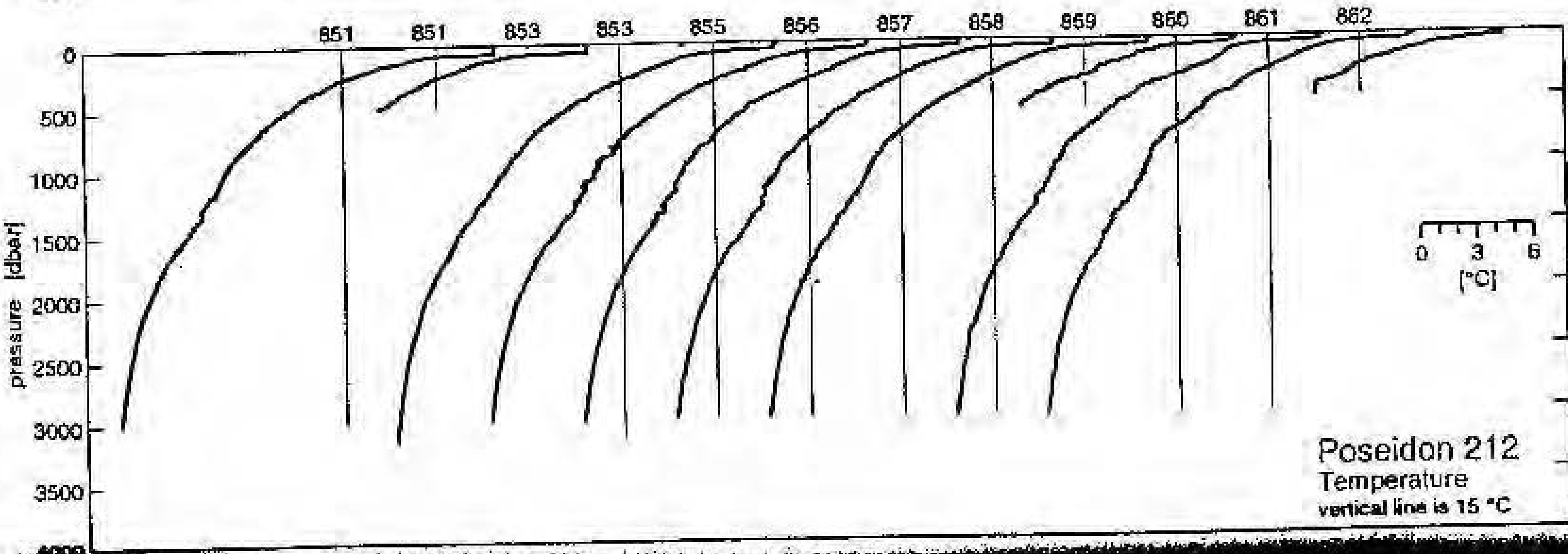

793
793
795
796
797
798
799
799
800
801
802
803
pressure [dbar]
0
500
1000
1500
2000
2500
3000
3500
4000
0 3 6
[°C]
Poseidon 212
Temperature
vertical line is 15 °C

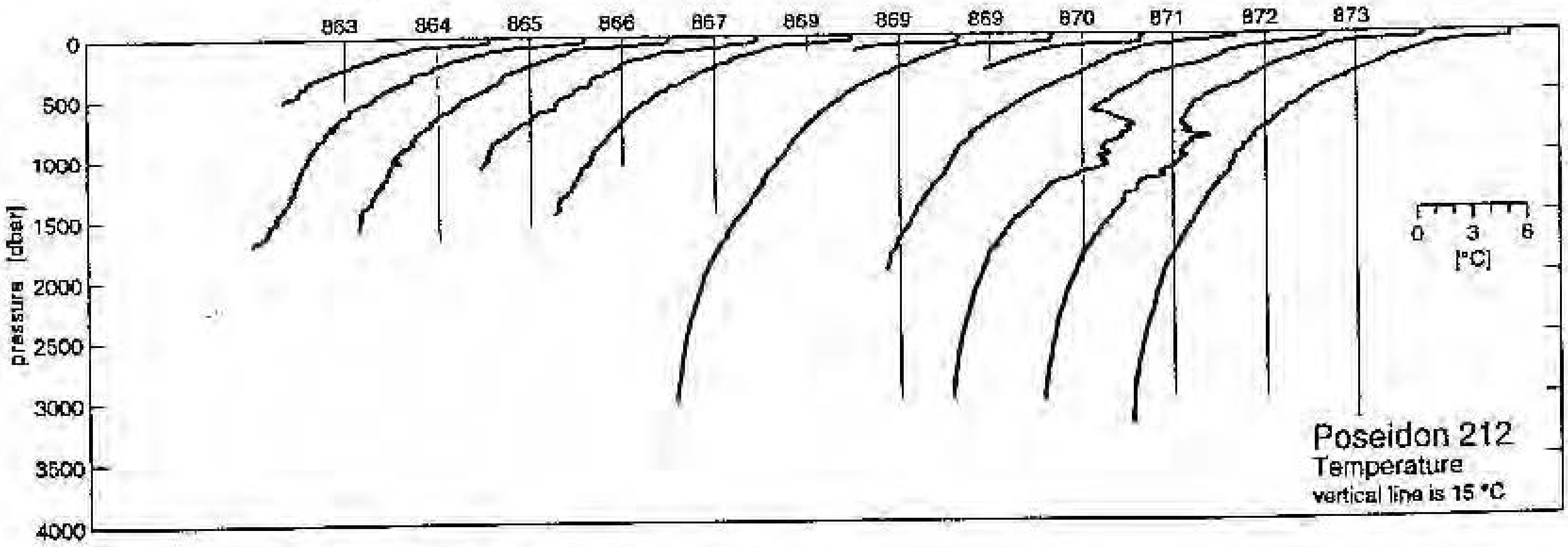

804
805
806
807
808
809
810
811
812
813
814
815
pressure [dbar]
0
500
1000
1500
2000
2500
3000
3500
4000
0 3 6
[°C]
Poseidon 212
Temperature
vertical line is 15 °C

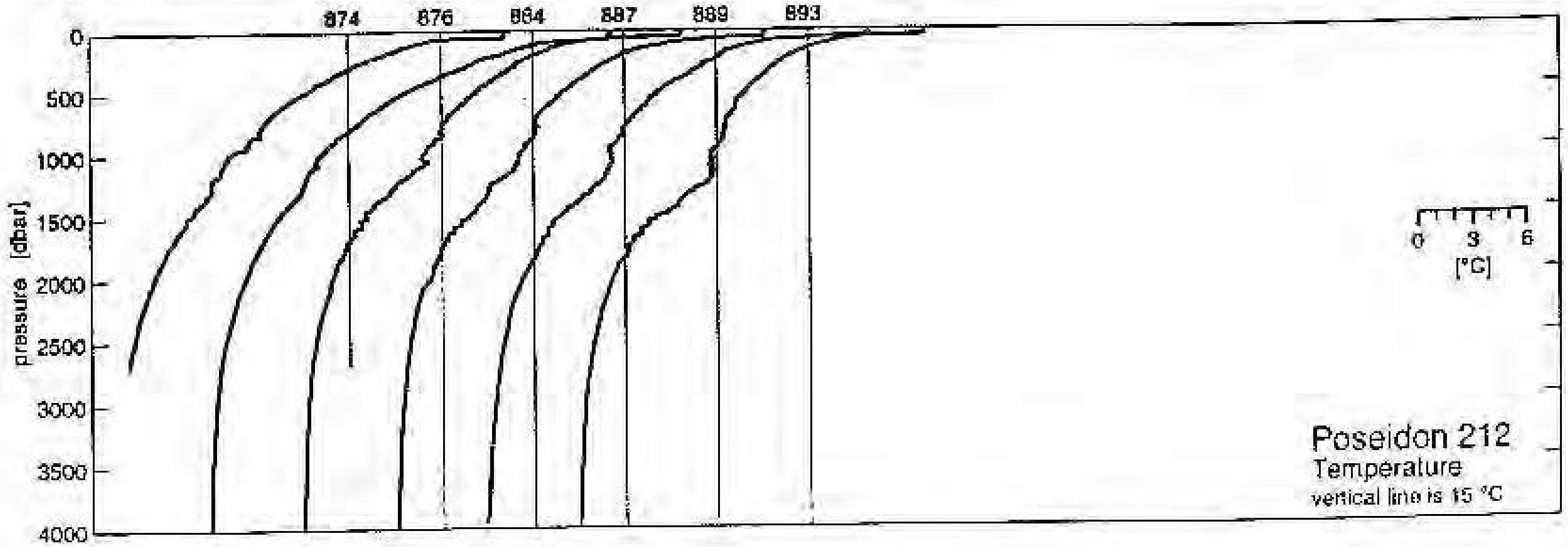

816 817 818 819 820 821 822 823 824 825 826 827
0
500
1000
1500
2000
2500
3000
3500
4000
pressure [dbar]
0 3 6
[°C]
Poseidon 212
Temperature
vertical line is 15 °C

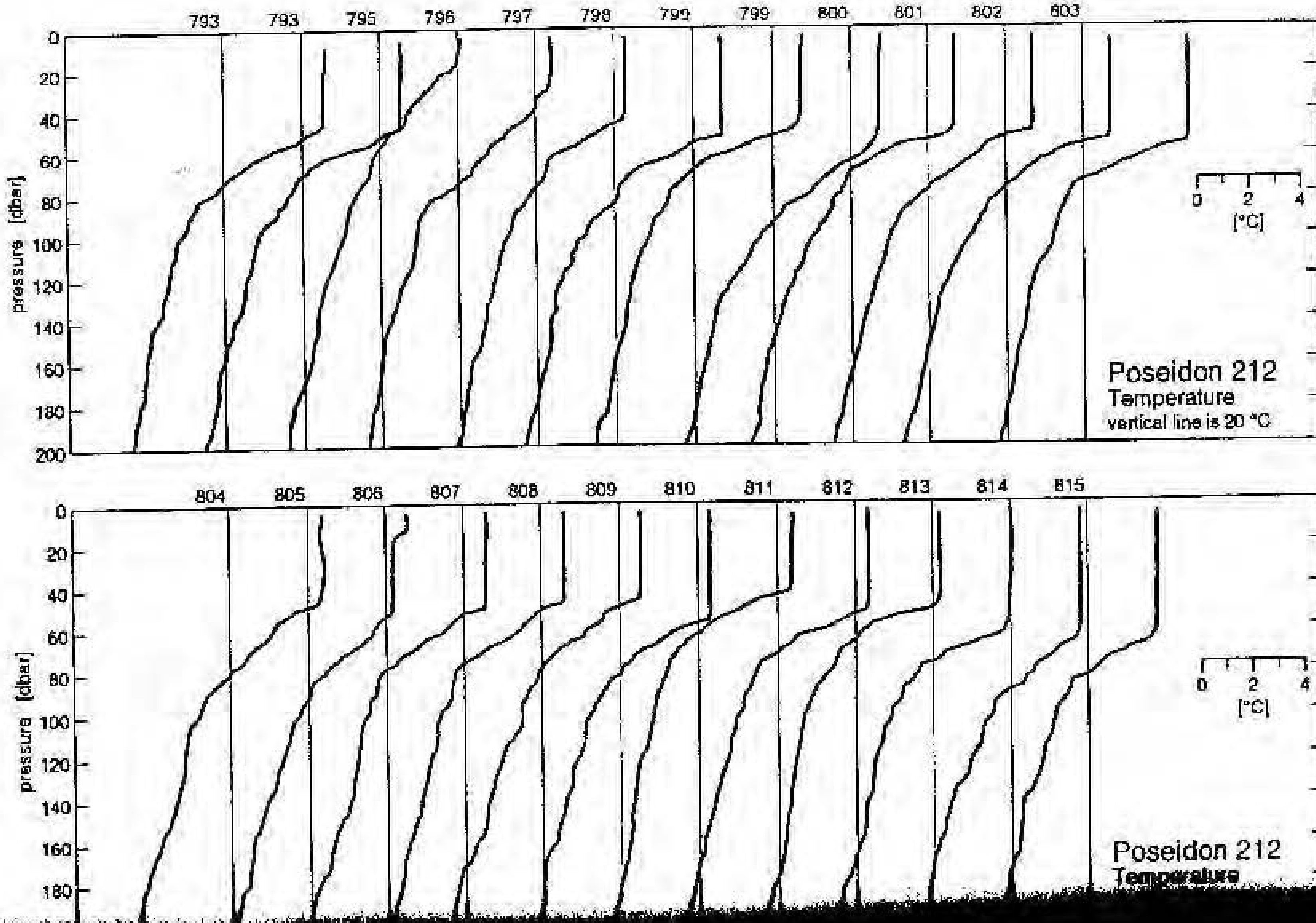

828 829 830 831 832 833 834 835 836 837 839 840
0
500
1000
1500
2000
2500
3000
3500
4000
pressure [dbar]
0 3 6
[°C]
Poseidon 212
Temperature
vertical line is 15 °C

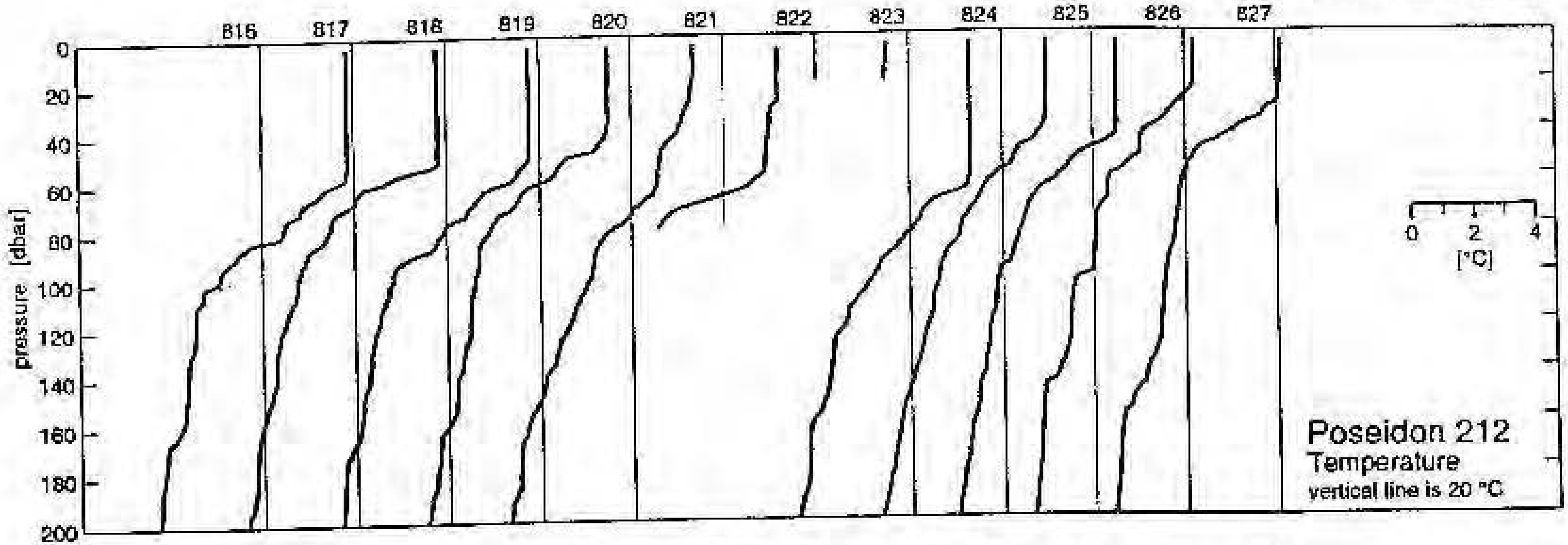

840
842
842
843
844
845
846
846
847
848
849
850
pressure [dbar]
0
500
1000
1500
2000
2500
3000
3500
4000
0 3 6
[°C]
Poseidon 212
Temperature
vertical line is 15 °C

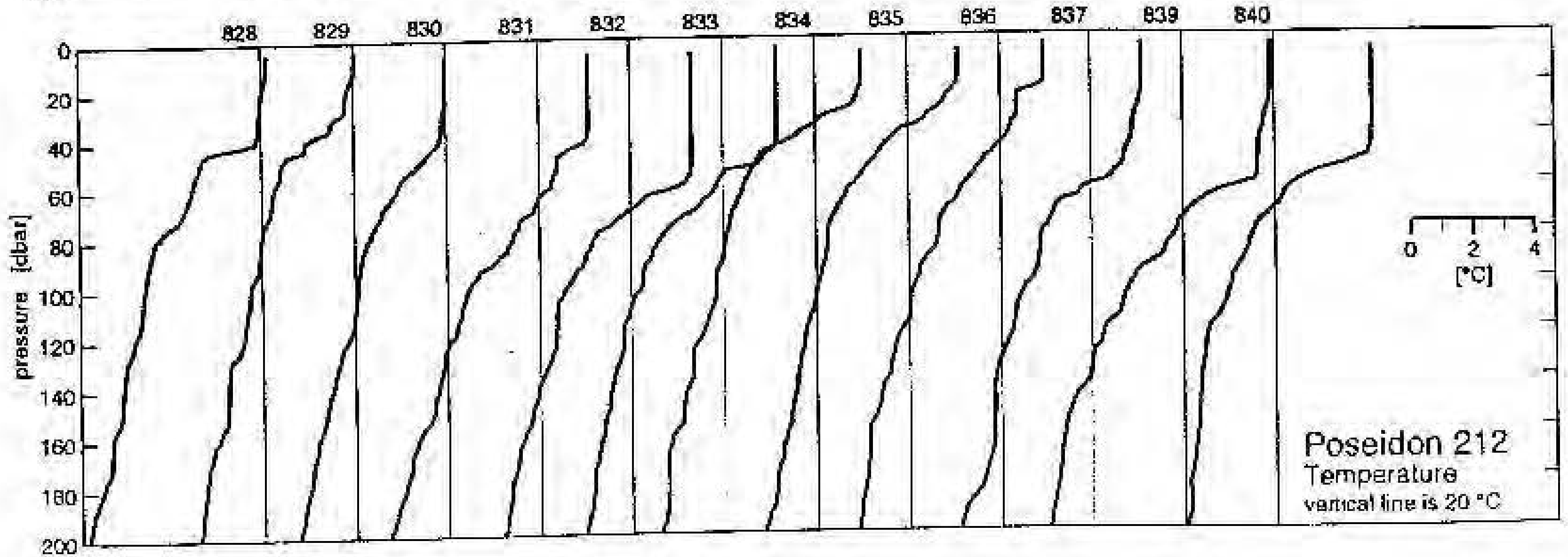

851
851
853
853
855
856
857
858
859
860
861
862
pressure [dbar]
0
500
1000
1500
2000
2500
3000
3500
0 3 6
[°C]
Poseidon 212
Temperature
vertical line is 15 °C

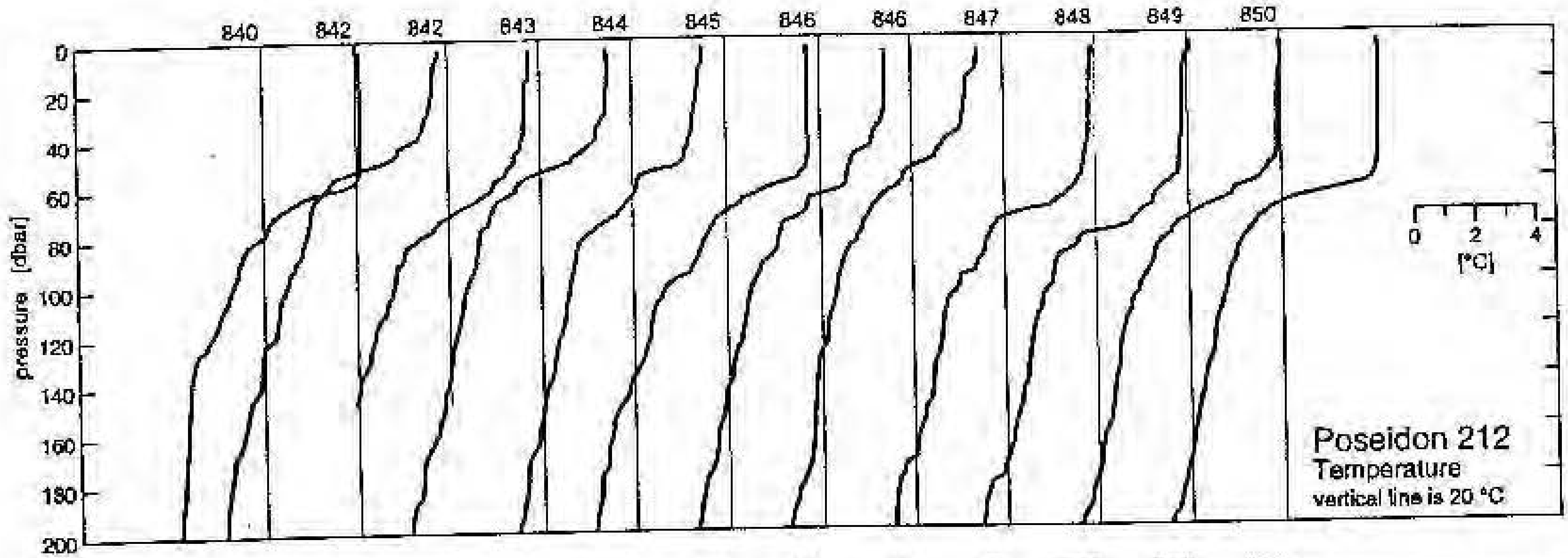

863
864
865
866
867
869
869
869
870
871
872
873
0
500
1000
1500
2000
2500
3000
3500
4000
pressure [dbar]
0 3 6
[°C]
Poseidon 212
Temperature
vertical line is 15 °C

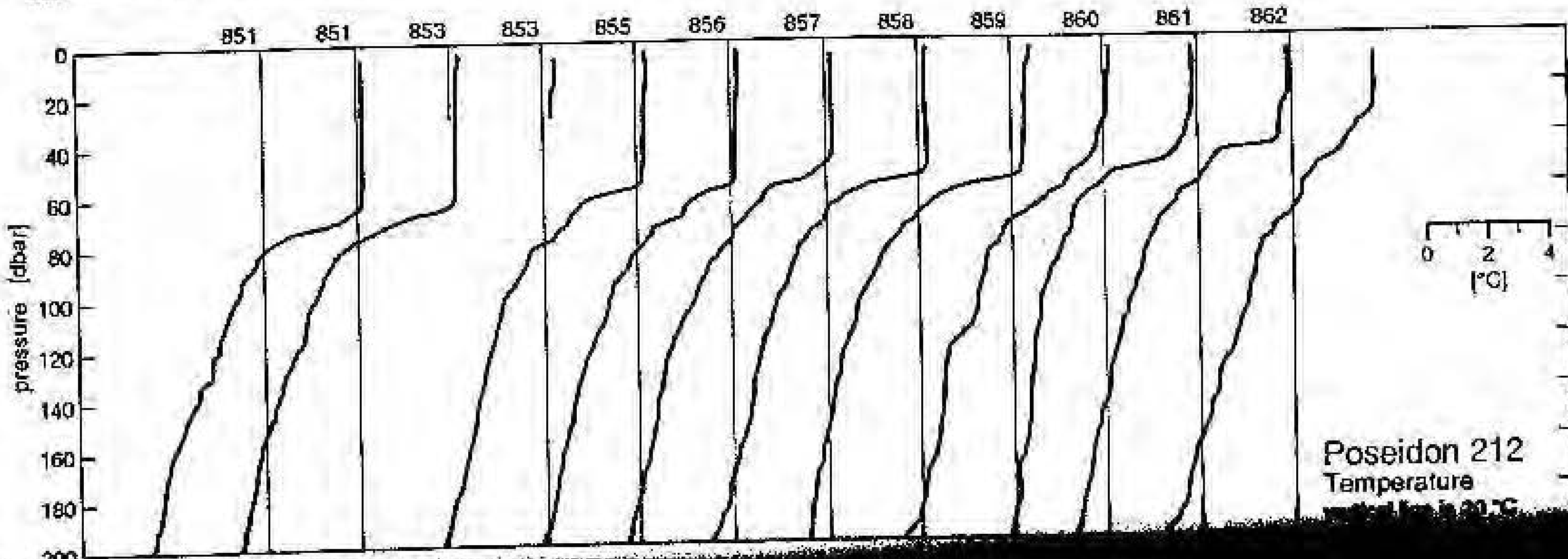

874
876
884
887
889
893
0
500
1000
1500
2000
2500
3000
3500
4000
pressure [dbar]
0 3 6
[°C]
Poseidon 212
Temperature
vertical line is 15 °C

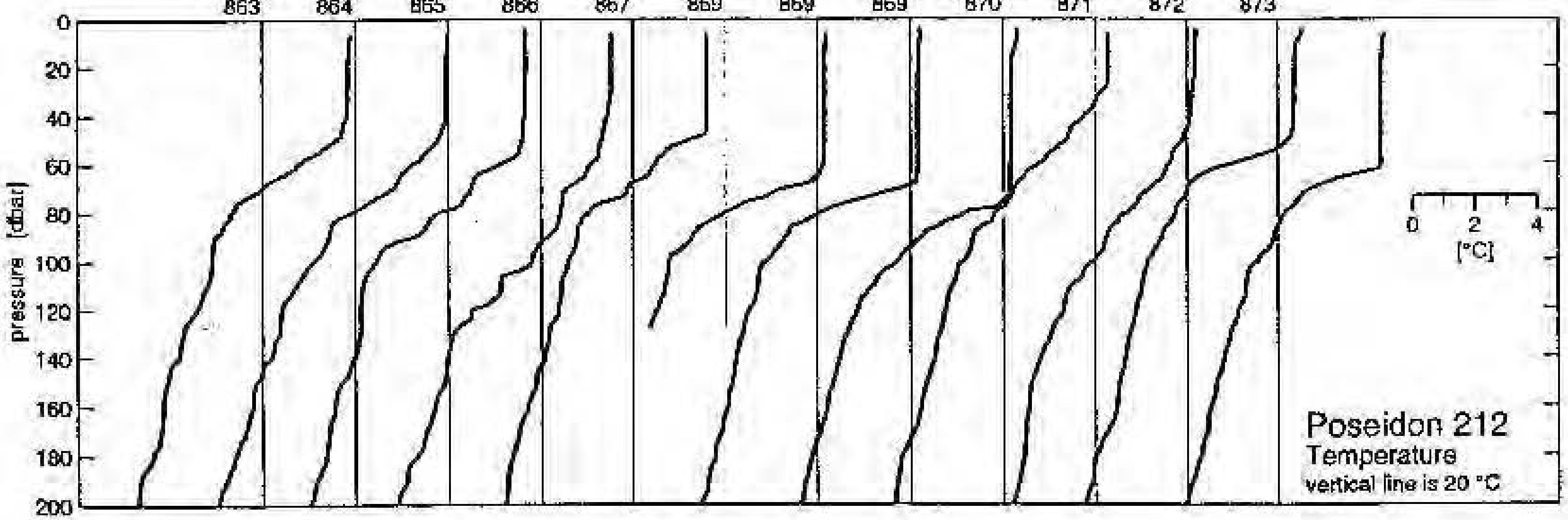

793
793
795
796
797
798
799
799
800
801
802
803
pressure [dbar]
0 2 4
[°C]
Poseidon 212
Temperature
vertical line is 20 °C
804
805
806
807
808
809
810
811
812
813
814
815
pressure [dbar]
0 2 4
[°C]
Poseidon 212
Temperature

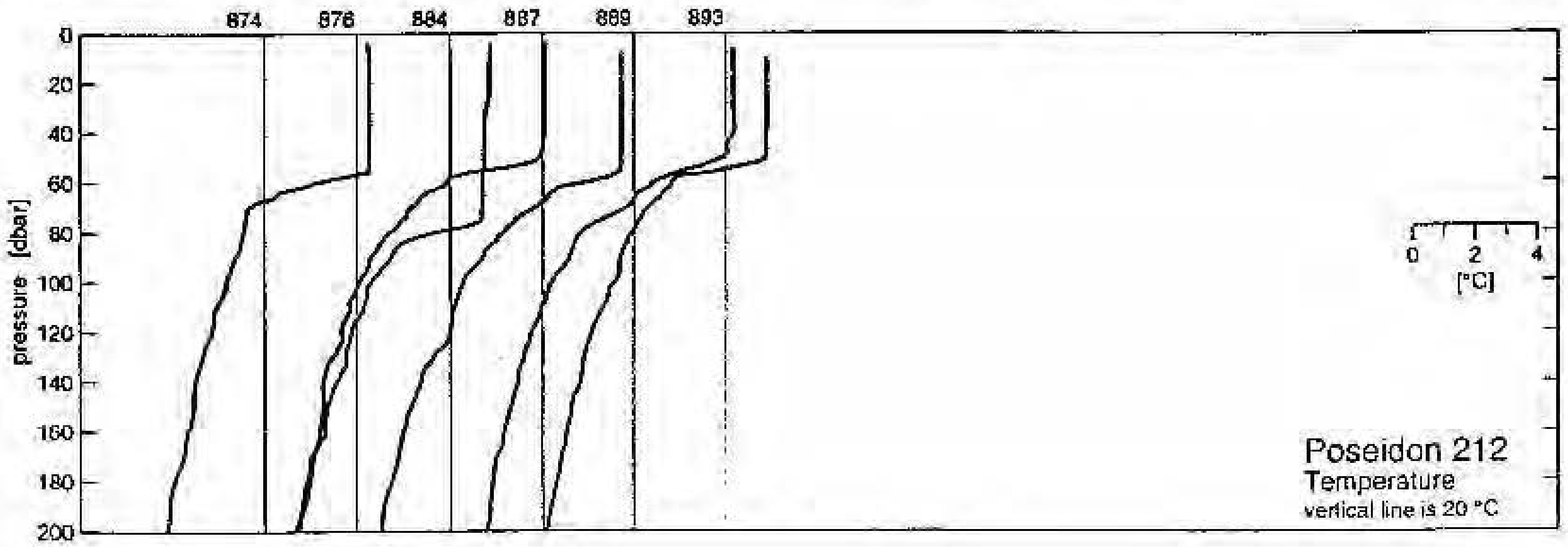

816
817
818
819
820
821
822
823
824
825
826
827
pressure [dbar]
0
20
40
60
80
100
120
140
160
180
200
0 2 4
[°C]
Poseidon 212
Temperature
vertical line is 20 °C

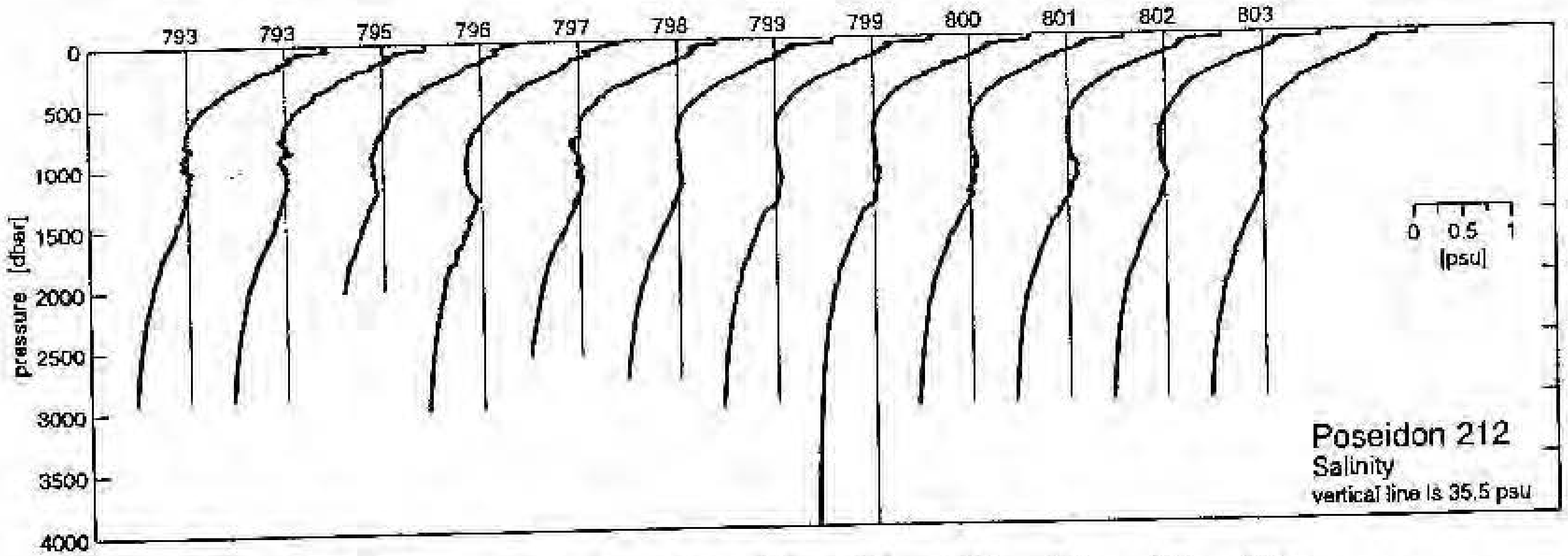

828
829
830
831
832
833
834
835
836
837
839
840
pressure [dbar]
0
20
40
60
80
100
120
140
160
180
200
0 2 4
[°C]
Poseidon 212
Temperature
vertical line is 20 °C

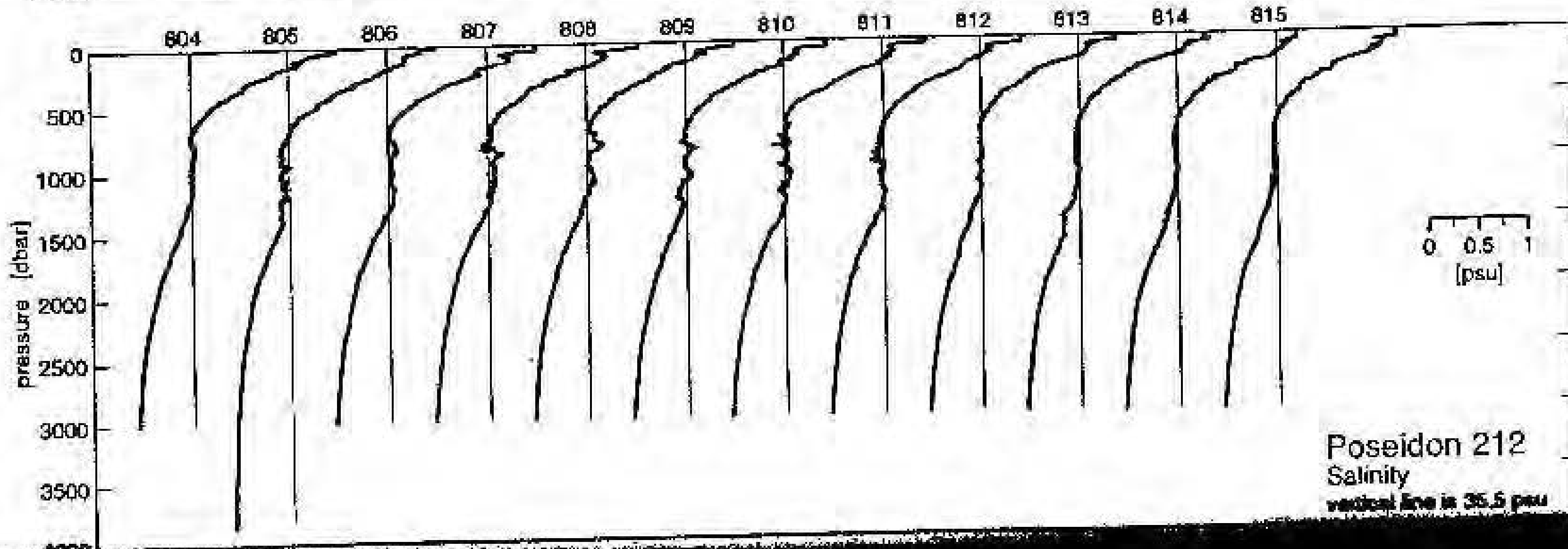

840 842 842 843 844 845 846 846 847 848 849 850
pressure [dbar]
0 20 40 60 80 100 120 140 160 180 200
0 2 4
[°C]
Poseidon 212
Temperature
vertical line is 20 °C

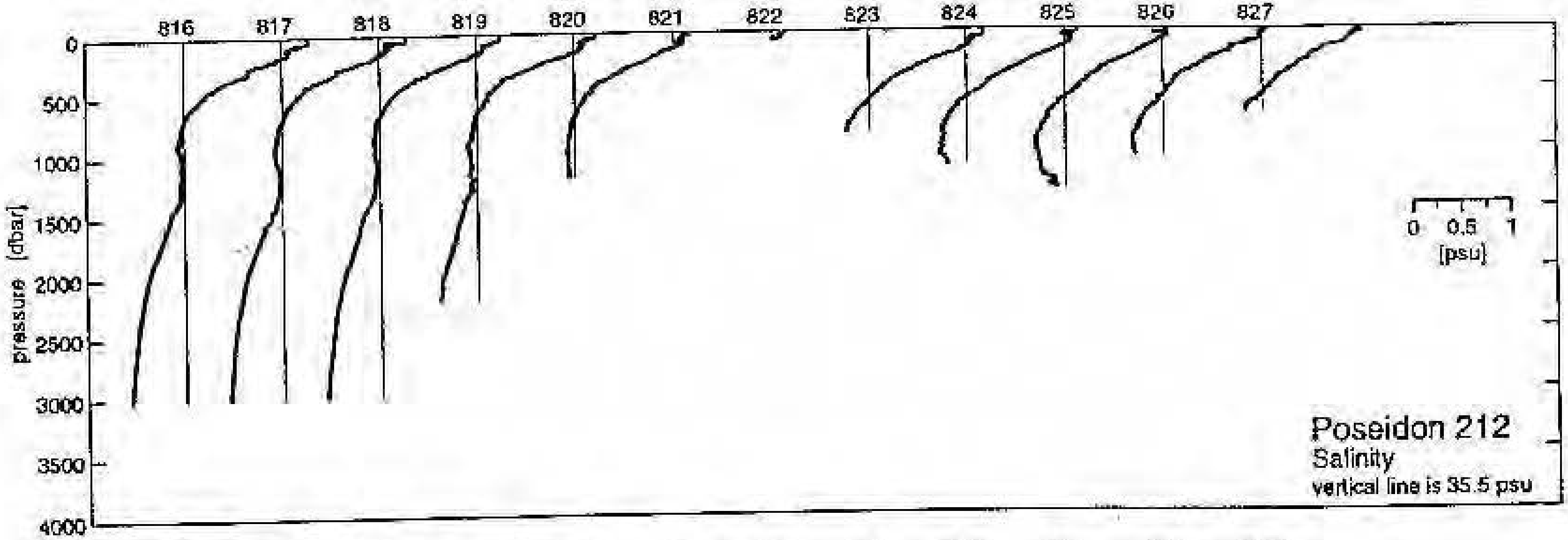

851 851 853 853 855 856 857 858 859 860 861 862
pressure [dbar]
0 20 40 60 80 100 120 140 160 180 200
0 2 4
[°C]
Poseidon 212
Temperature

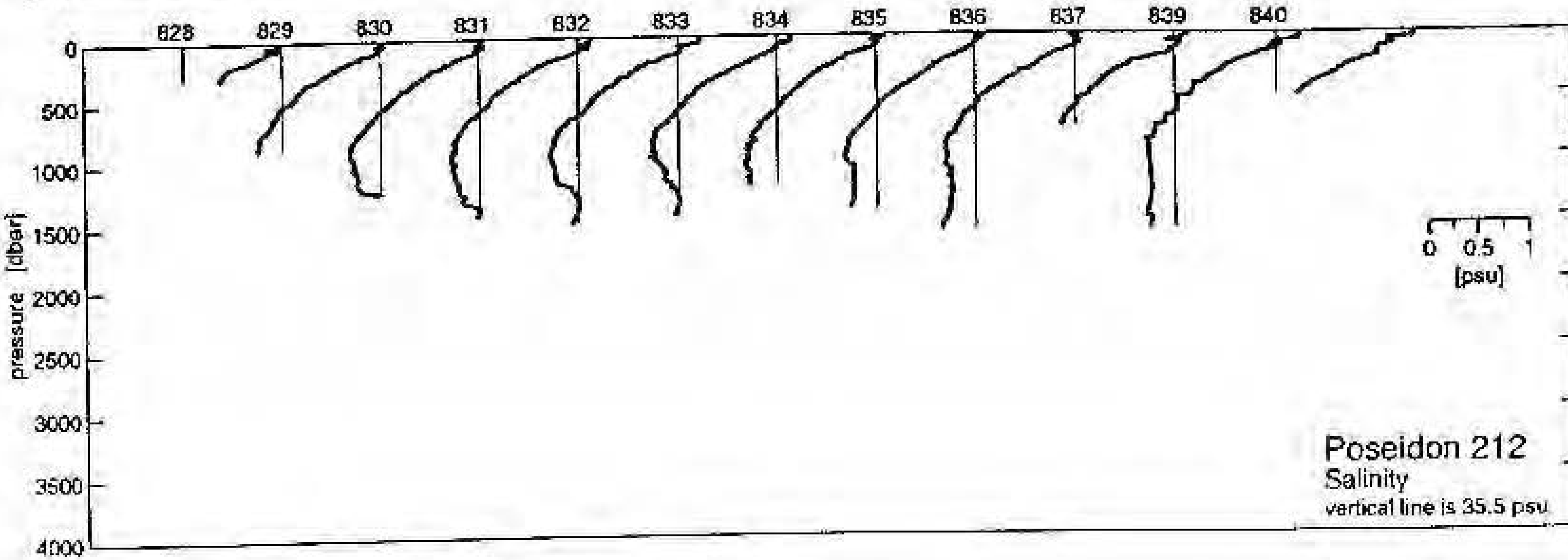

863 864 865 866 867 869 869 869 870 871 872 873
pressure [dbar]
0 20 40 60 80 100 120 140 160 180 200
0 2 4
[°C]
Poseidon 212
Temperature
vertical line is 20 °C

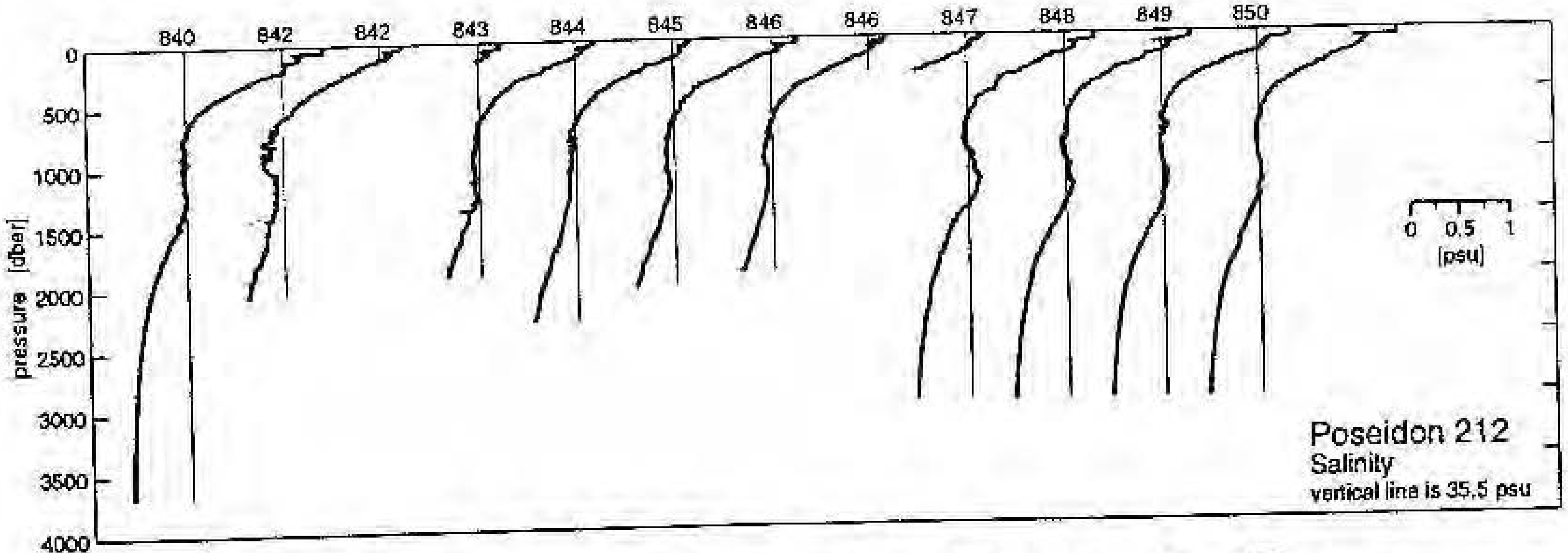

874 876 884 887 889 893
pressure [dbar]
0 20 40 60 80 100 120 140 160 180 200
0 2 4
[°C]
Poseidon 212
Temperature
vertical line is 20 °C

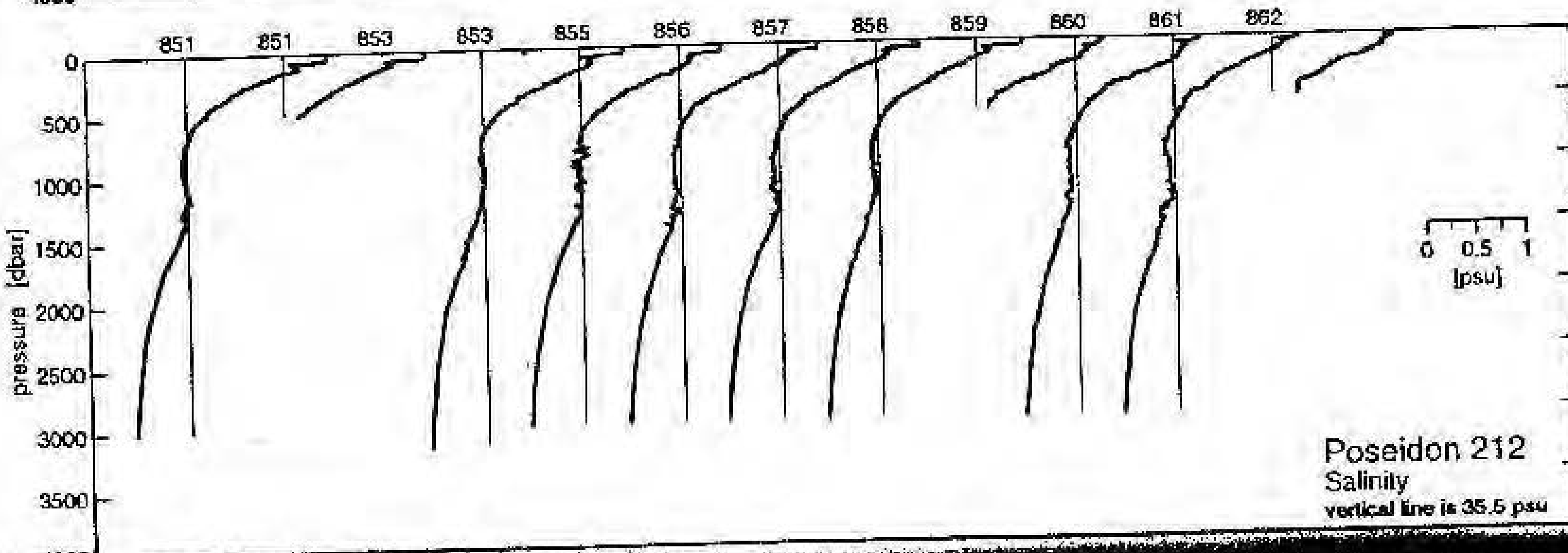

793
793
795
796
797
798
799
799
800
801
802
803
pressure [dbar]
0
500
1000
1500
2000
2500
3000
3500
4000
0 0.5 1
[psu]
Poseidon 212
Salinity
vertical line is 35.5 psu

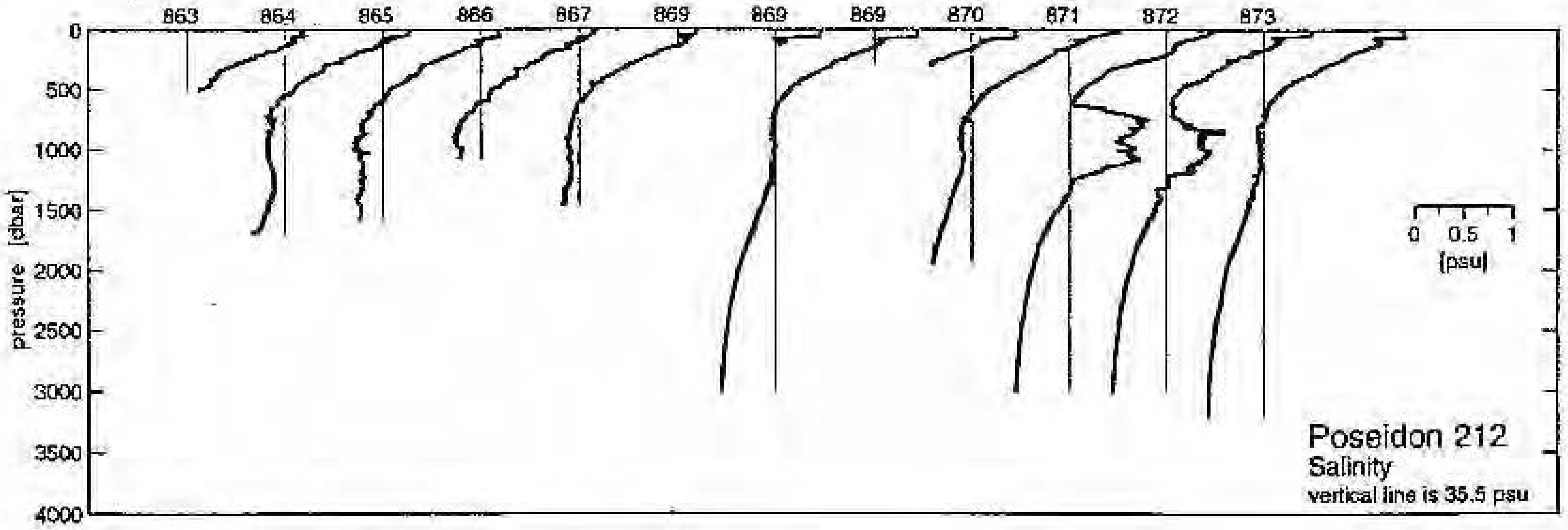

804
805
806
807
808
809
810
811
812
813
814
815
pressure [dbar]
0
500
1000
1500
2000
2500
3000
3500
0 0.5 1
[psu]
Poseidon 212
Salinity
vertical line is 35.5 psu

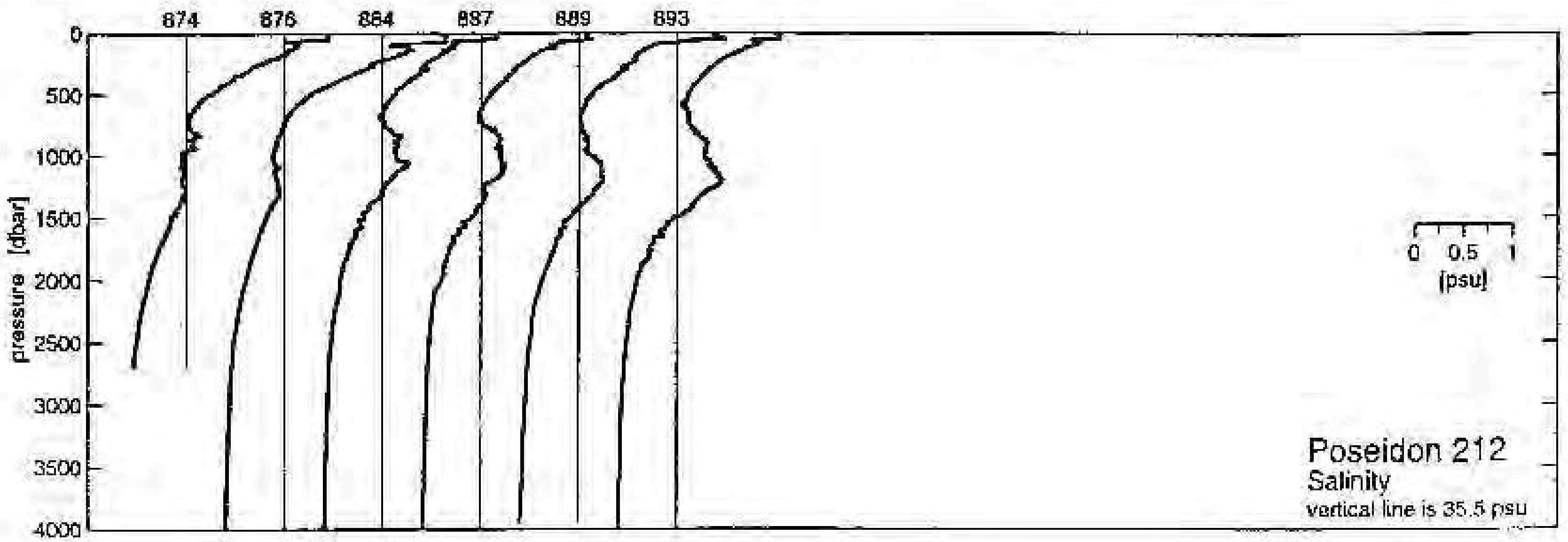

816 817 818 819 820 821 822 823 824 825 826 827
0
500
1000
1500
2000
2500
3000
3500
4000
pressure [dbar]
0 0.5 1
[psu]
Poseidon 212
Salinity
vertical line is 35.5 psu

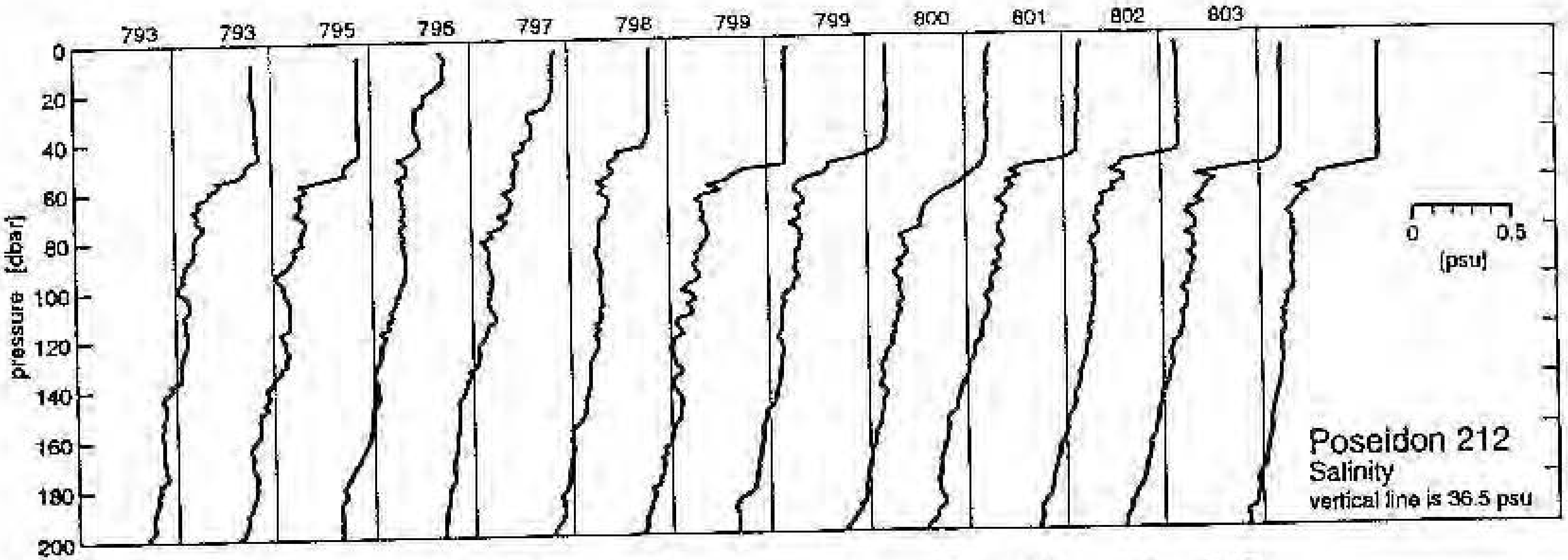

828 829 830 831 832 833 834 835 836 837 839 840
0
500
1000
1500
2000
2500
3000
3500
4000
pressure [dbar]
0 0.5 1
[psu]
Poseidon 212
Salinity
vertical line is 35.5 psu

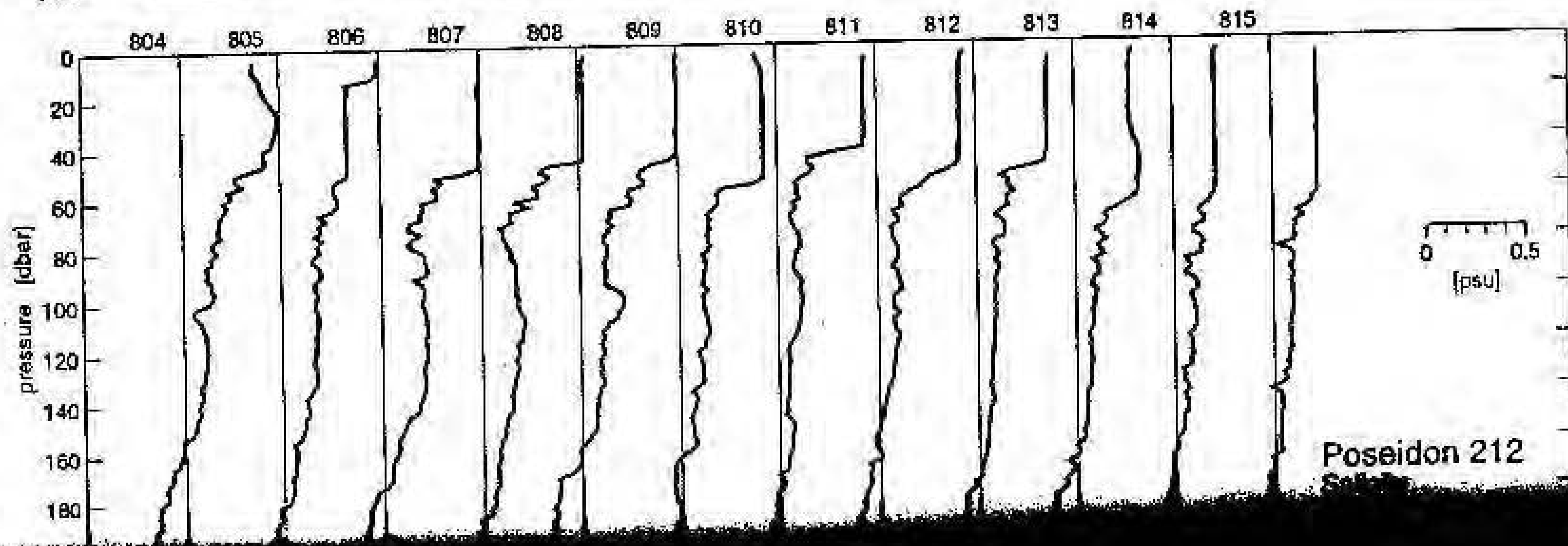

840 842 842 843 844 845 846 846 847 848 849 850
pressure [dbar]
0
500
1000
1500
2000
2500
3000
3500
4000
0 0.5 1
[psu]
Poseidon 212
Salinity
vertical line is 35.5 psu

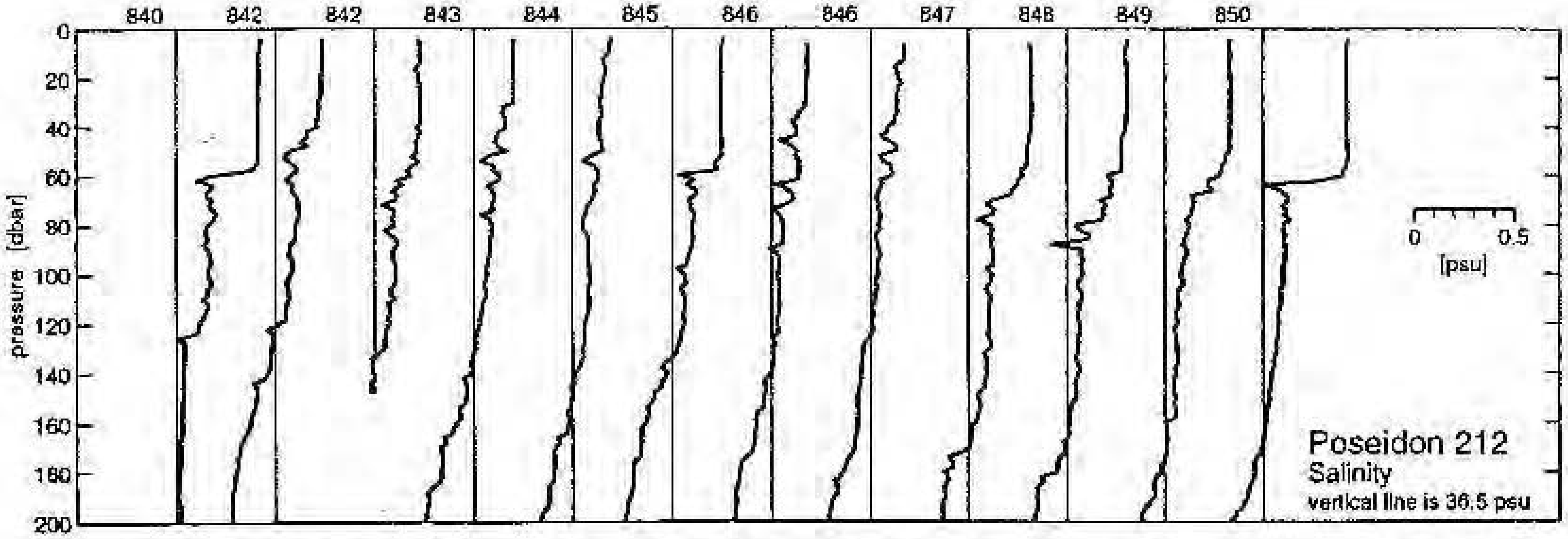

851 851 853 853 855 856 857 858 859 860 861 862
pressure [dbar]
0
500
1000
1500
2000
2500
3000
3500
0 0.5 1
[psu]
Poseidon 212
Salinity
vertical line is 35.5 psu

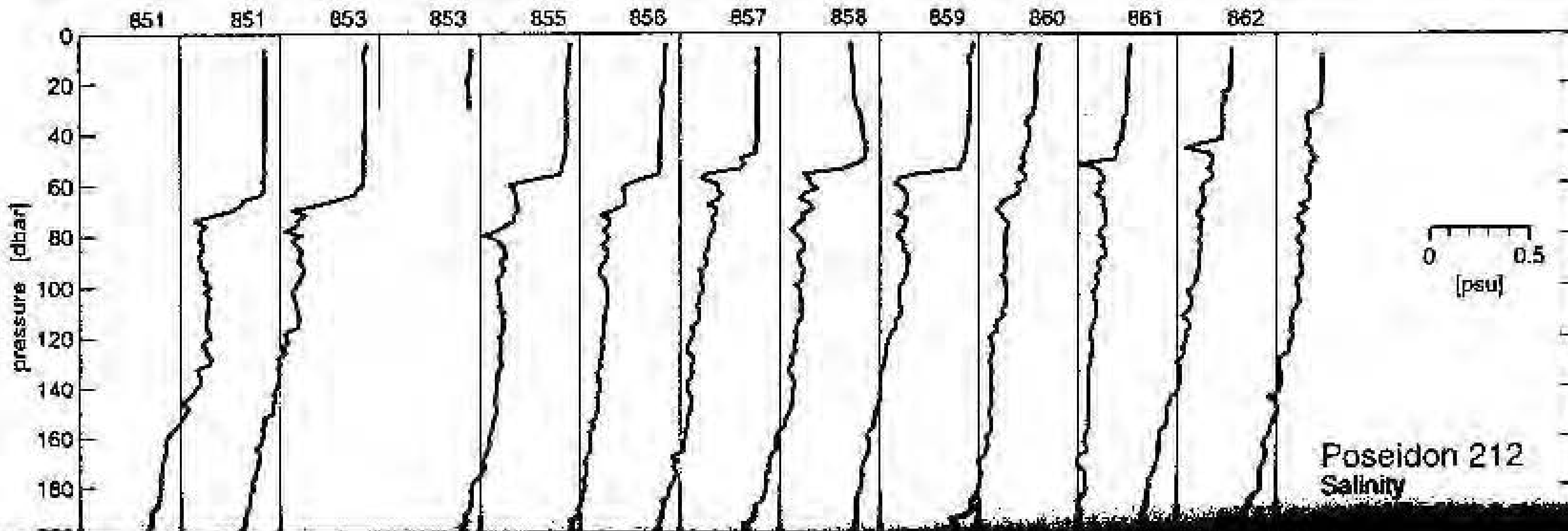

863
864
865
866
867
869
869
869
870
871
872
873
0
500
1000
1500
2000
2500
3000
3500
4000
pressure [dbar]
0 0.5 1
[psu]
Poseidon 212
Salinity
vertical line is 35.5 psu

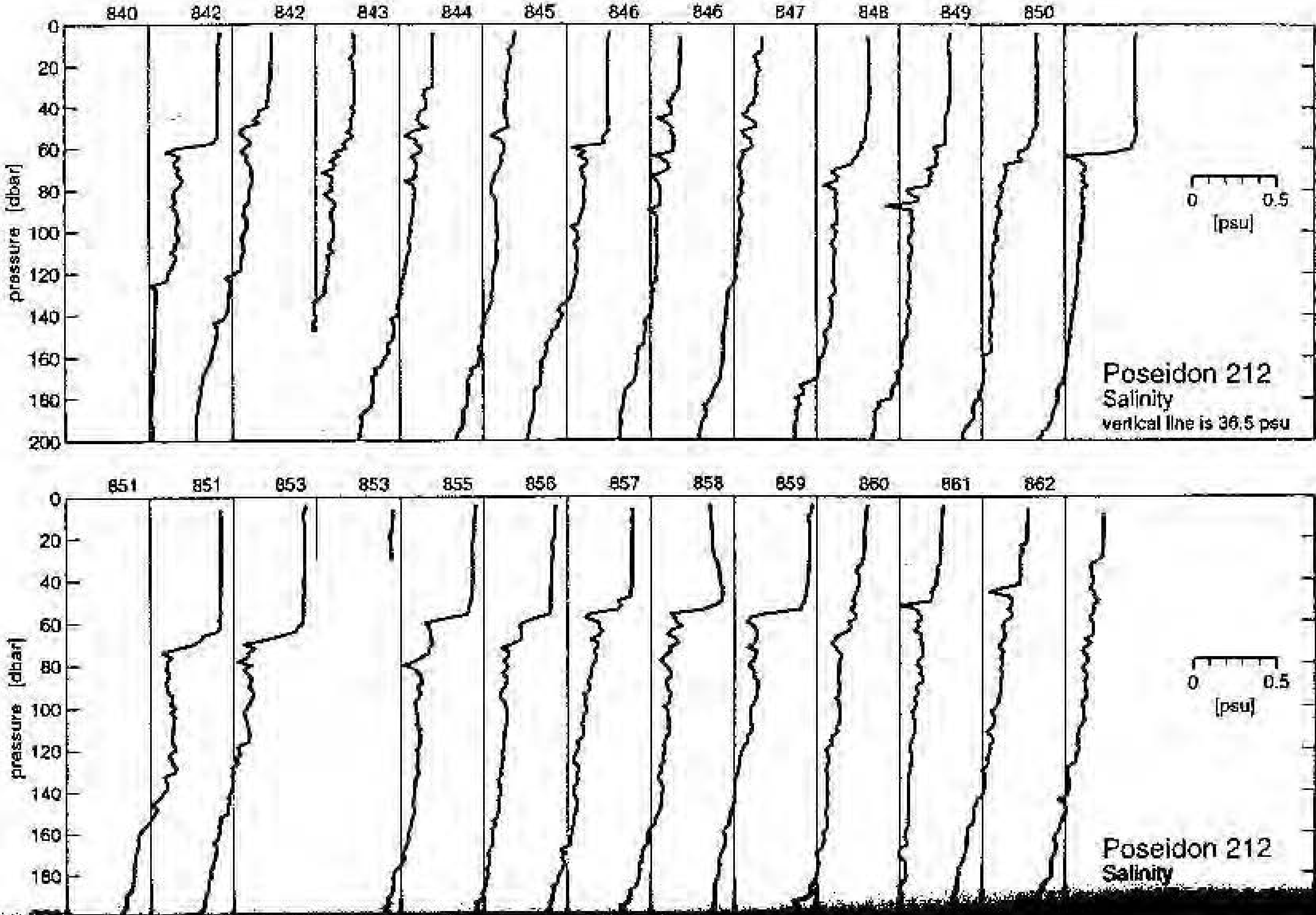

874
876
884
887
889
893
0
500
1000
1500
2000
2500
3000
3500
4000
pressure [dbar]
0 0.5 1
[psu]
Poseidon 212
Salinity
vertical line is 35.5 psu

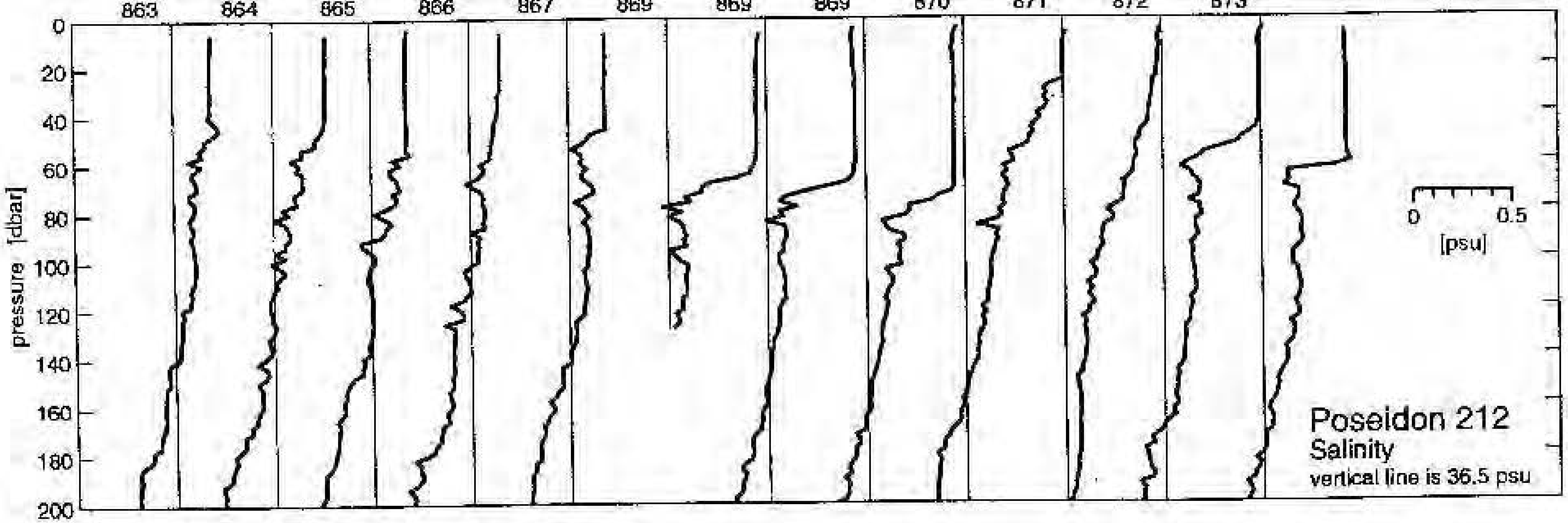

793
793
795
796
797
798
799
799
800
801
802
803
0
20
40
60
80
100
120
140
160
180
200
pressure [dbar]
0
0.5
[psu]
Poseidon 212
Salinity
vertical line is 36.5 psu

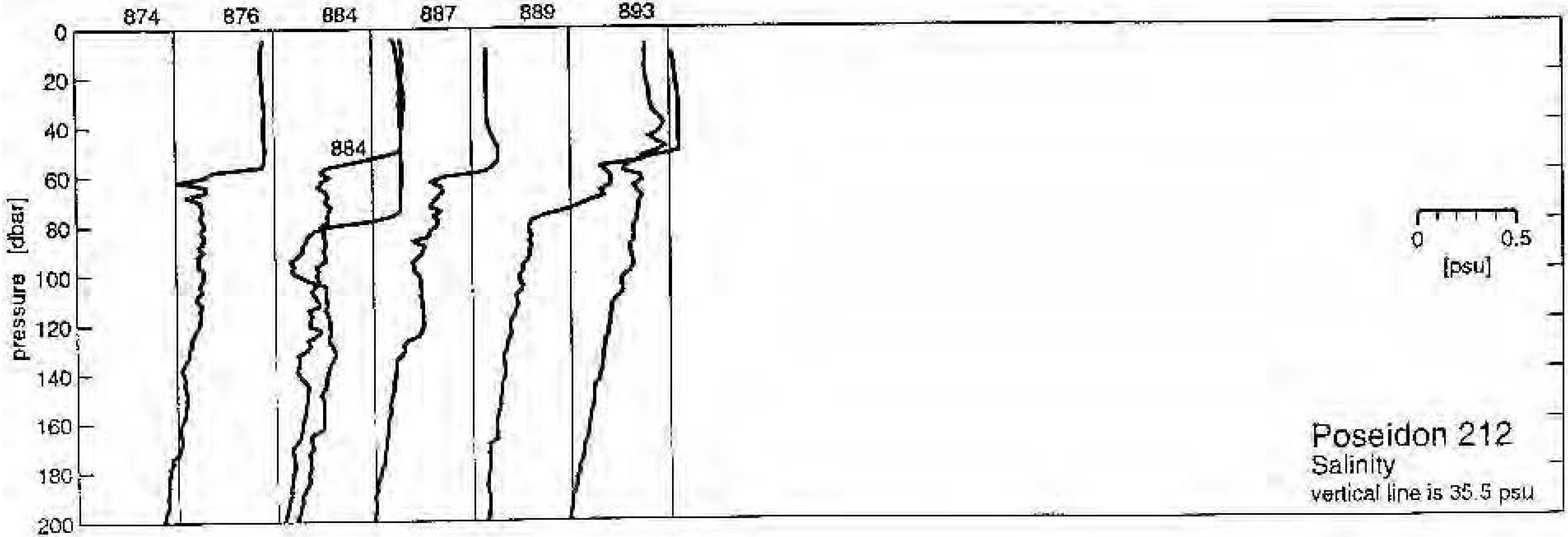

804
805
806
807
808
809
810
811
812
813
814
815
0
20
40
60
80
100
120
140
160
180
pressure [dbar]
0
0.5
[psu]
Poseidon 212

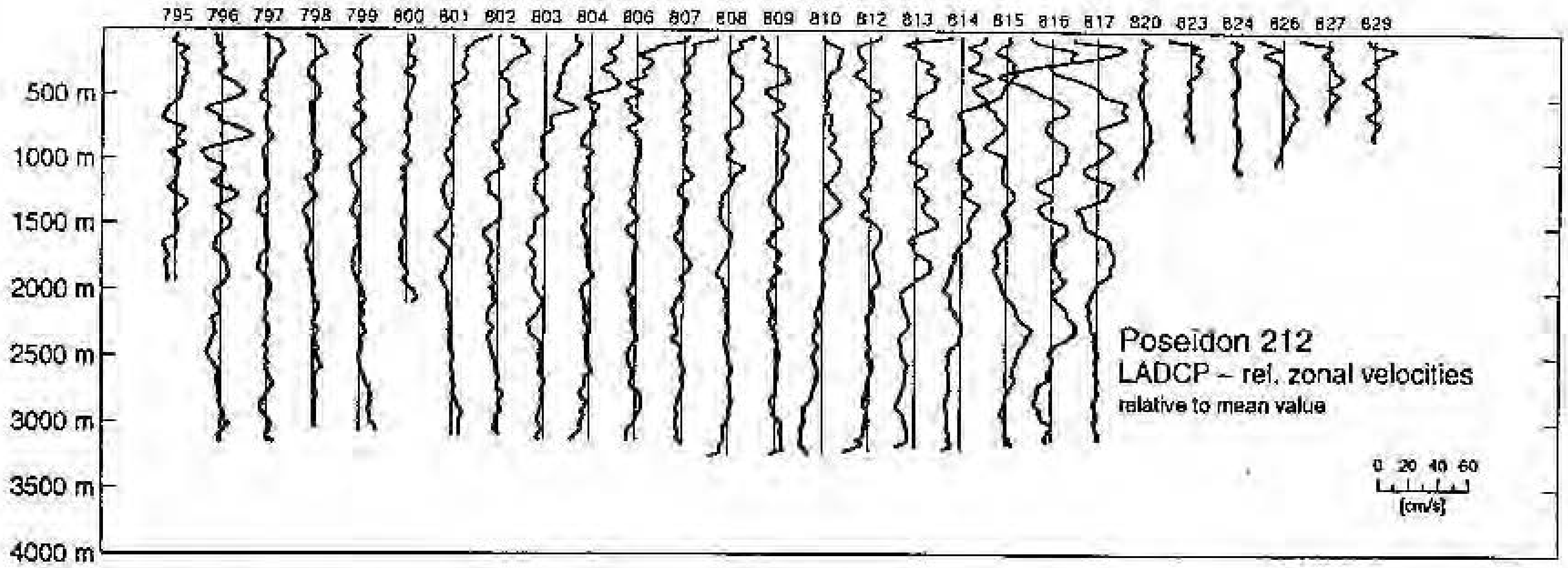

840 842 842 843 844 845 846 846 847 848 849 850
pressure [dbar]
0
[psu]
0.5
Poseidon 212
Salinity
vertical line is 36.5 psu

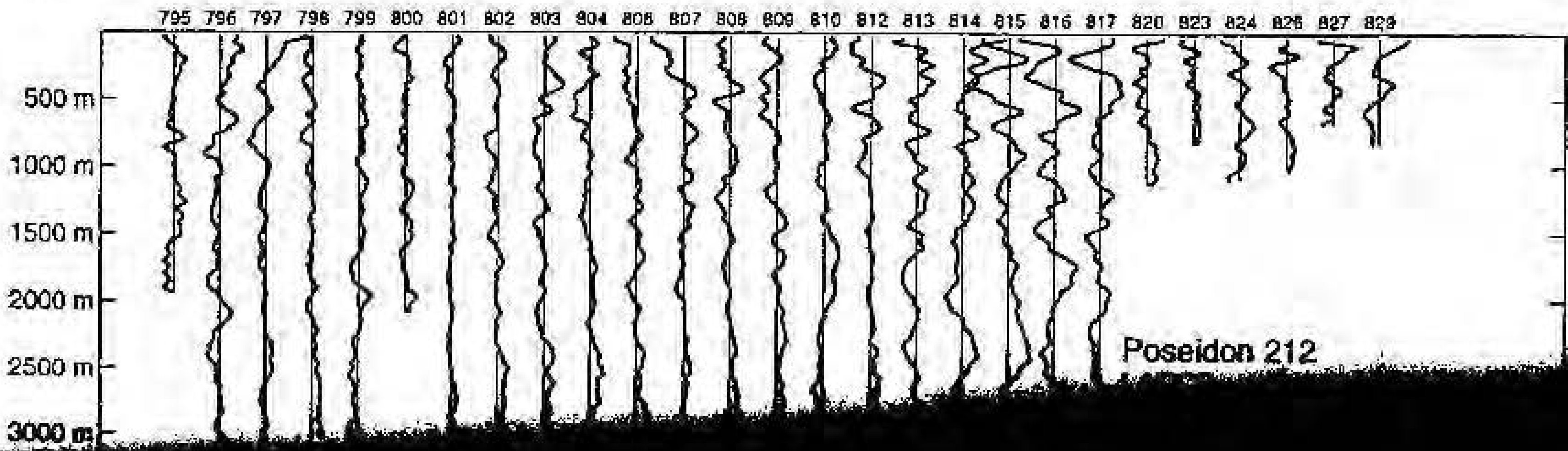

851 851 853 853 855 856 857 858 859 860 861 862
pressure [dbar]
0
[psu]
0.5
Poseidon 212
Salinity

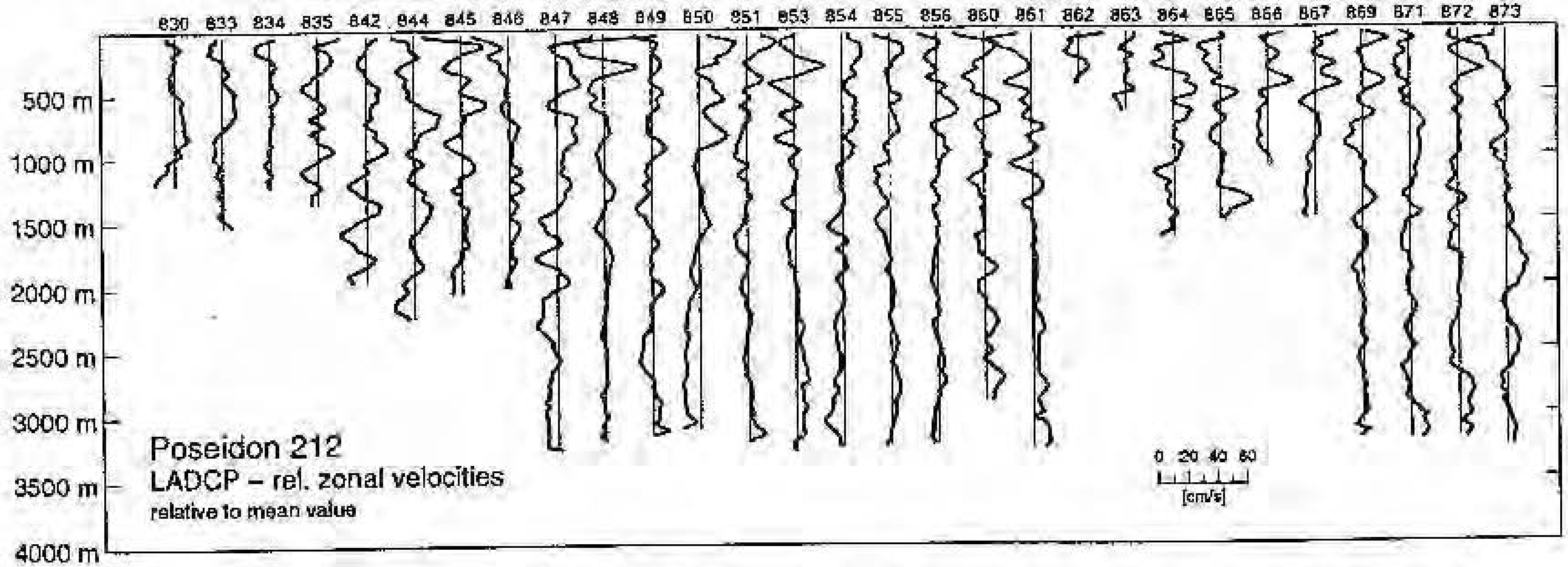

840
842
842
843
844
845
846
846
847
848
849
850
pressure [dbar]
0
20
40
60
80
100
120
140
160
180
200
0
0.5
[psu]
Poseidon 212
Salinity
vertical line is 36.5 psu
851
851
853
853
855
856
857
858
859
860
861
862
pressure [dbar]
0
0.5
[psu]
Poseidon 212
Salinity

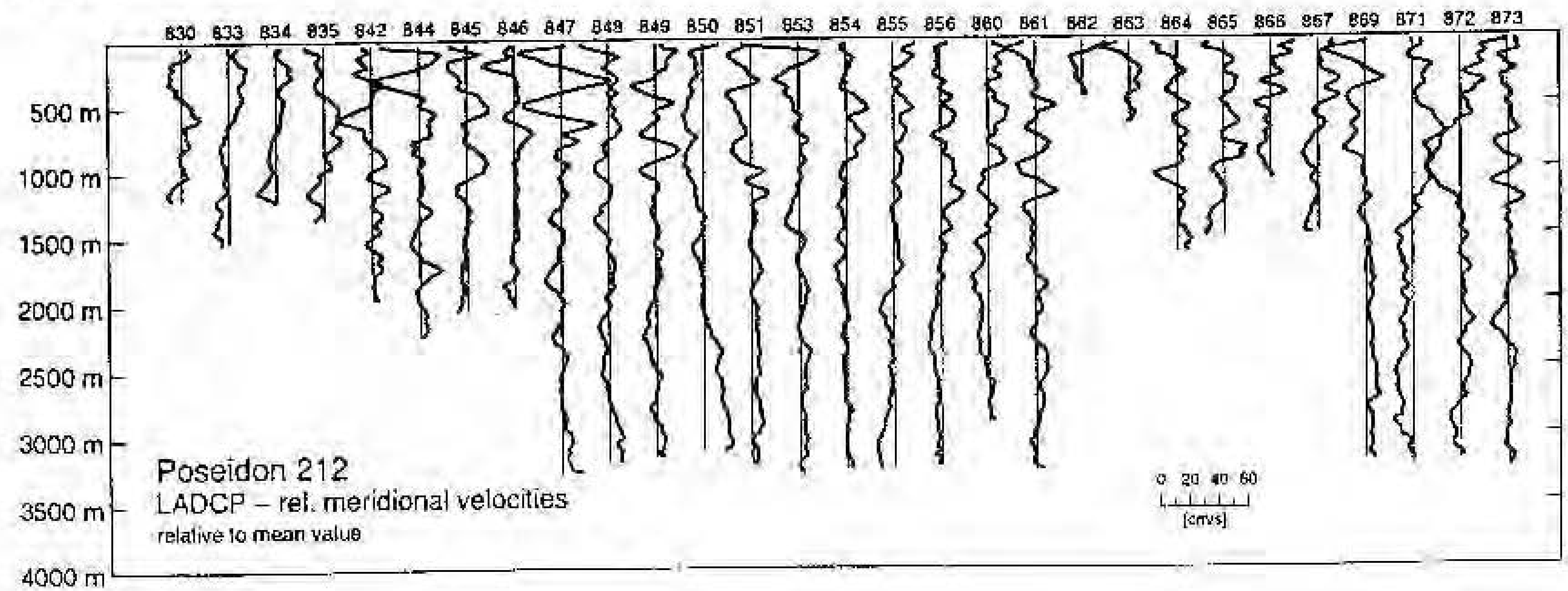

863
864
865
866
867
869
869
869
870
871
872
873
pressure [dbar]
0
20
40
60
80
100
120
140
160
180
200
0
0.5
[psu]
Poseidon 212
Salinity
vertical line is 36.5 psu

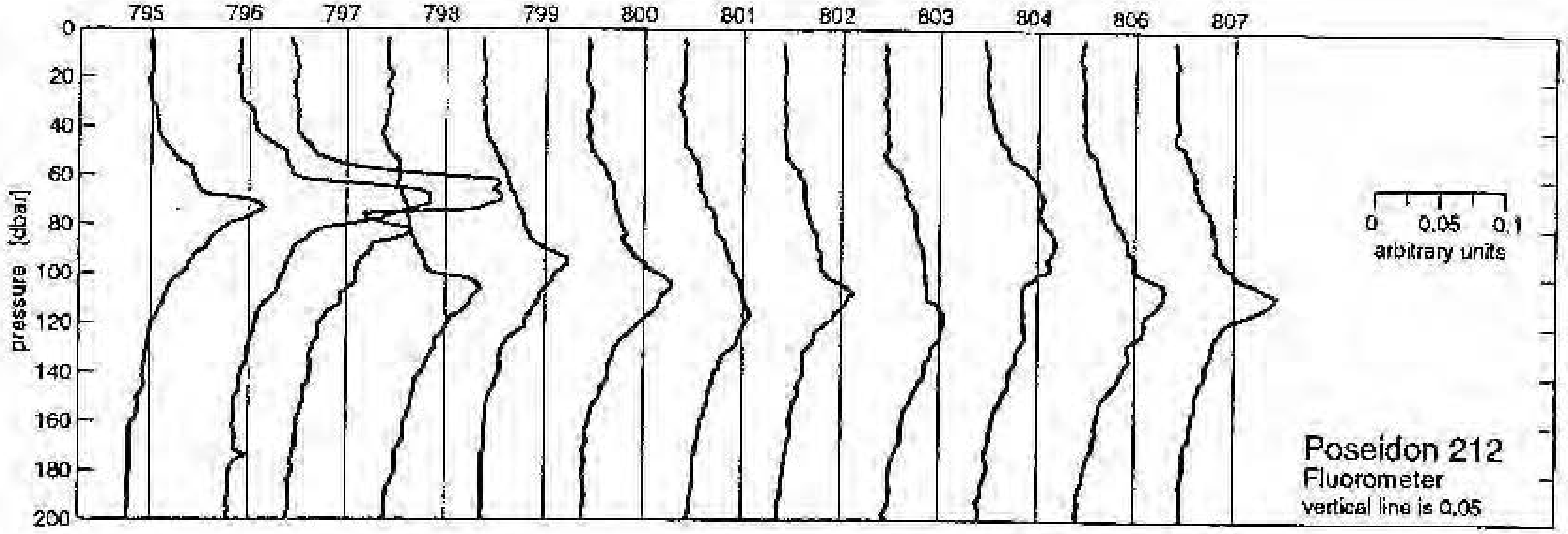

874
876
884
887
889
893
884
pressure [dbar]
0
20
40
60
80
100
120
140
160
180
200
0
0.5
[psu]
Poseidon 212
Salinity
vertical line is 35.5 psu

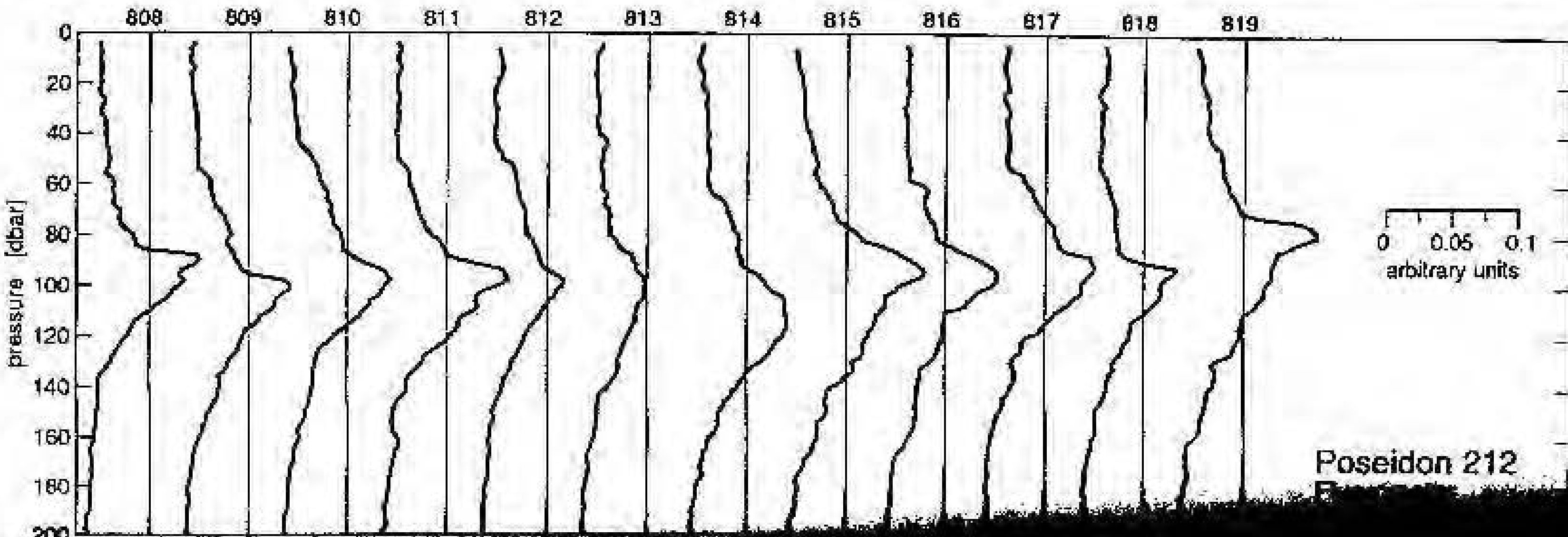

795 796 797 798 799 800 801 802 803 804 806 807 808 809 810 812 813 814 815 816 817 820 823 824 826 827 829
500 m
1000 m
1500 m
2000 m
2500 m
3000 m
3500 m
4000 m
Poseidon 212
LADCP – rel. zonal velocities
relative to mean value
0 20 40 60
[cm/s]

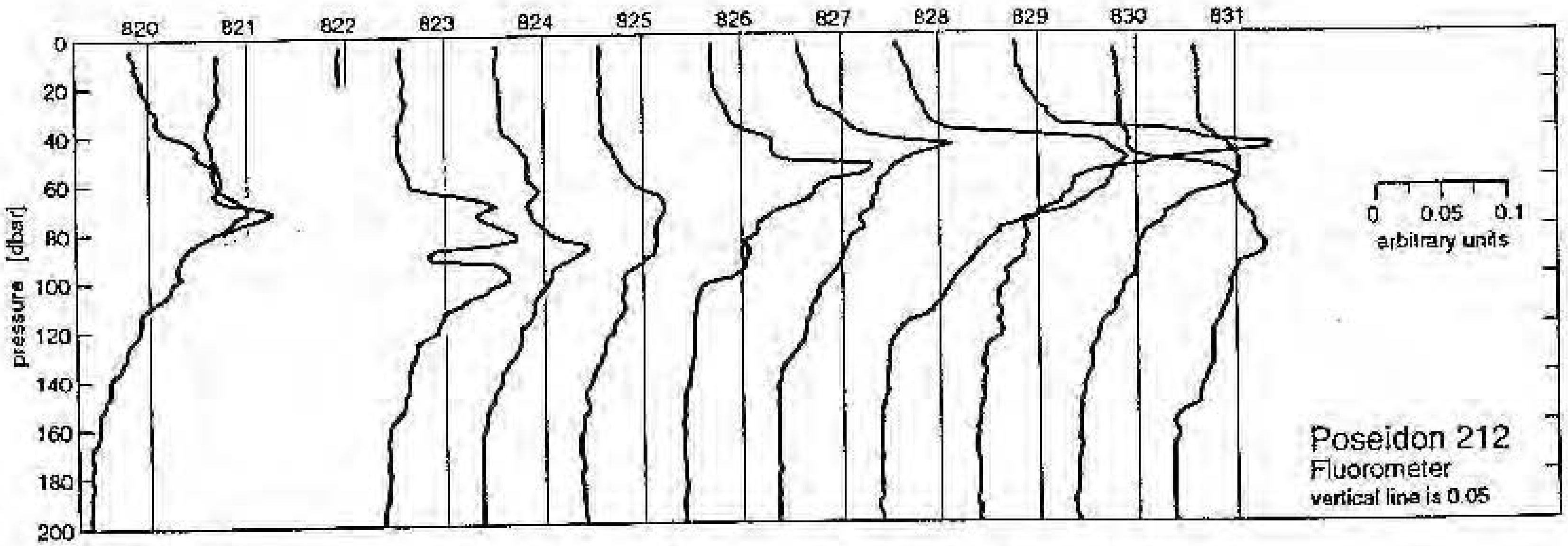

795 796 797 798 799 800 801 802 803 804 806 807 808 809 810 812 813 814 815 816 817 820 823 824 826 827 829
500 m
1000 m
1500 m
2000 m
2500 m
3000 m
Poseidon 212

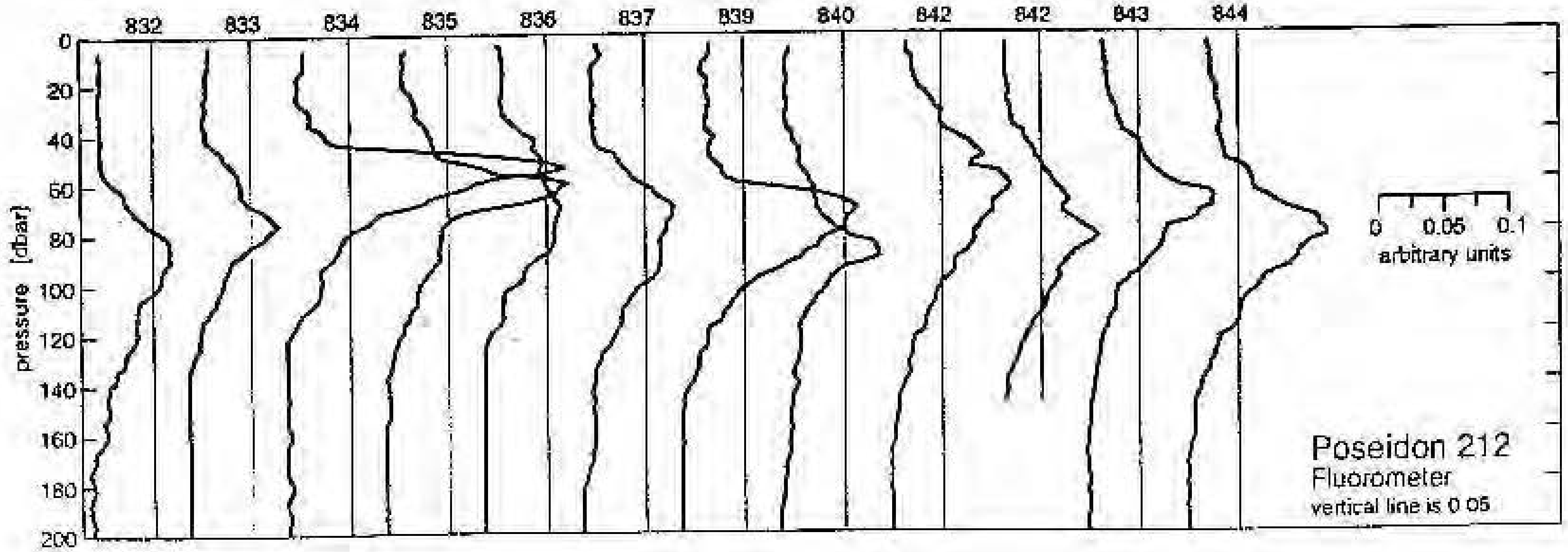

830 833 834 835 842 844 845 846 847 848 849 850 851 853 854 855 856 860 861 862 863 864 865 866 867 869 871 872 873
500 m
1000 m
1500 m
2000 m
2500 m
3000 m
3500 m
4000 m
Poseidon 212
LADCP – rel. zonal velocities
relative to mean value
0 20 40 60
[cm/s]

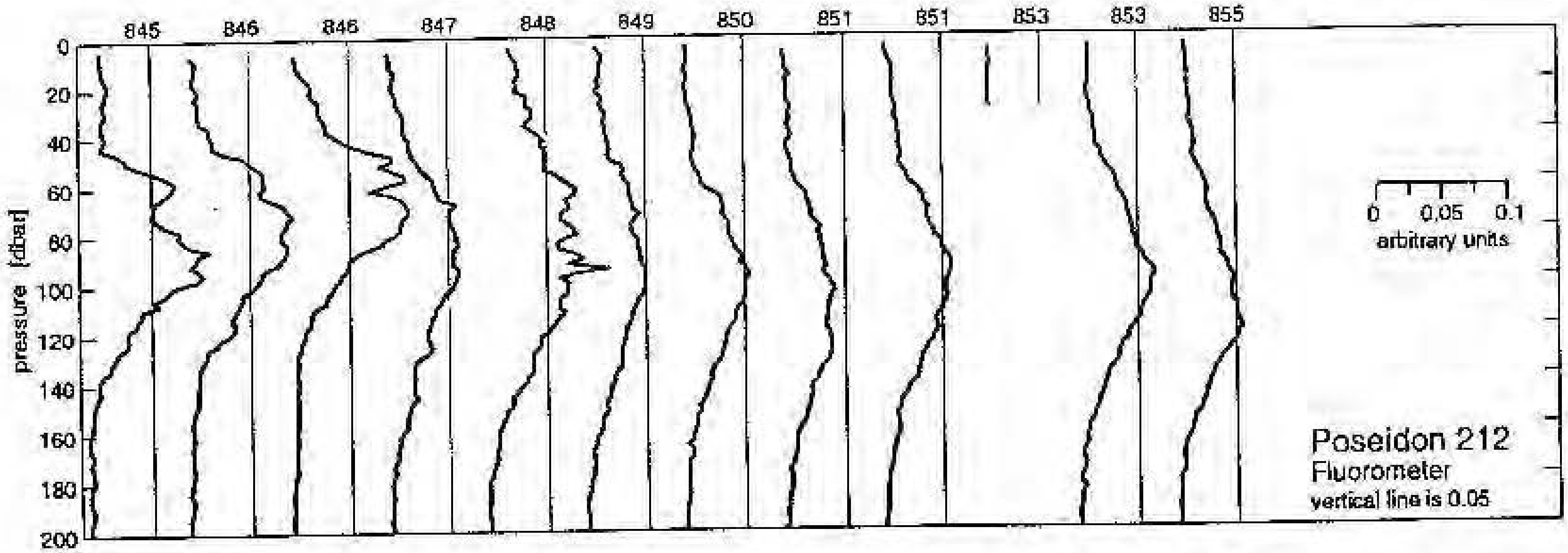

830 833 834 835 842 844 845 846 847 848 849 850 851 853 854 855 856 860 861 862 863 864 865 866 867 869 871 872 873
500 m
1000 m
1500 m
2000 m
2500 m
3000 m
3500 m
4000 m
Poseidon 212
LADCP – rel. meridional velocities
relative to mean value
0 20 40 60
[cm/s]


795 796 797 798 799 800 801 802 803 804 806 807
0 20 40 60 80 100 120 140 160 180 200
pressure [dbar]
0 0.05 0.1
arbitrary units
Poseidon 212
Fluorometer
vertical line is 0.05

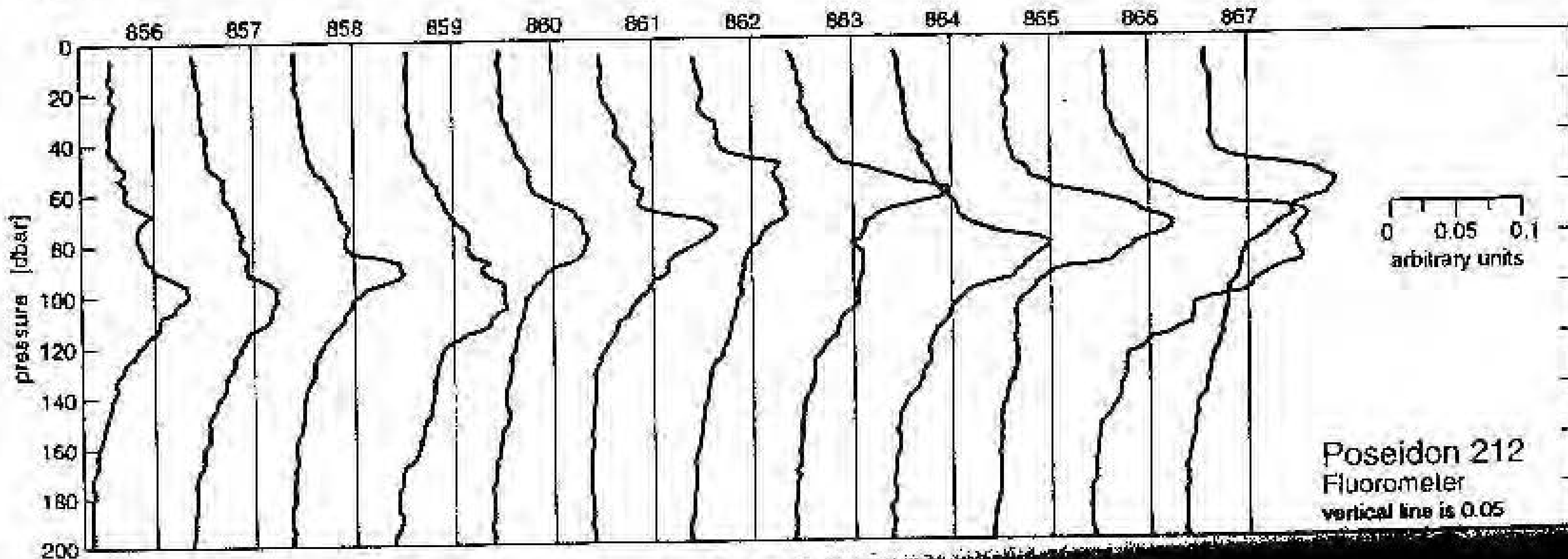

808 809 810 811 812 813 814 815 816 817 818 819
0 20 40 60 80 100 120 140 160 180 200
pressure [dbar]
0 0.05 0.1
arbitrary units
Poseidon 212


820 821 822 823 824 825 826 827 828 829 830 831
pressure [dbar]
0 20 40 60 80 100 120 140 160 180 200
0 0.05 0.1
arbitrary units
Poseidon 212
Fluorometer
vertical line is 0.05

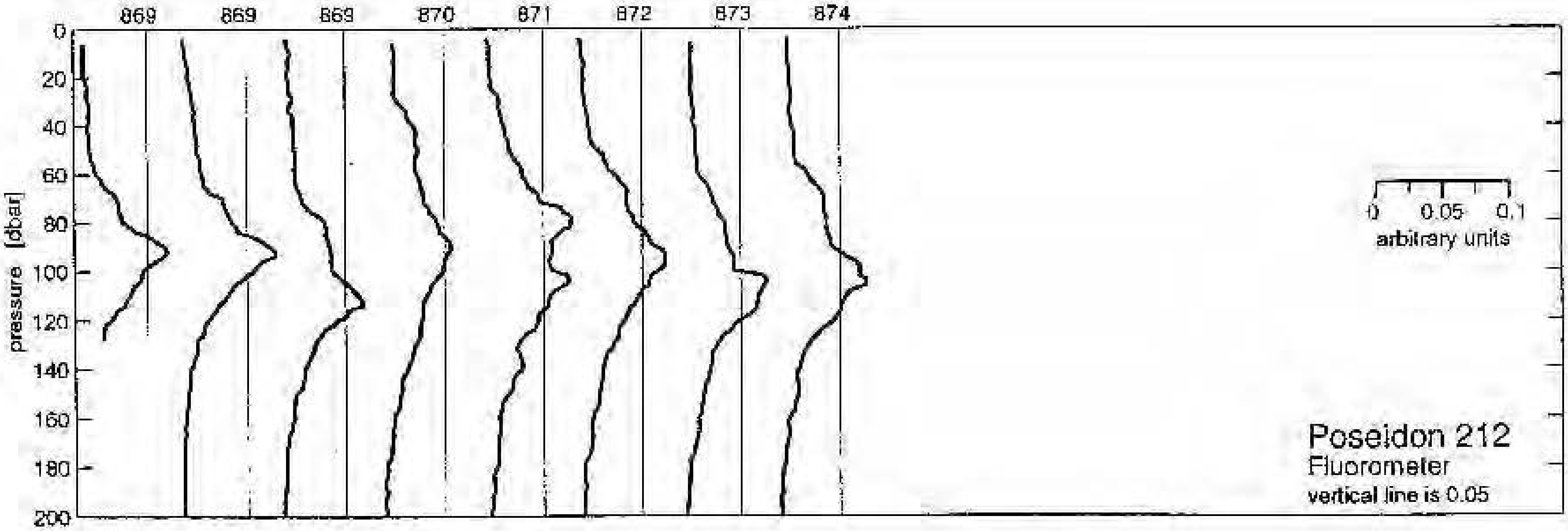

832 833 834 835 836 837 839 840 842 842 843 844
pressure [dbar]
0 20 40 60 80 100 120 140 160 180 200
0 0.05 0.1
arbitrary units
Poseidon 212
Fluorometer
vertical line is 0.05



845 846 846 847 848 849 850 851 851 853 853 855
0 20 40 60 80 100 120 140 160 180 200
pressure [dbar]
0 0.05 0.1
arbitrary units
Poseidon 212
Fluorometer
vertical line is 0.05



856 857 858 859 860 861 862 863 864 865 866 867
0 20 40 60 80 100 120 140 160 180 200
pressure [dbar]
0 0.05 0.1
arbitrary units
Poseidon 212
Fluorometer
vertical line is 0.05


869
869
869
870
871
872
873
874
pressure [dbar]
0
20
40
60
80
100
120
140
160
180
200
0 0.05 0.1
arbitrary units
Poseidon 212
Fluorometer
vertical line is 0.05

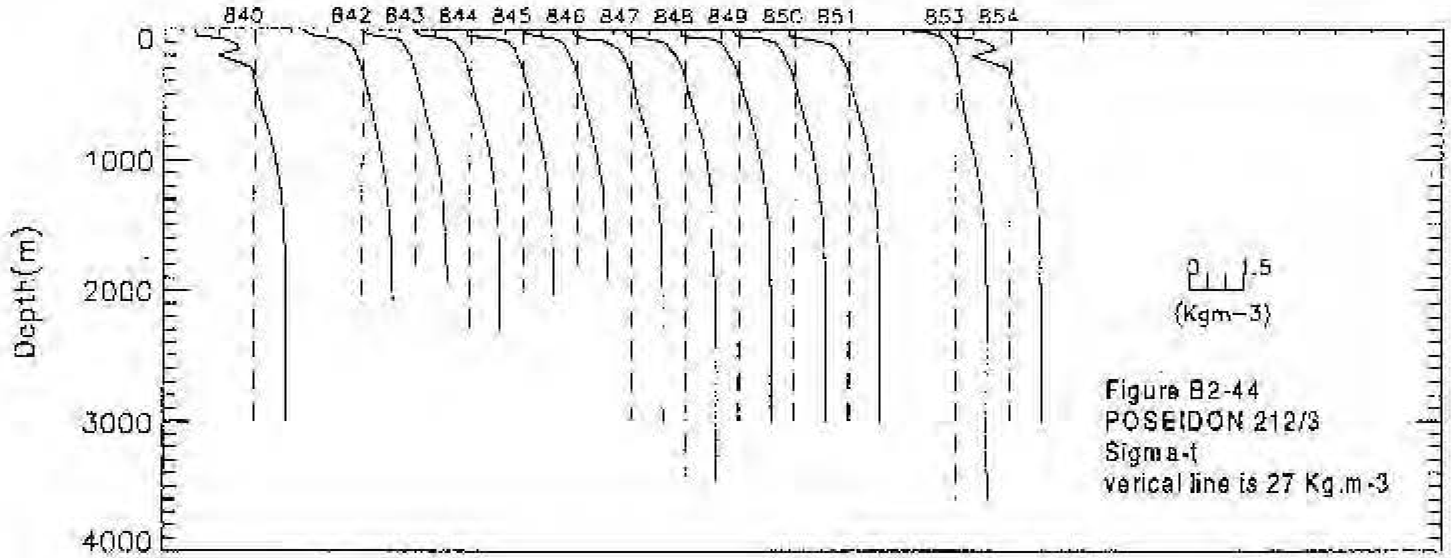


Figure B2-44
POSEIDON 212/3
Sigma-t
verical line is 27 Kg.m-3

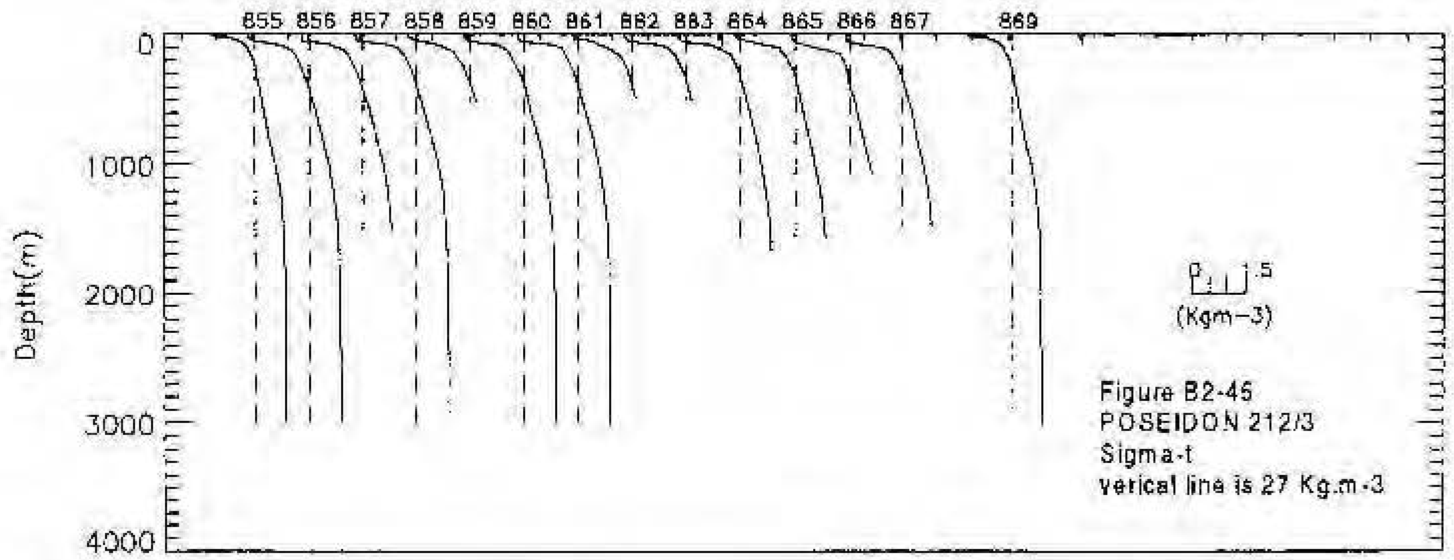


Figure B2-45
POSEIDON 212/3
Sigma-t
verical line is 27 Kg.m-3

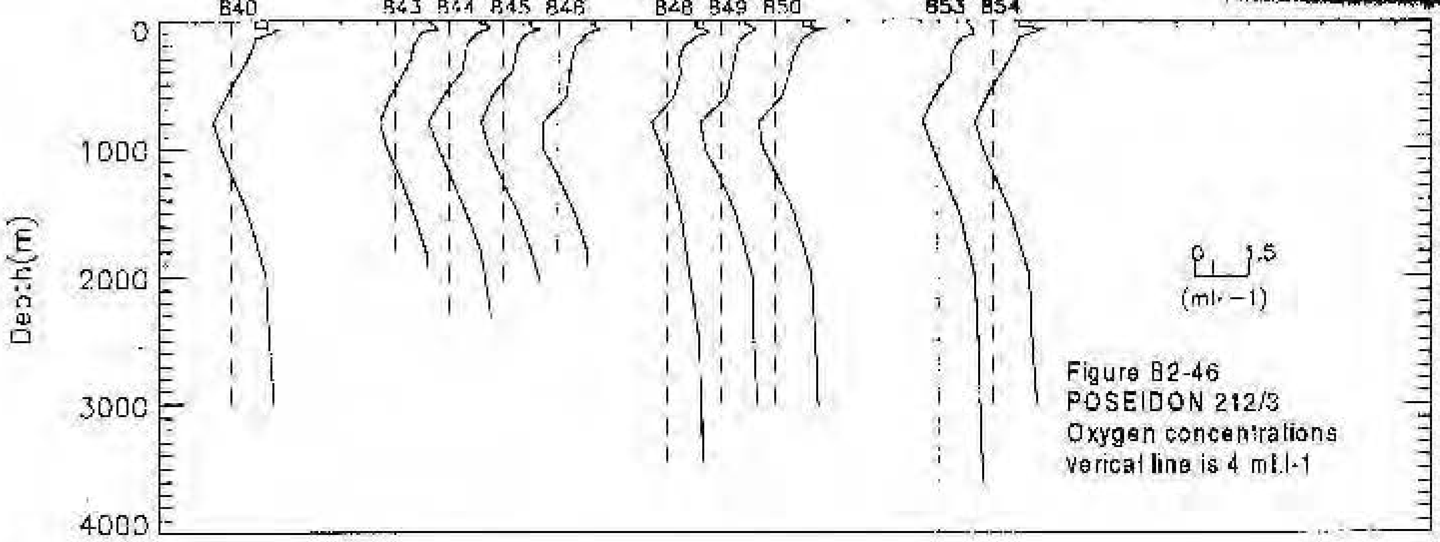


Figure B2-46
POSEIDON 212/3
Oxygen concentrations
verical line is 4 ml.l-1

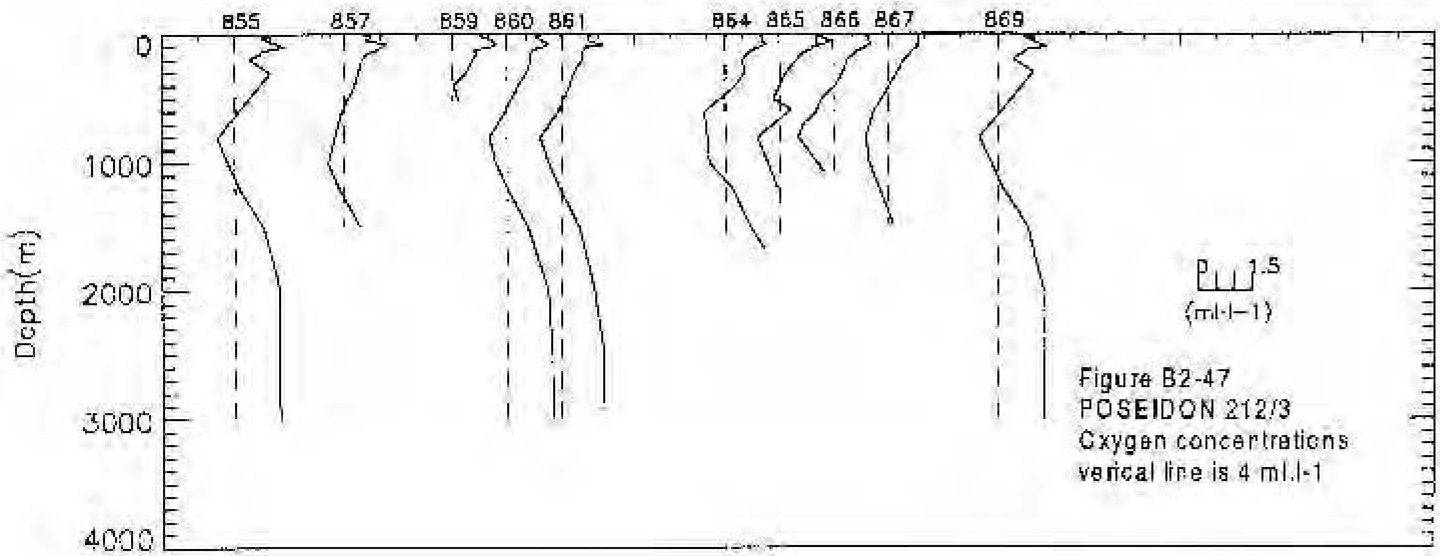


Figure B2-47
POSEIDON 212/3
Oxygen concentrations
verical line is 4 ml.l-1

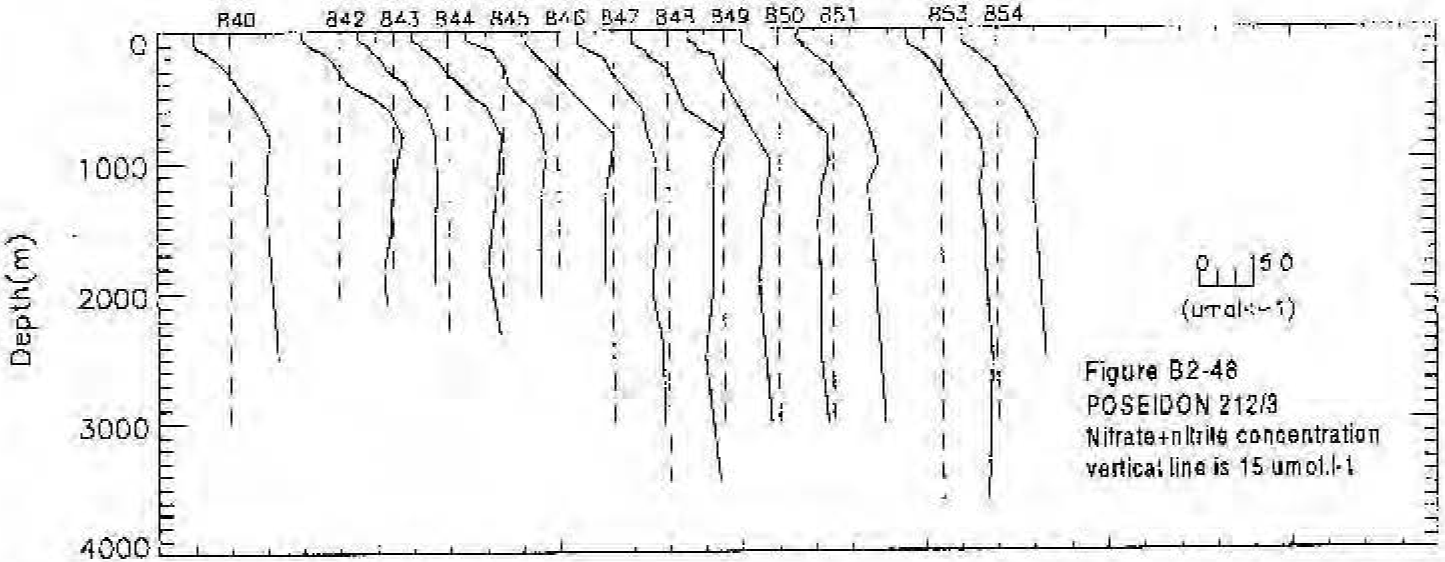


Figure B2-48
POSEIDON 212/3
Nitrate+nitrite concentration
vertical line is 15 umol.l-1

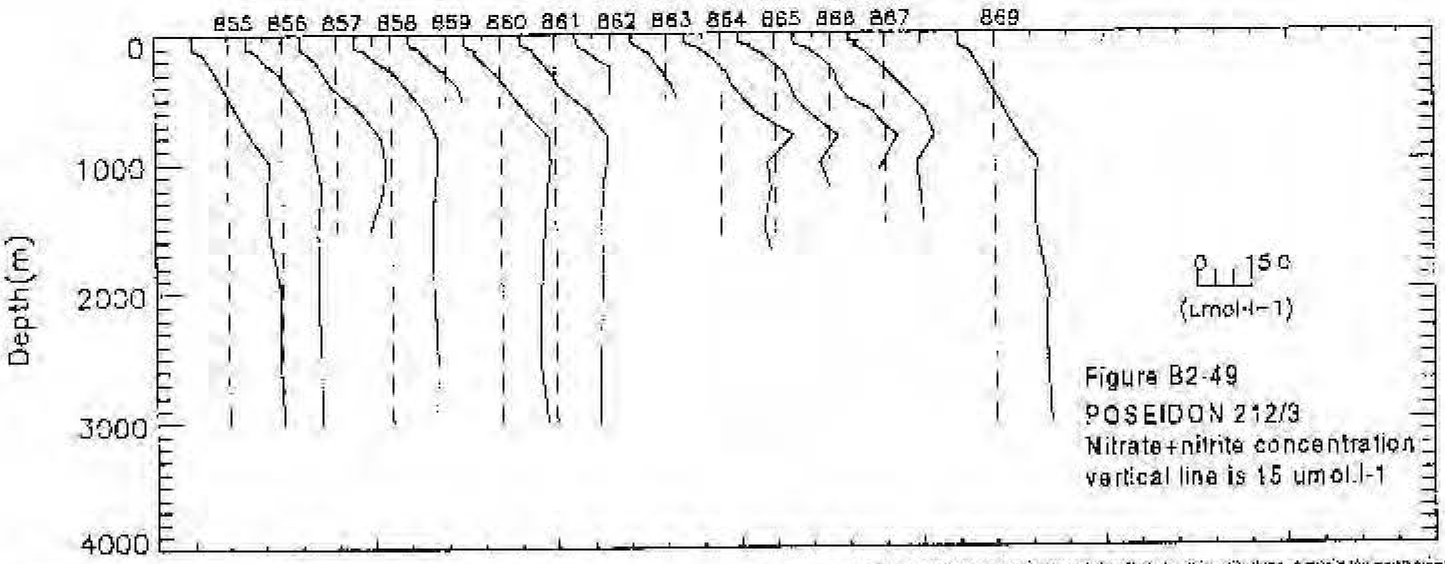


Figure B2-49
POSEIDON 212/3
Nitrate+nitrite concentration
vertical line is 15 umol.l-1

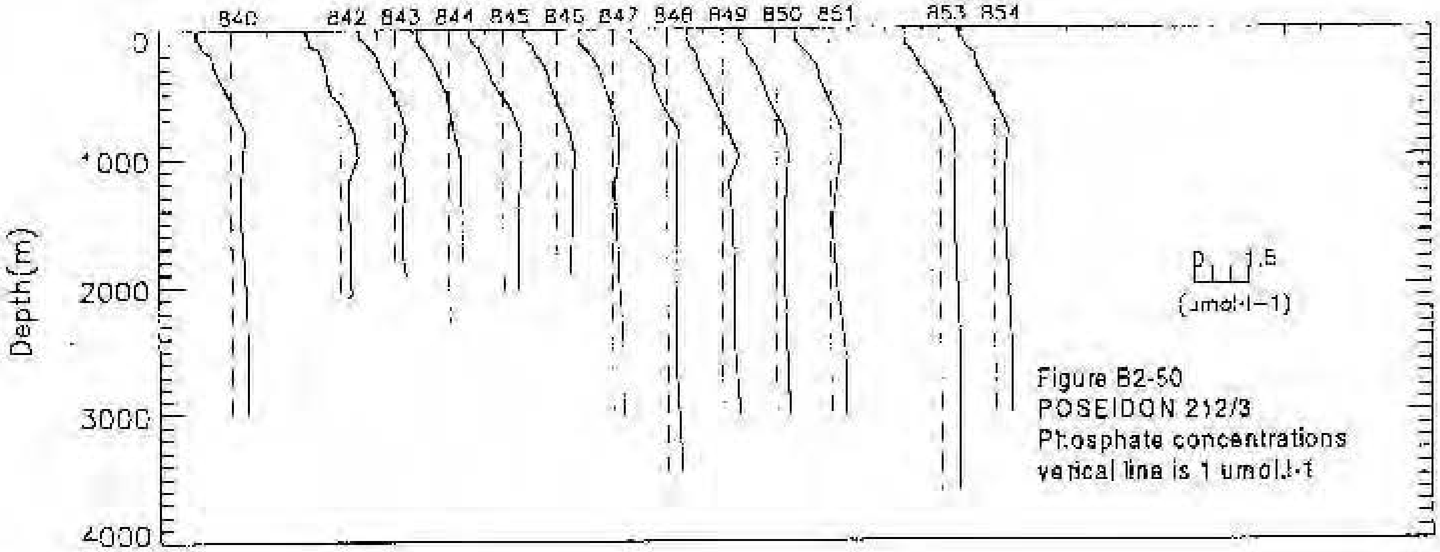


Figure B2-50
POSEIDON 212/3
Phosphate concentrations
verical line is 1 umol.l-1

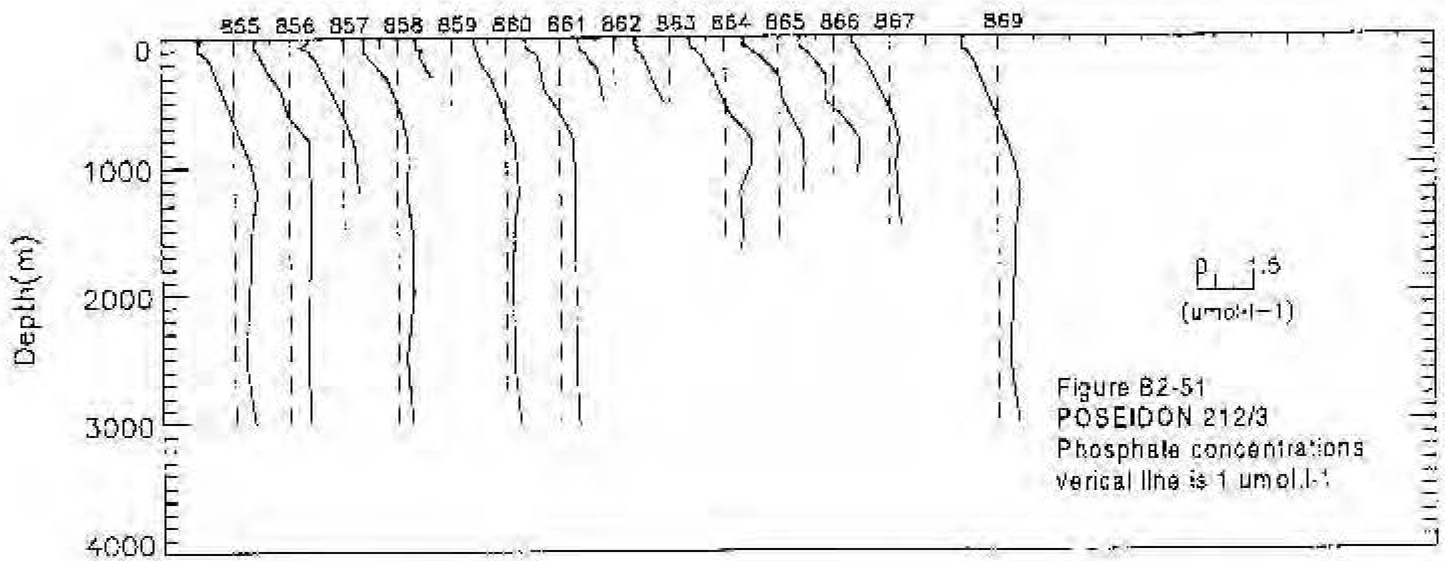


Figure B2-51
POSEIDON 212/3
Phosphate concentrations
verical line is 1 umol.l-1

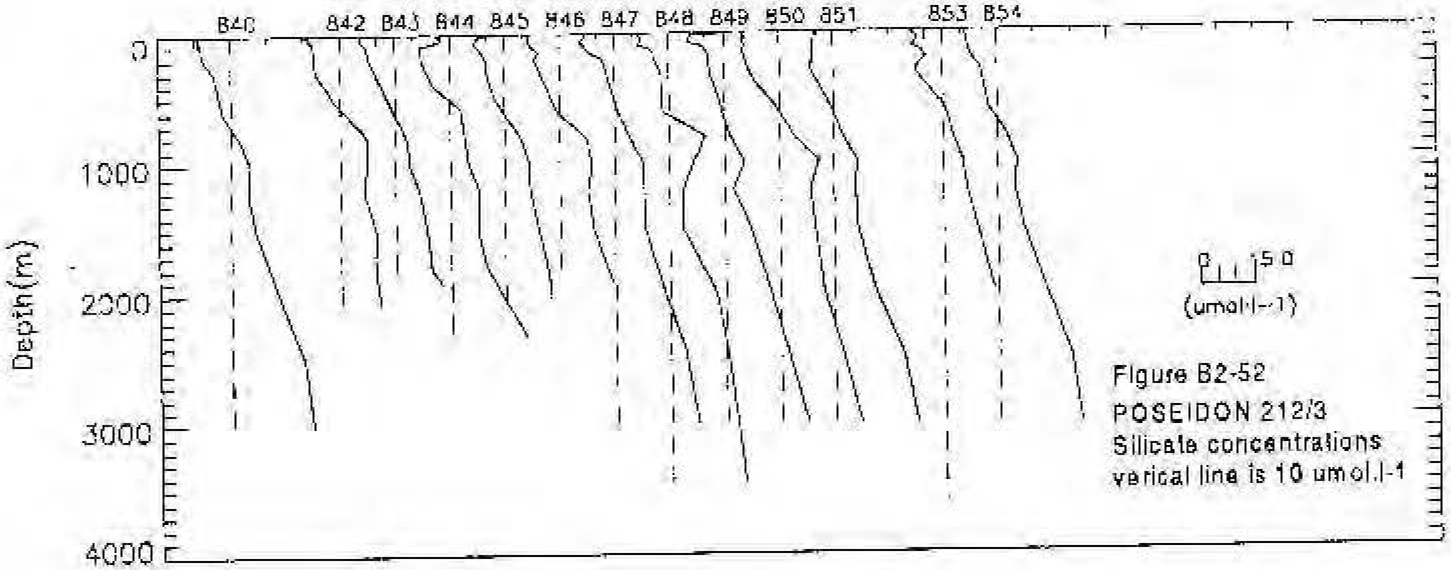


Figure B2-52
POSEIDON 212/3
Silicate concentrations
verical line is 10 umol.l-1

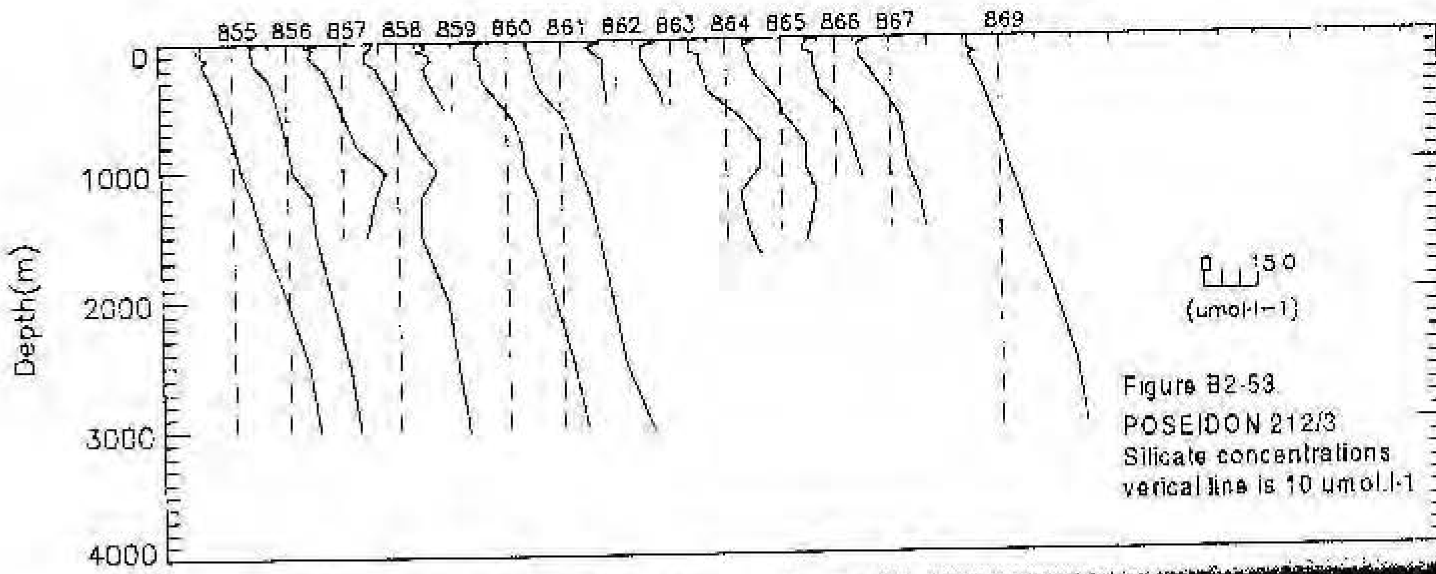


Figure B2-53
POSEIDON 212/3
Silicate concentrations
verical line is 10 umol.l-1

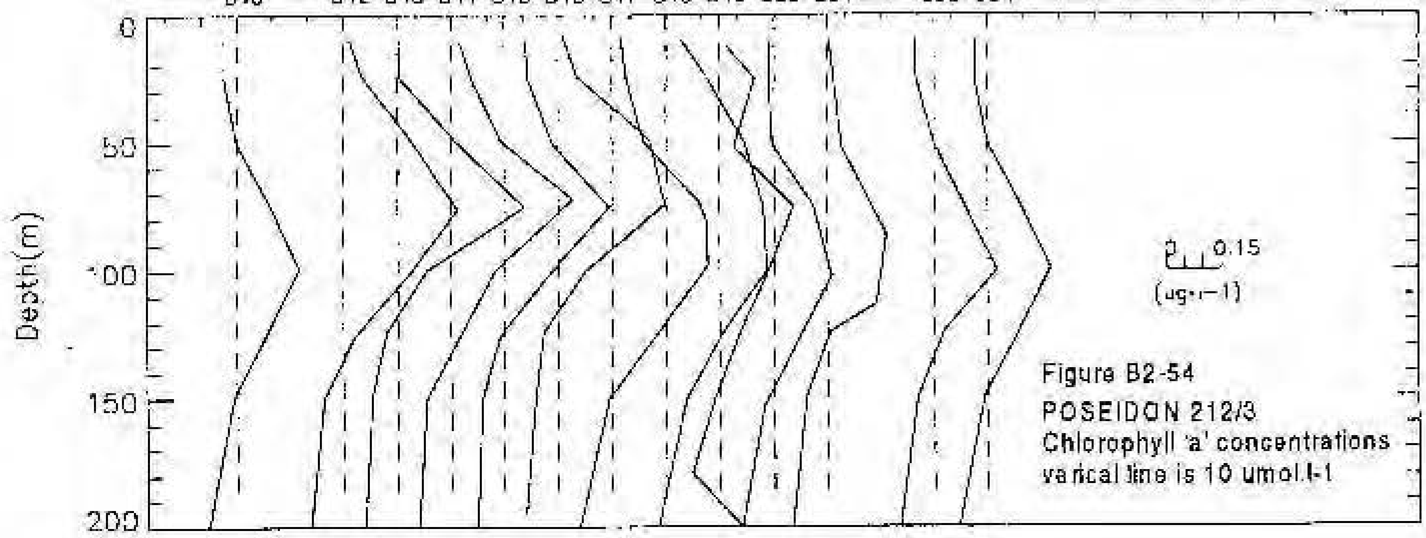


Figure B2-54
POSEIDON 212/3
Chlorophyll 'a' concentrations
verical line is 10 umol.l-1

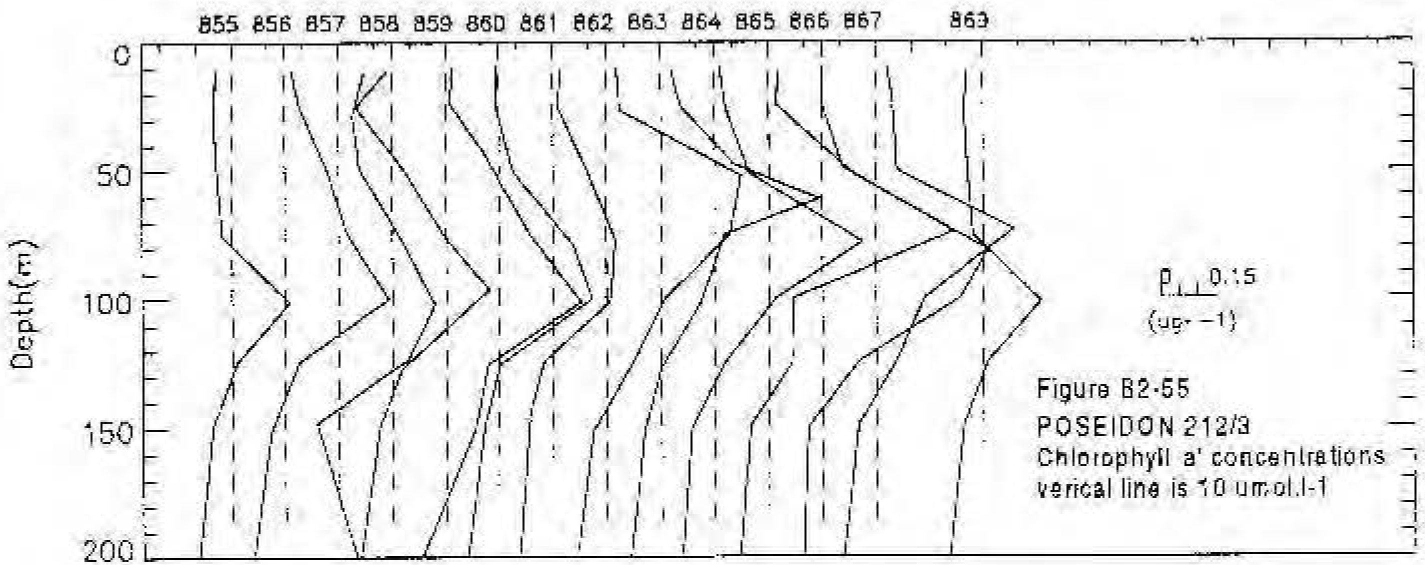
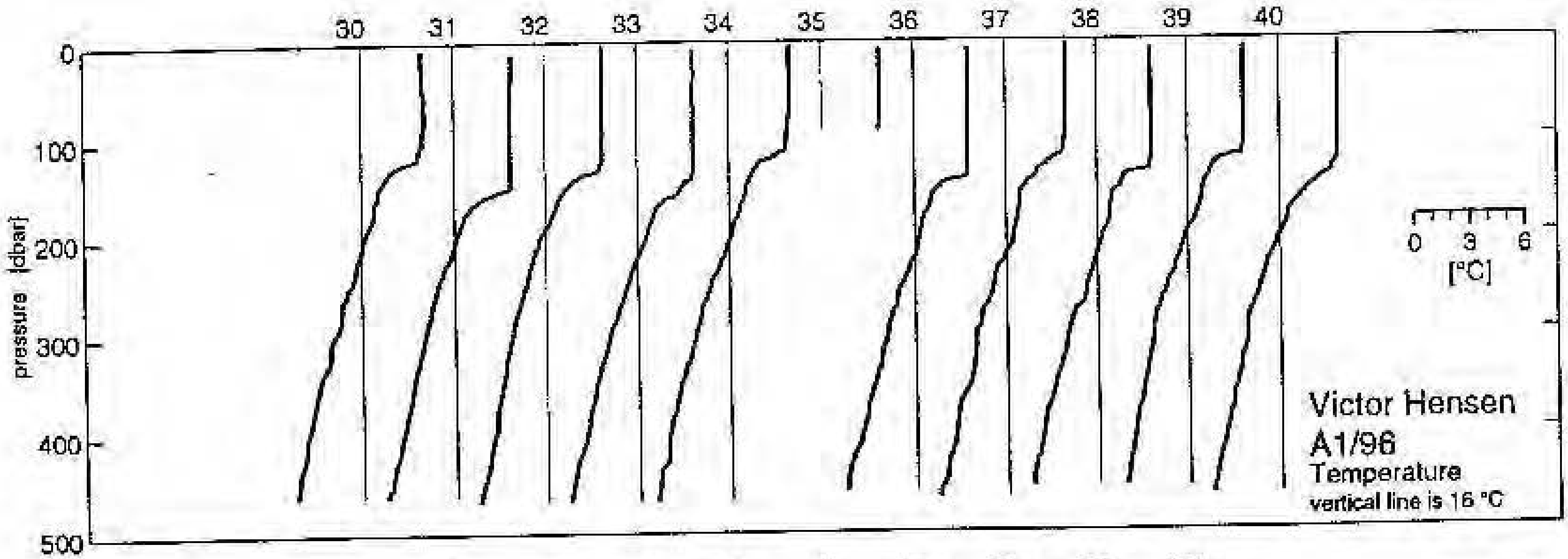
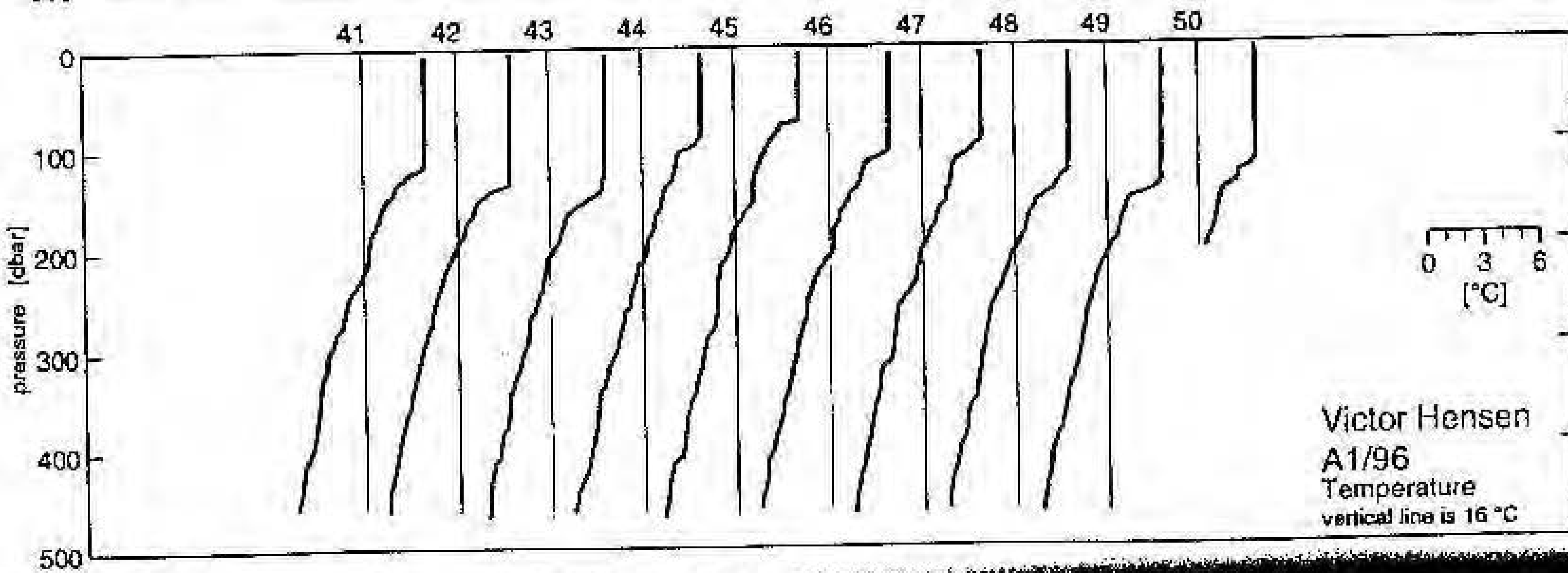
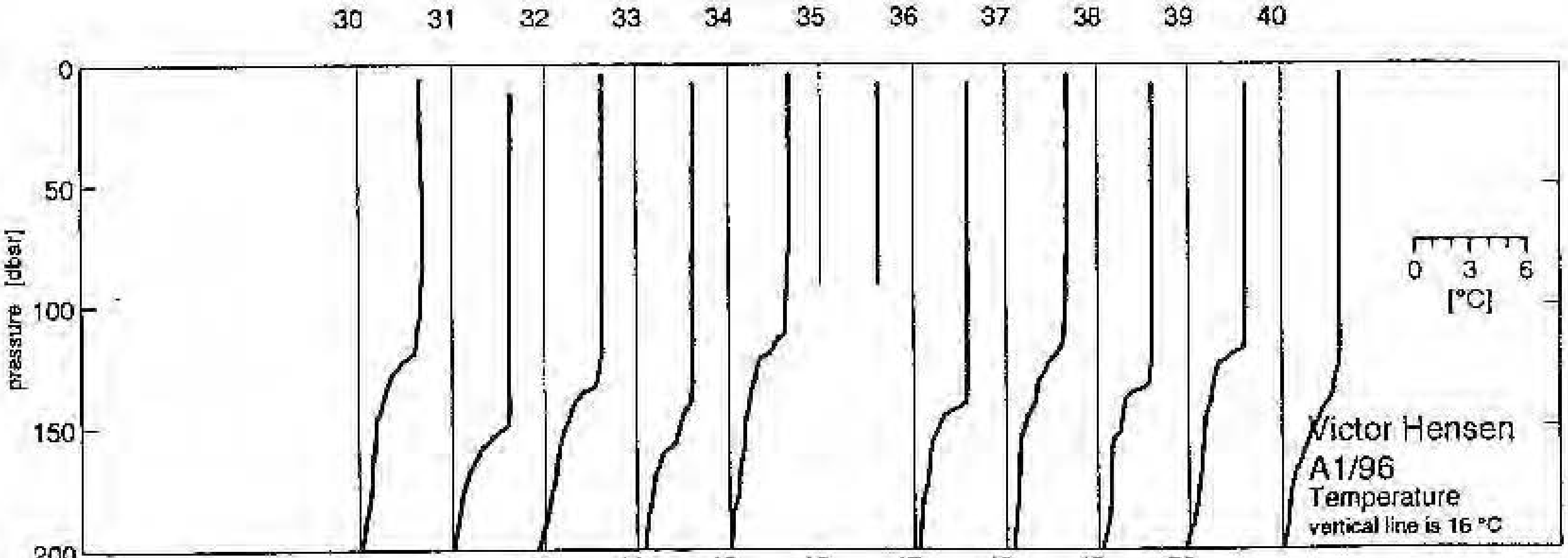
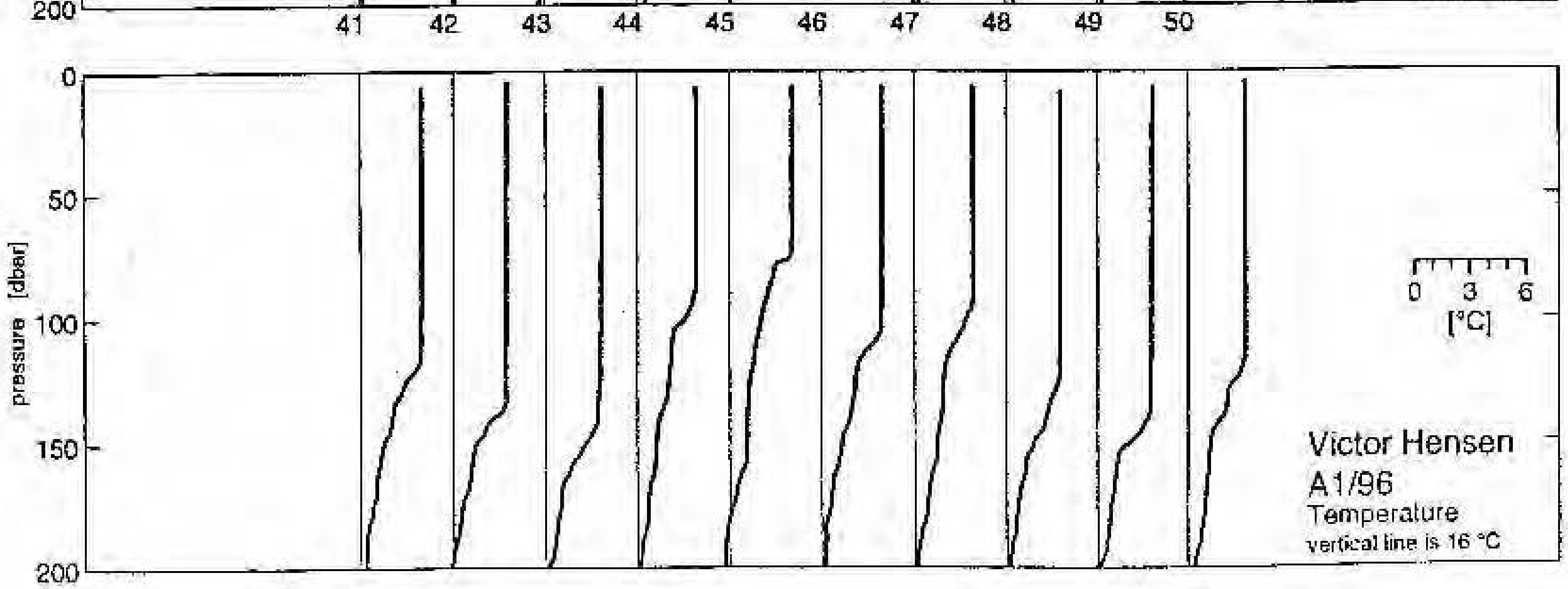


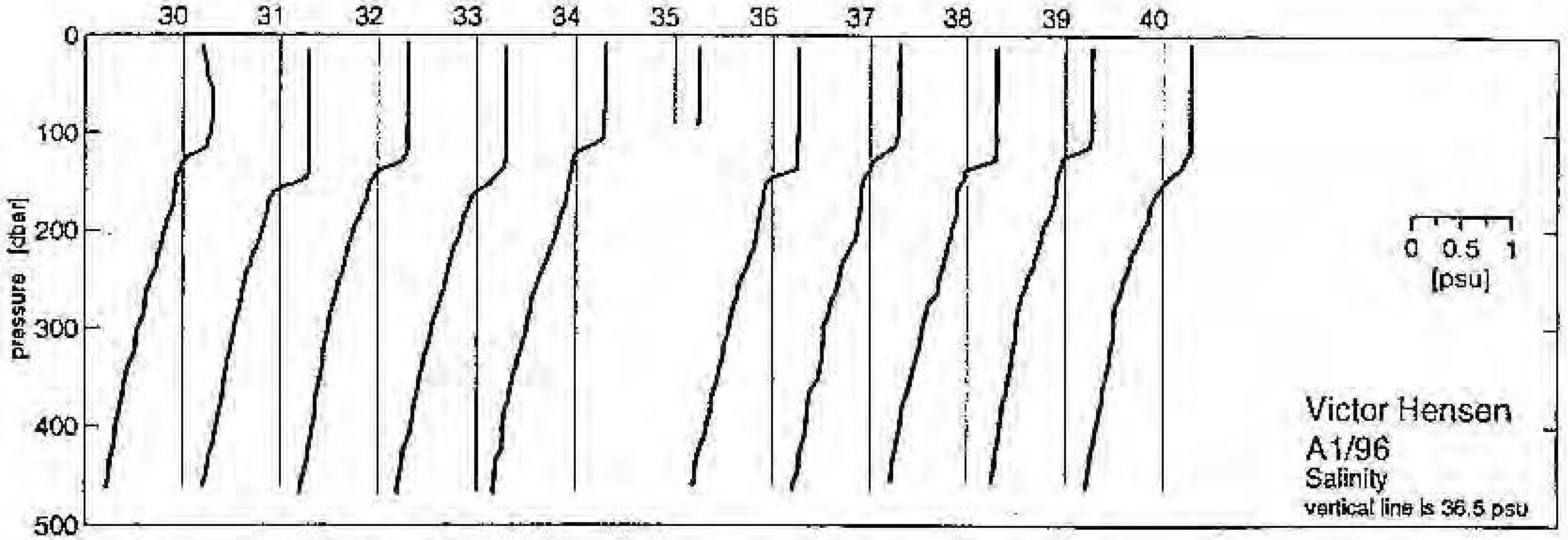
Figure B2-55
POSEIDON 212/3
Chlorophyll 'a' concentrations
verical line is 10 umol.l-1

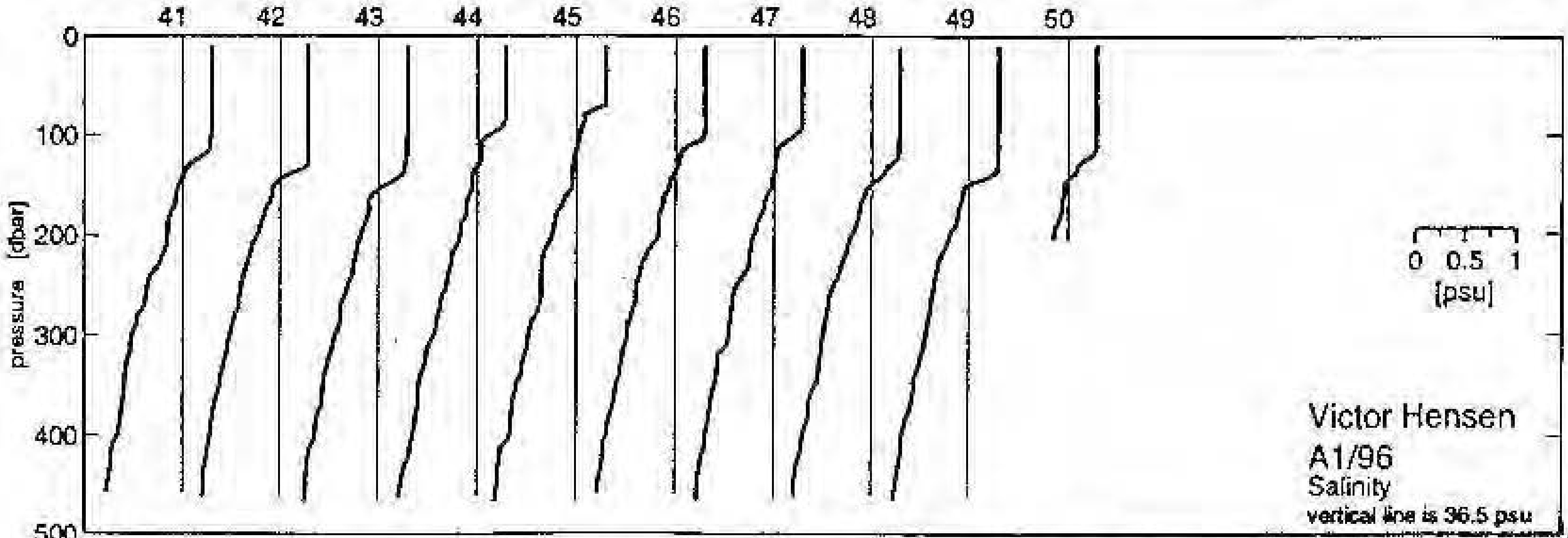

30 31 32 33 34 35 36 37 38 39 40
0
100
200
300
400
500
pressure [dbar]
0 3 6
[°C]
Victor Hensen
A1/96
Temperature
vertical line is 16 °C

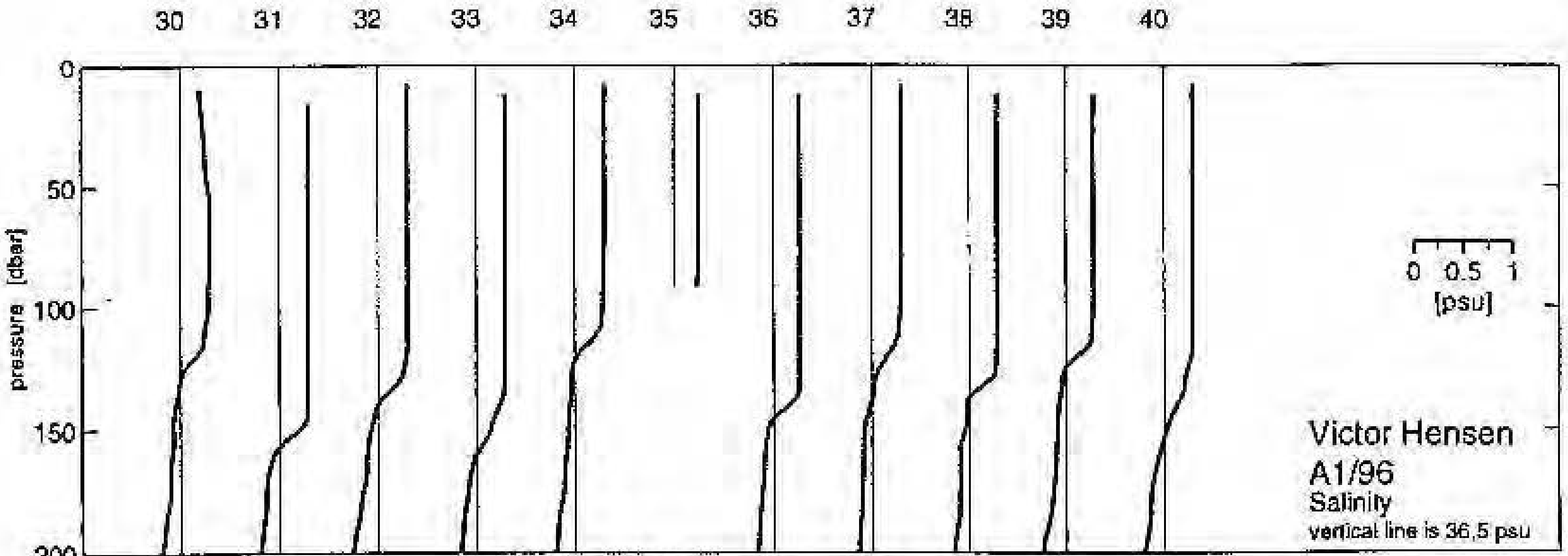

41 42 43 44 45 46 47 48 49 50
0
100
200
300
400
500
pressure [dbar]
0 3 6
[°C]
Victor Hensen
A1/96
Temperature
vertical line is 16 °C

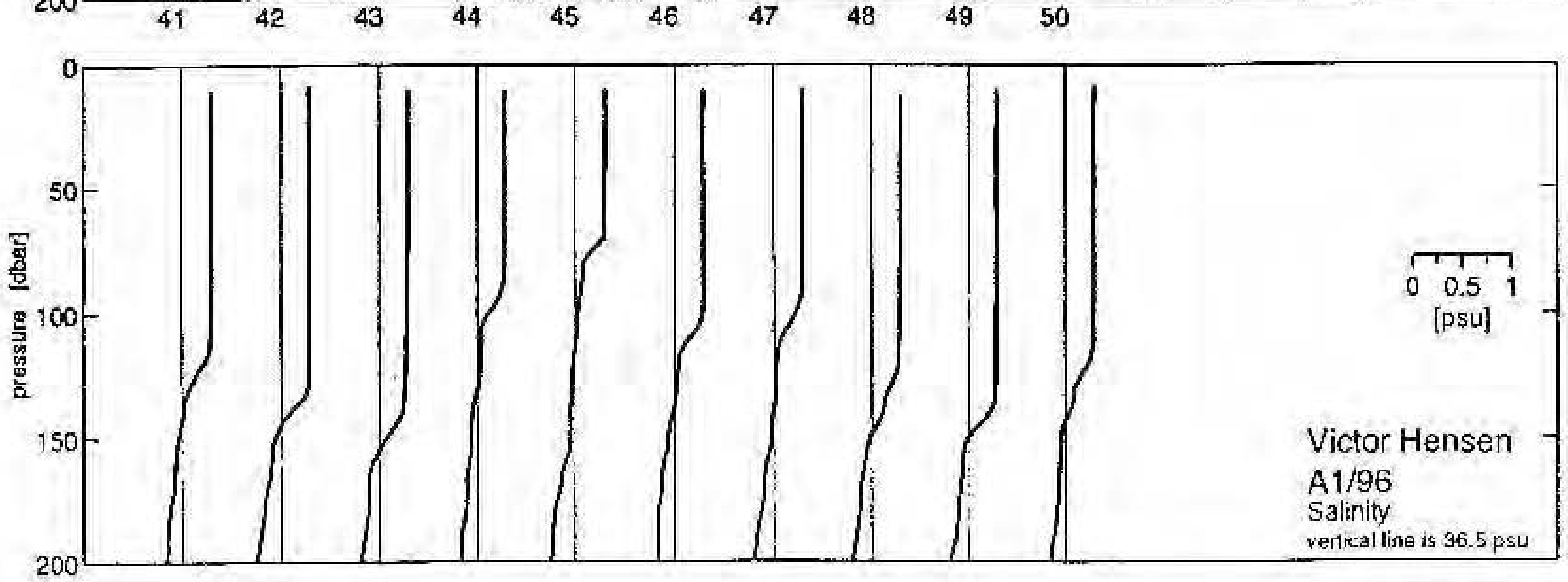

30 31 32 33 34 35 36 37 38 39 40
0
50
100
150
200
pressure [dbar]
0 3 6
[°C]
Victor Hensen
A1/96
Temperature
vertical line is 16 °C

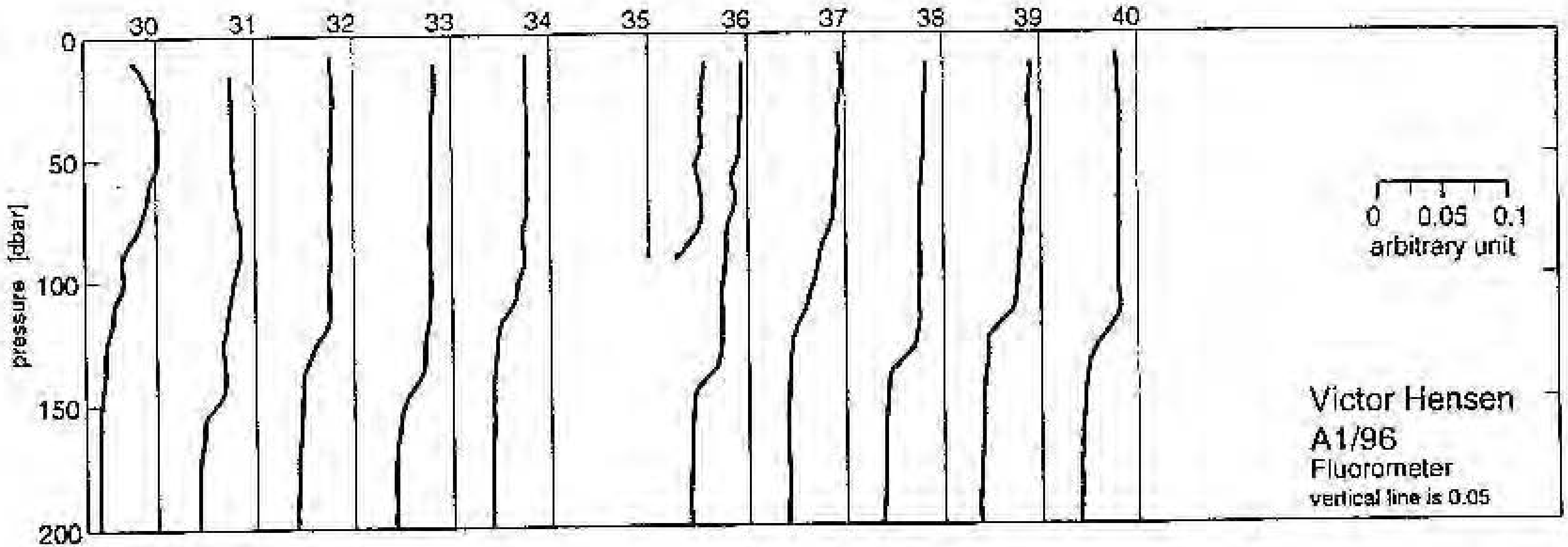

41 42 43 44 45 46 47 48 49 50
0
50
100
150
200
pressure [dbar]
0 3 6
[°C]
Victor Hensen
A1/96
Temperature
vertical line is 16 °C

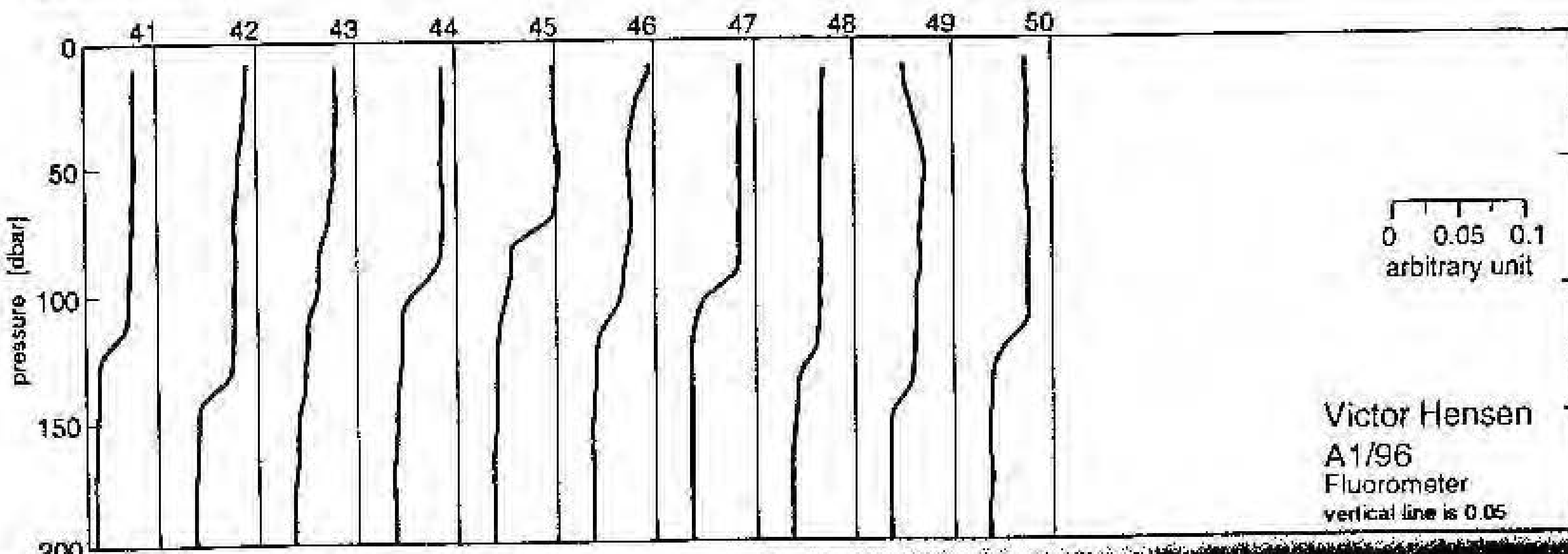

30
31
32
33
34
35
36
37
38
39
40
0
100
200
300
400
500
pressure [dbar]
0 0.5 1
[psu]
Victor Hensen
A1/96
Salinity
vertical line is 36.5 psu


41
42
43
44
45
46
47
48
49
50
0
100
200
300
400
500
pressure [dbar]
0 0.5 1
[psu]
Victor Hensen
A1/96
Salinity
vertical line is 36.5 psu


30 31 32 33 34 35 36 37 38 39 40
pressure [dbar]
0
50
100
150
200
0 0.5 1
[psu]
Victor Hensen
A1/96
Salinity
vertical line is 36,5 psu


41 42 43 44 45 46 47 48 49 50
pressure [dbar]
0
50
100
150
200
0 0.5 1
[psu]
Victor Hensen
A1/96
Salinity
vertical line is 36.5 psu


30
31
32
33
34
35
36
37
38
39
40
0
50
100
150
200
pressure [dbar]
0 0.05 0.1
arbitrary unit
Victor Hensen
A1/96
Fluorometer
vertical line is 0.05


41
42
43
44
45
46
47
48
49
50
0
50
100
150
200
pressure [dbar]
0 0.05 0.1
arbitrary unit
Victor Hensen
A1/96
Fluorometer
vertical line is 0.05

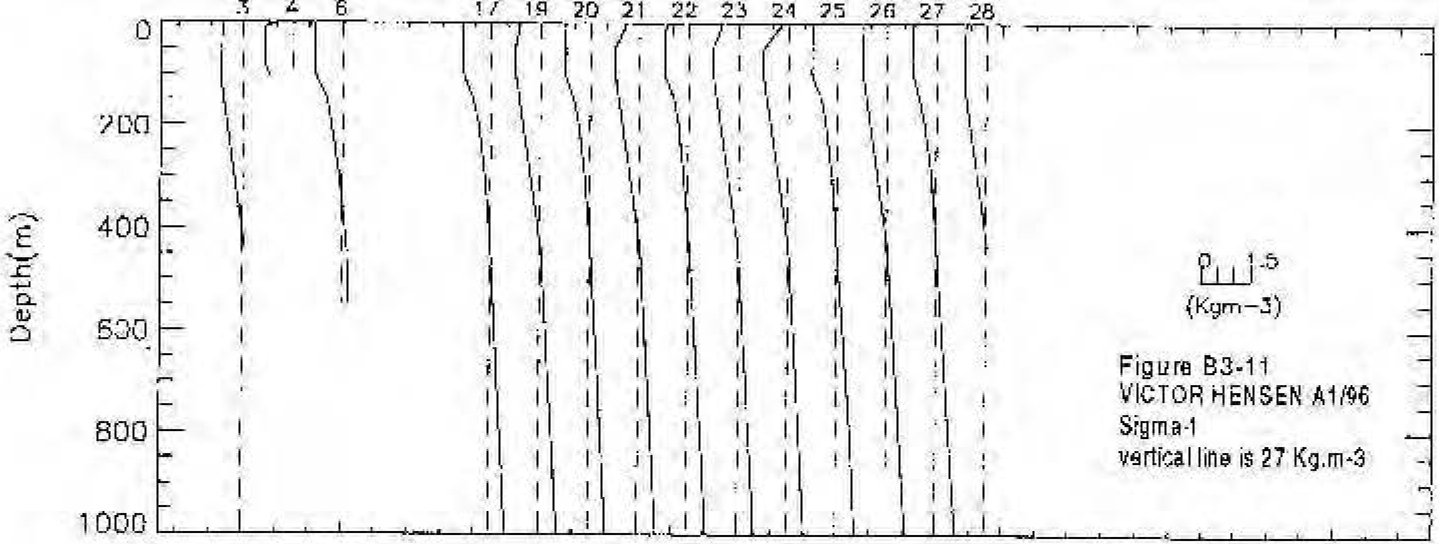


Figure B3-11
VICTOR HENSEN A1/96
Sigma-1
vertical line is 27 Kg.m-3

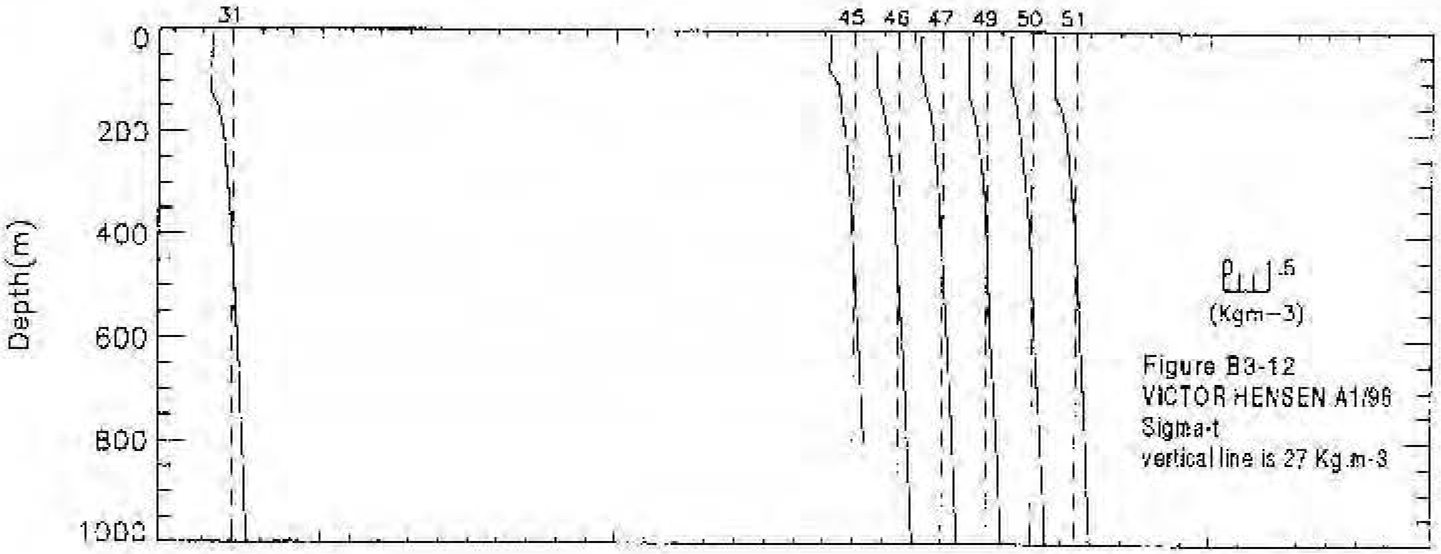


Figure B3-12
VICTOR HENSEN A1/96
Sigma-t
vertical line is 27 Kg.m-3

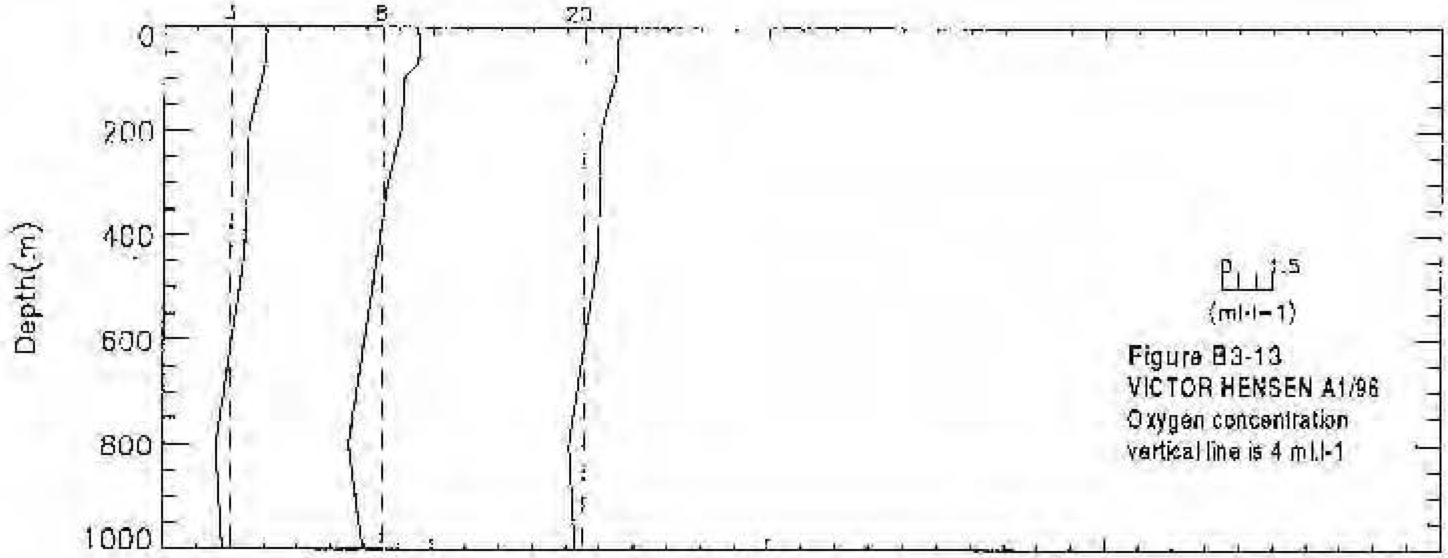


Figure B3-13
VICTOR HENSEN A1/96
Oxygen concentration
vertical line is 4 ml.l-1

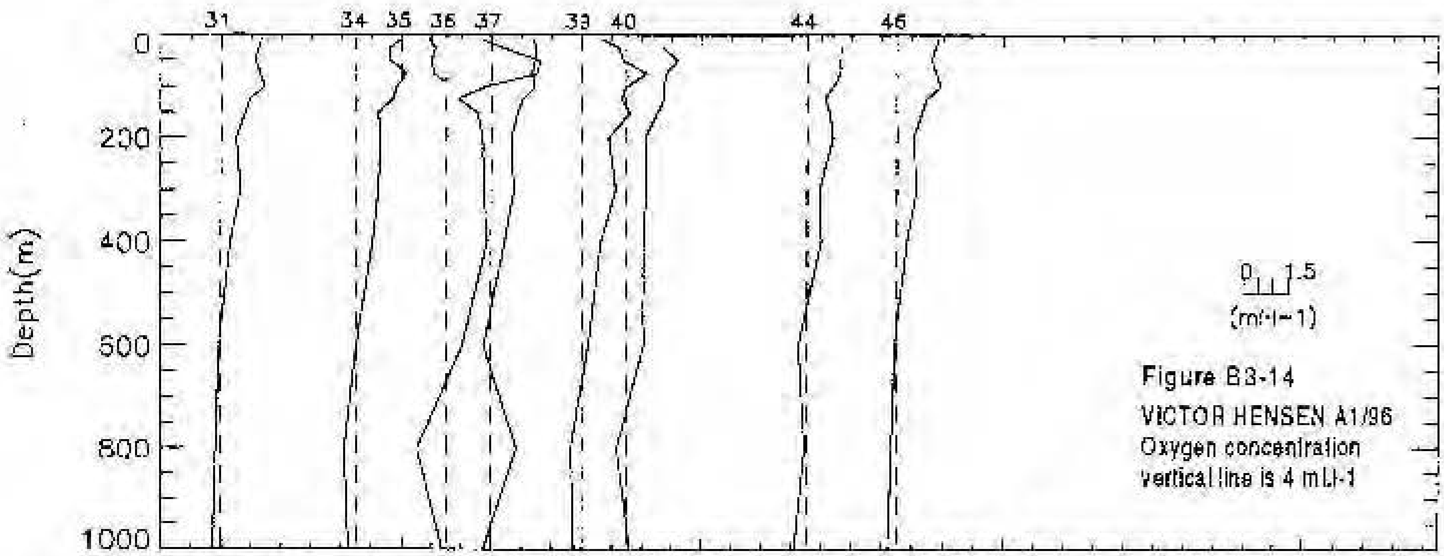


Figure B3-14
VICTOR HENSEN A1/96
Oxygen concentration
vertical line is 4 ml.l-1

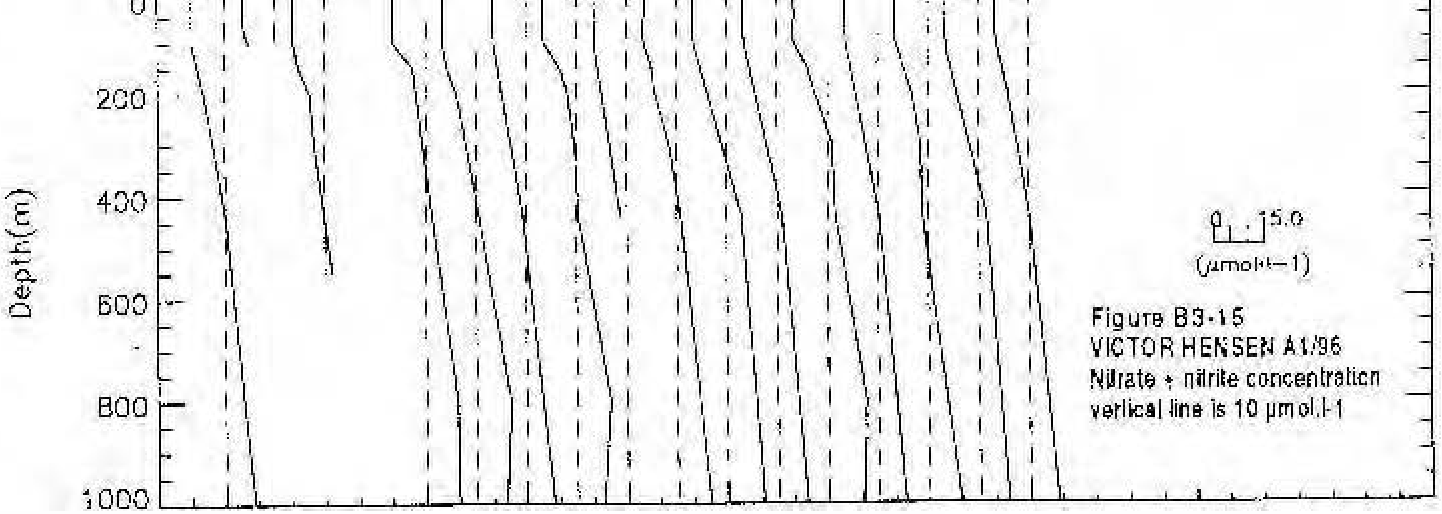


Figure B3-15
VICTOR HENSEN A1/96
Nitrate + nitrite concentration
vertical line is 10 µmol.l-1

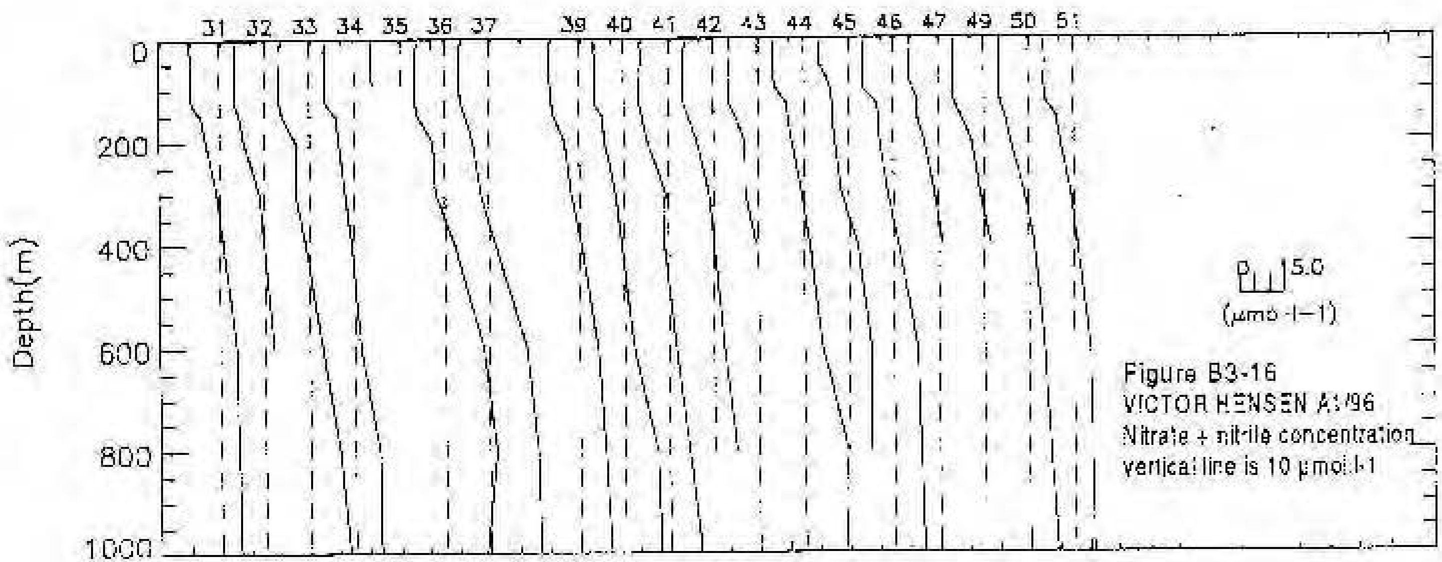


Figure B3-16
VICTOR HENSEN A1/96
Nitrate + nitrite concentration
vertical line is 10 µmol.l-1

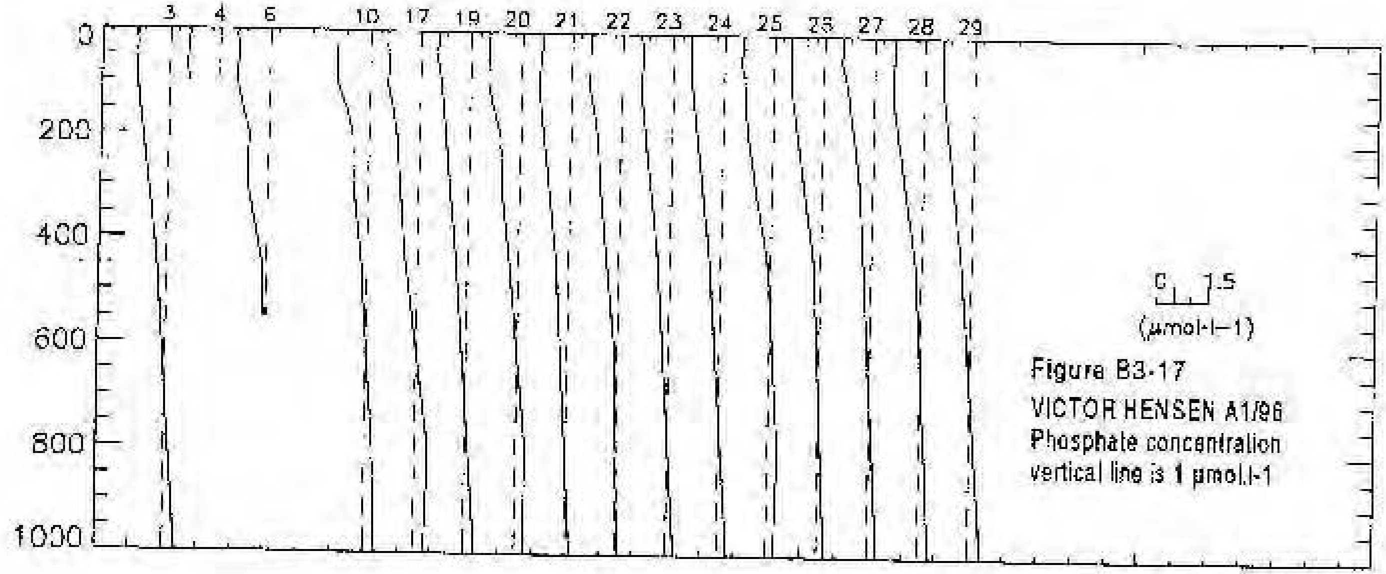


Figura B3-17
VICTOR HENSEN A1/96
Phosphate concentration
vertical line is 1 μmol.l-1

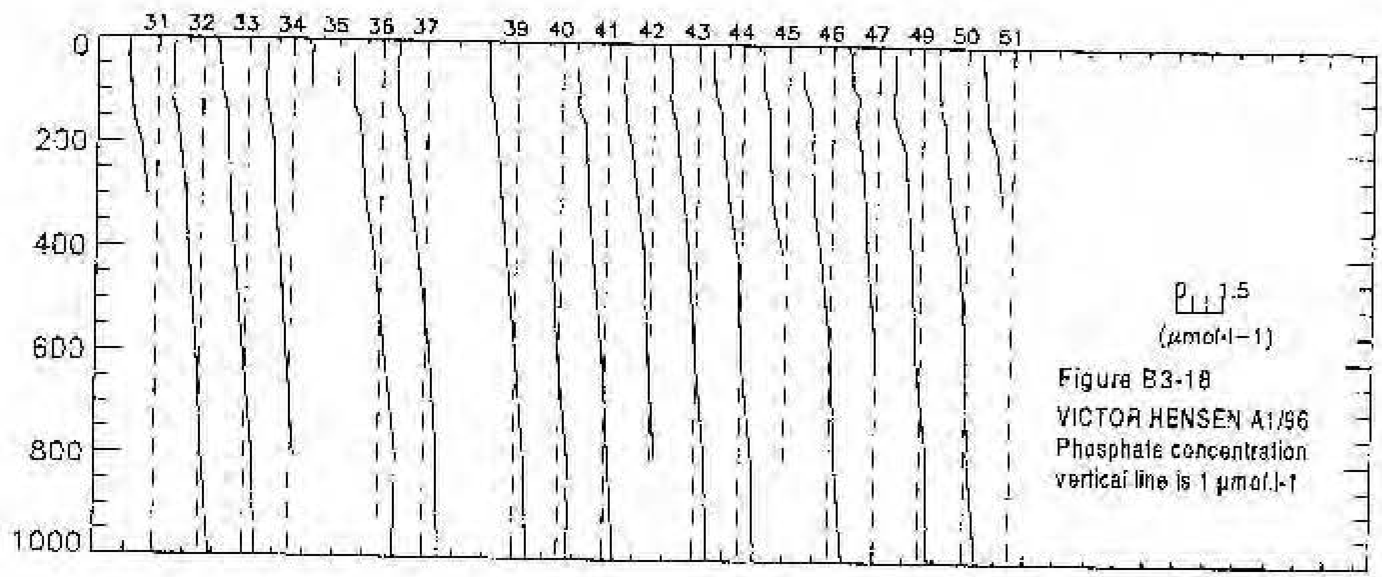


Figura B3-18
VICTOR HENSEN A1/96
Phosphate concentration
vertical line is 1 μmol.l-1

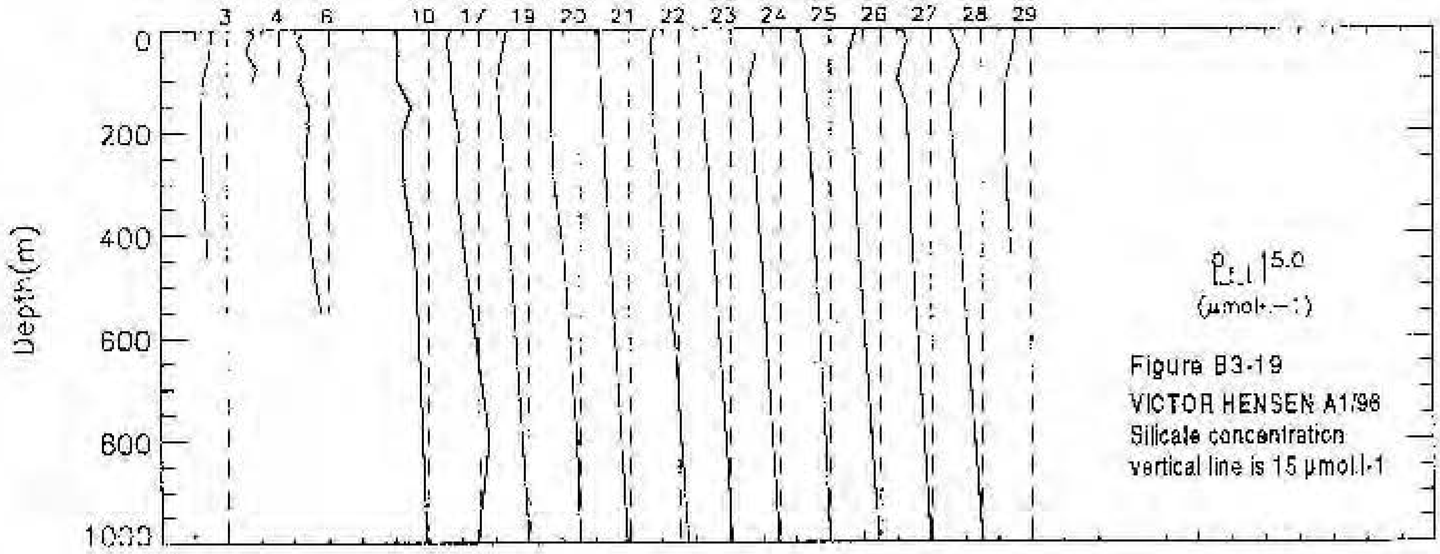


Figure B3-19
VICTOR HENSEN A1/96
Silicate concentration
vertical line is 15 μmol.l-1

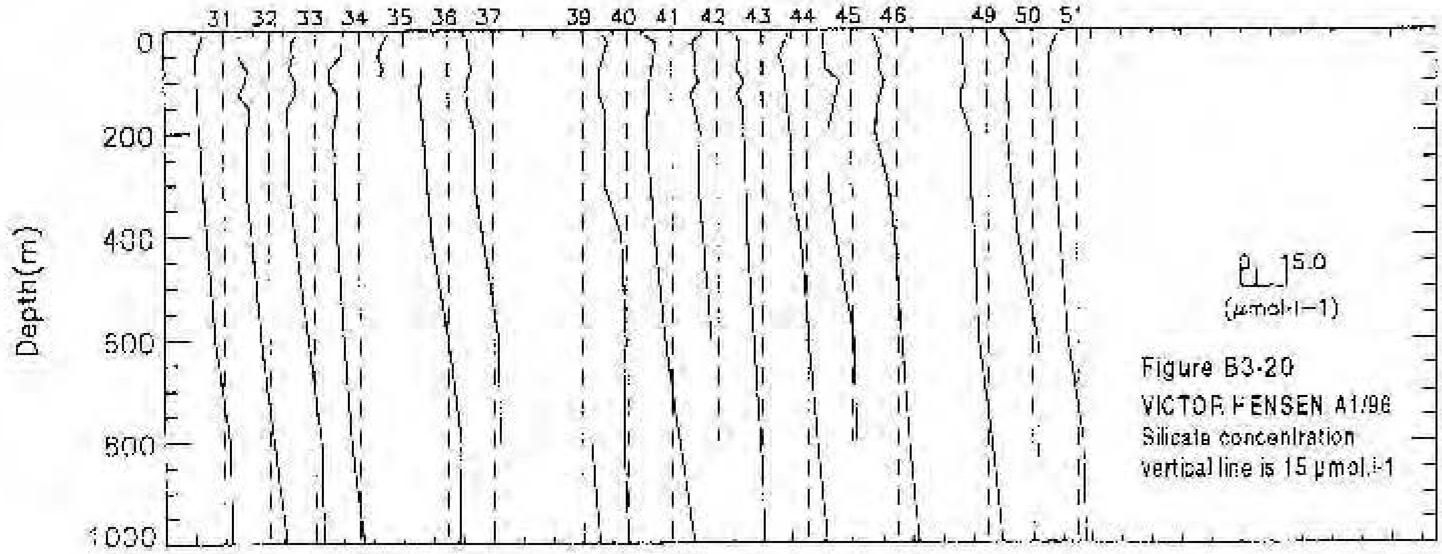


Figure B3-20
VICTOR HENSEN A1/96
Silicate concentration
vertical line is 15 μmol.l-1

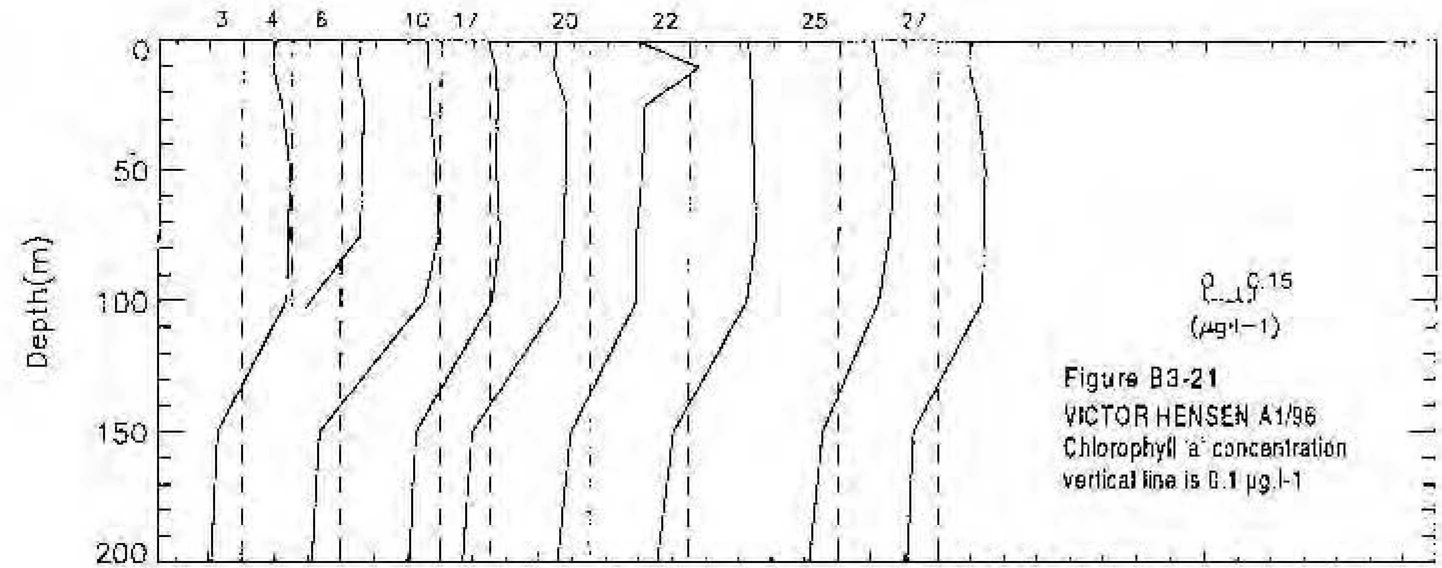


Figure B3-21
VICTOR HENSEN A1/96
Chlorophyll 'a' concentration
vertical line is 0.1 µg.l-1

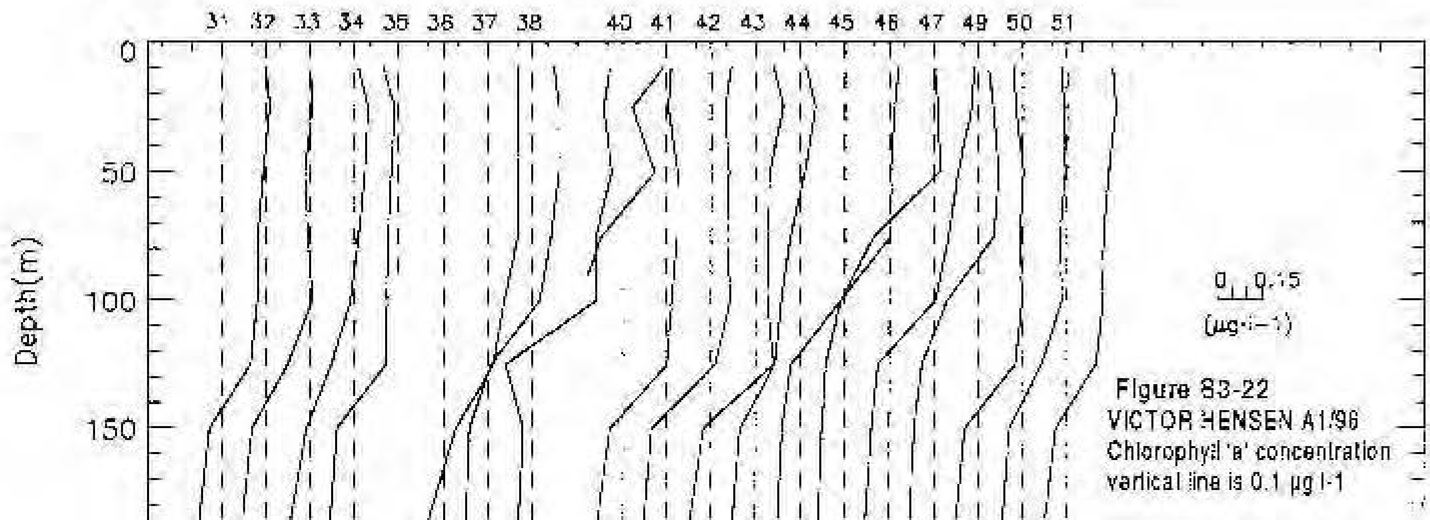
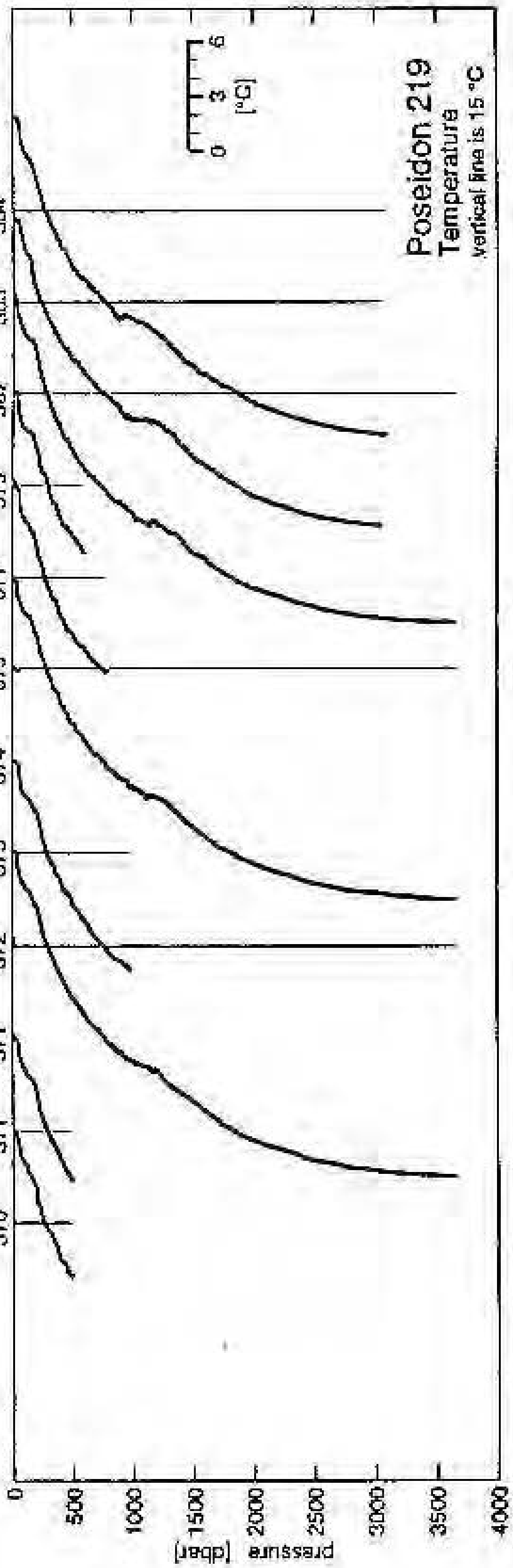
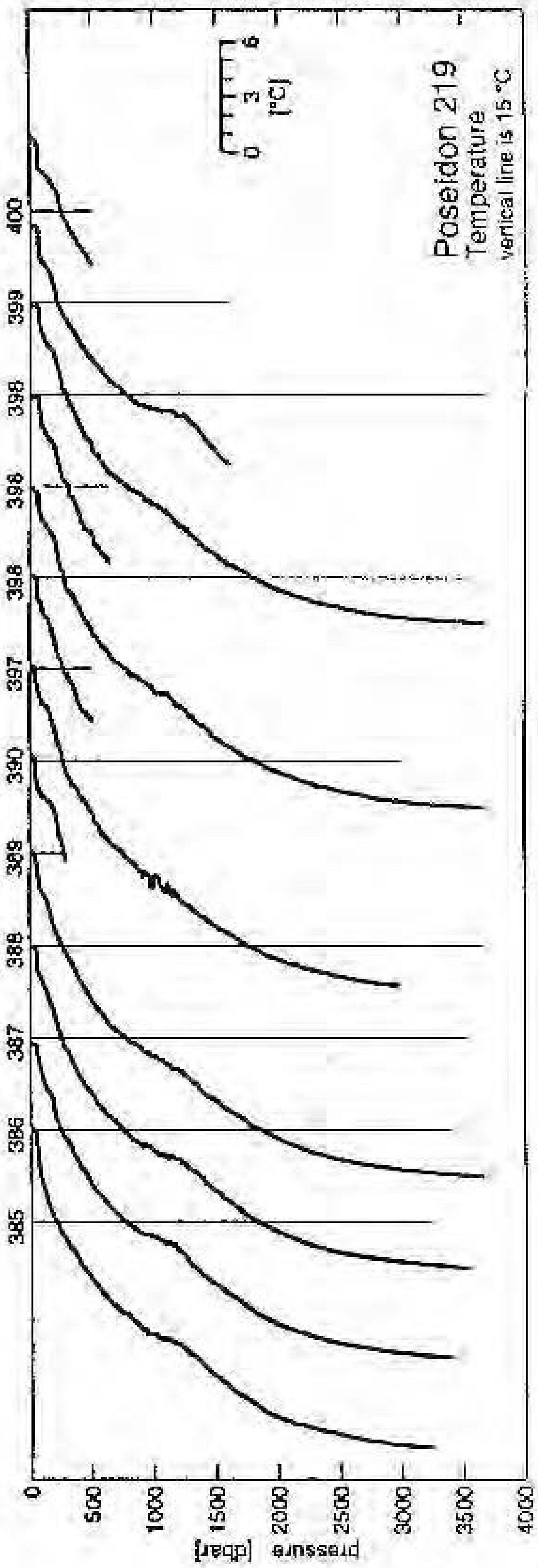
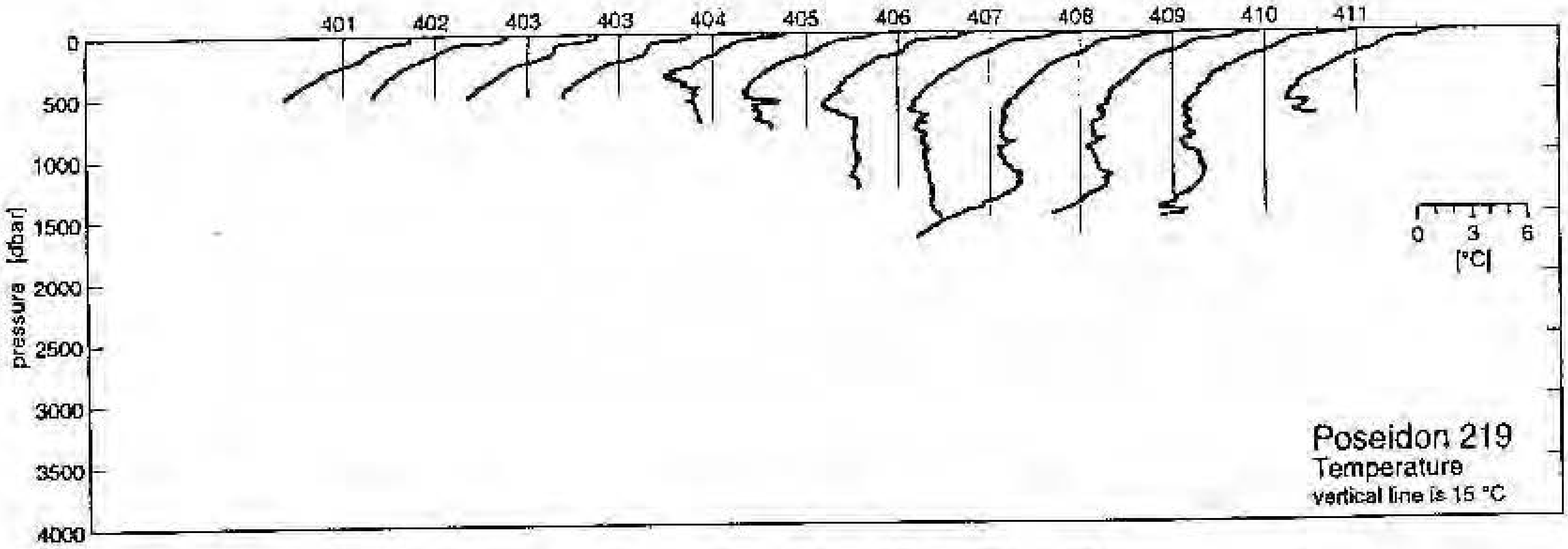


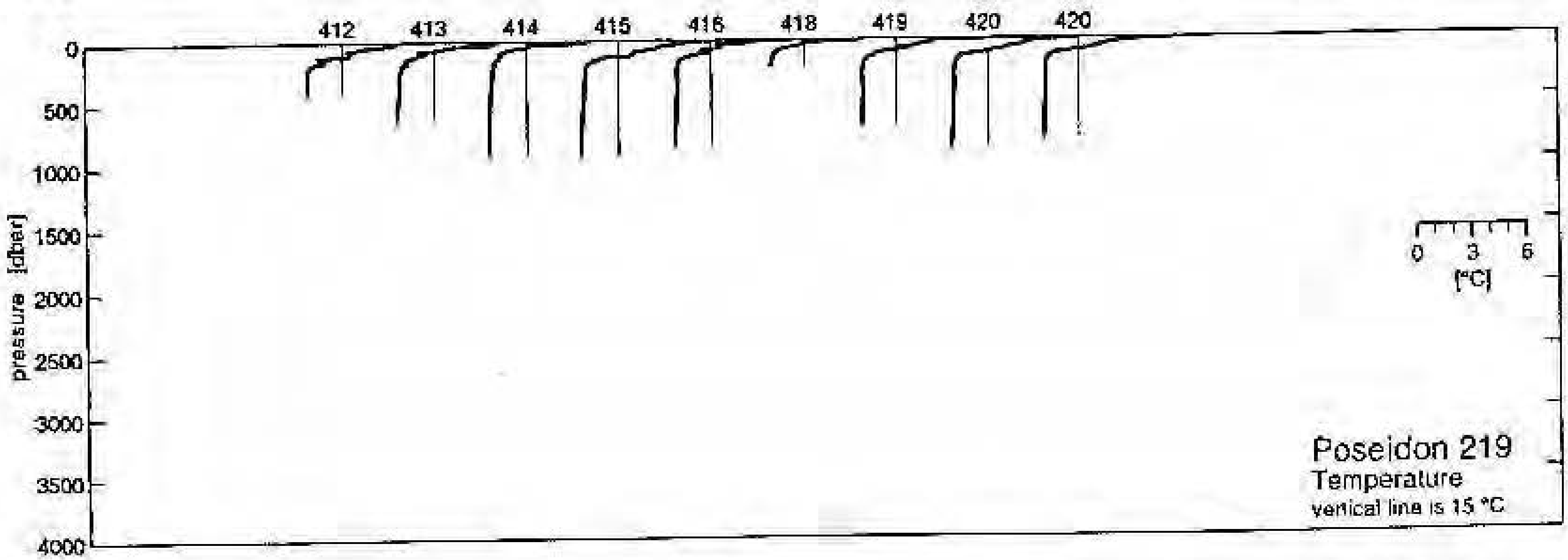
Figure B3-22
VICTOR HENSEN A1/96
Chlorophyll 'a' concentration
vertical line is 0.1 µg l-1

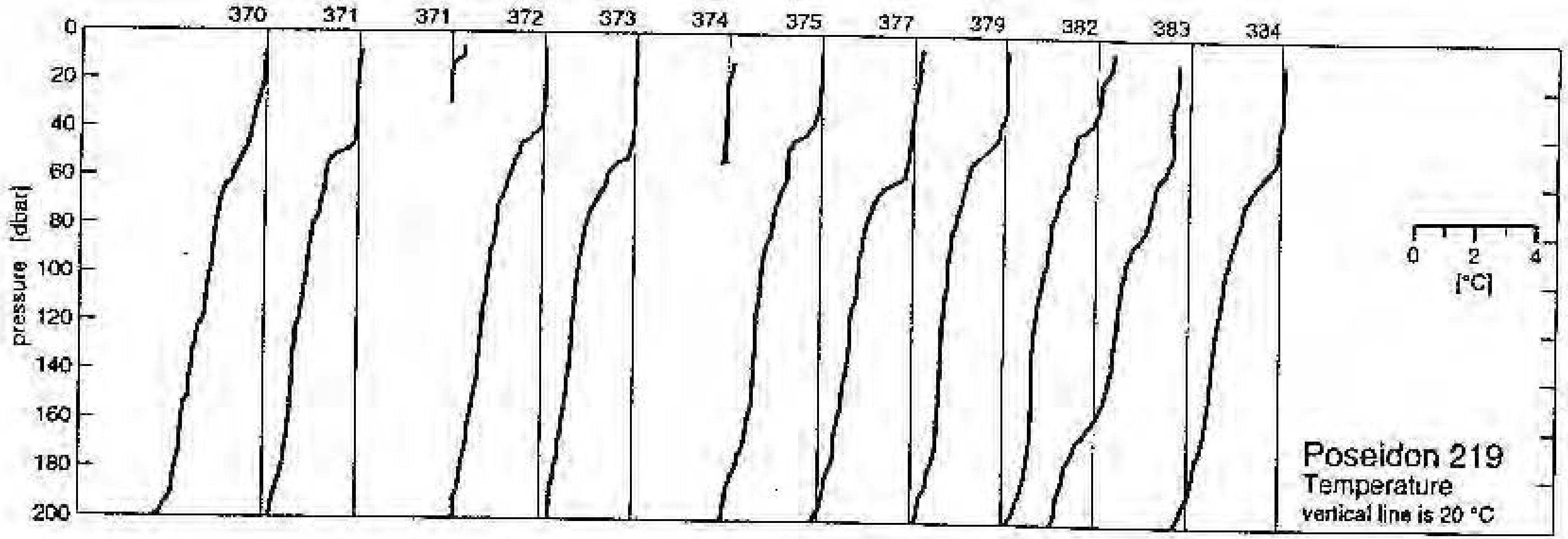
B4 "Poseidon" Cruise P 219

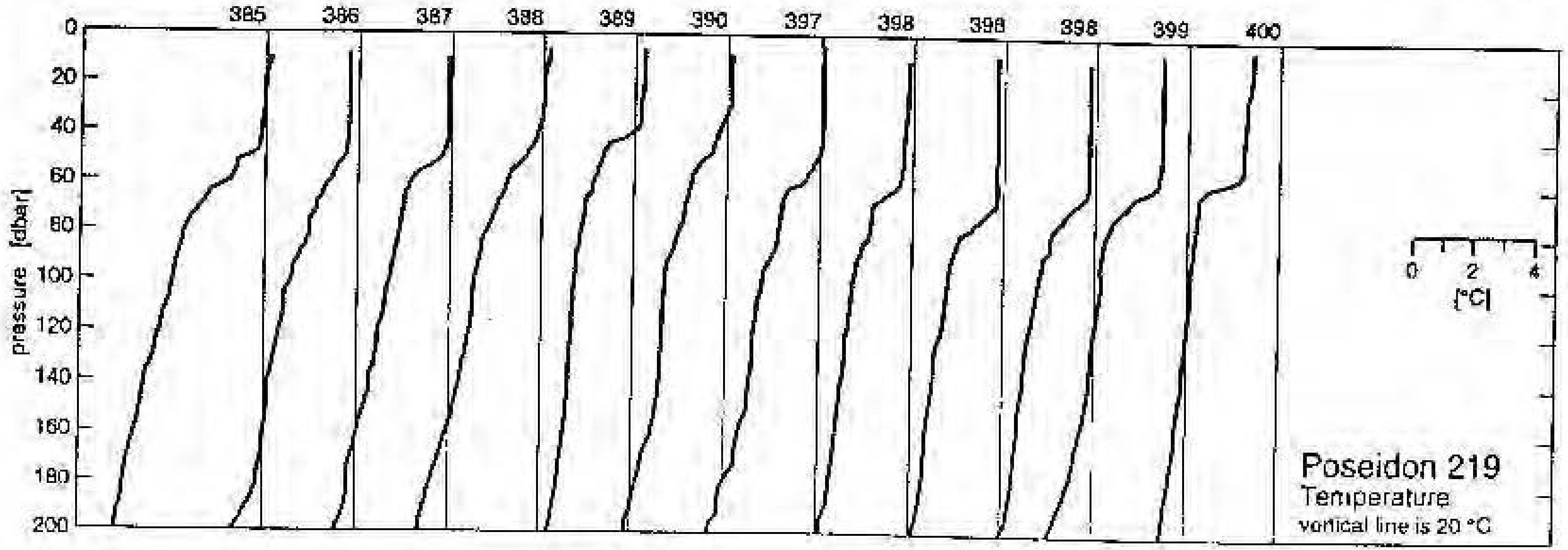


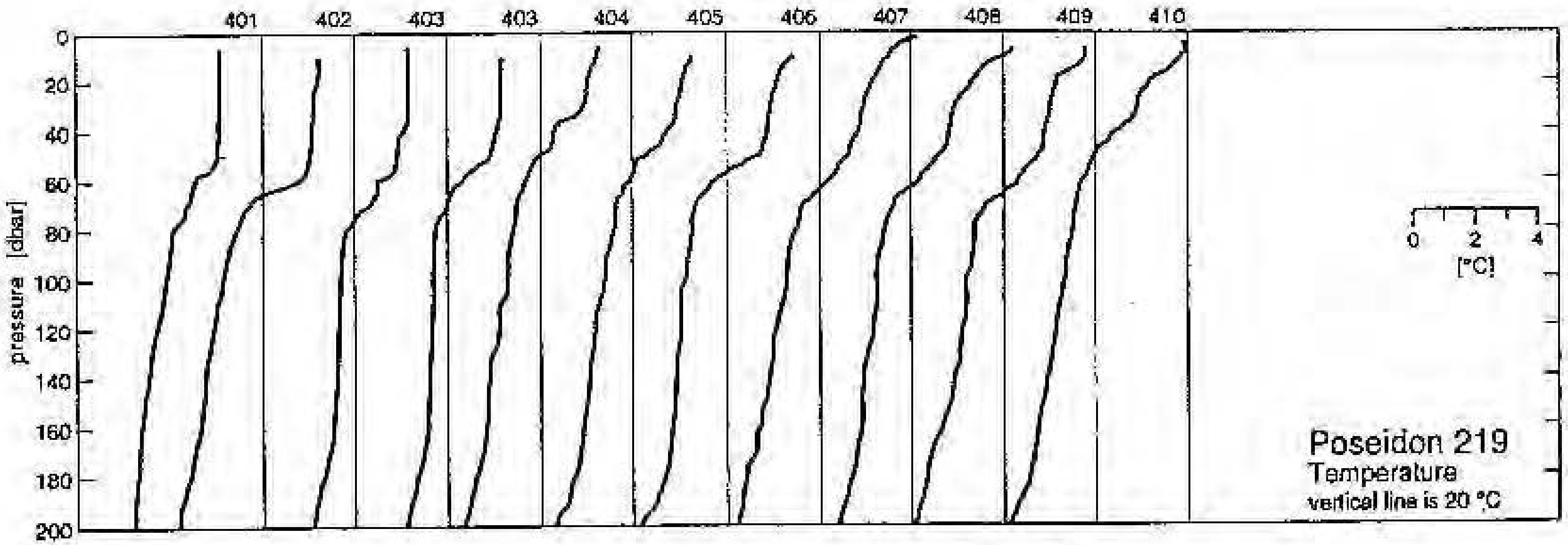


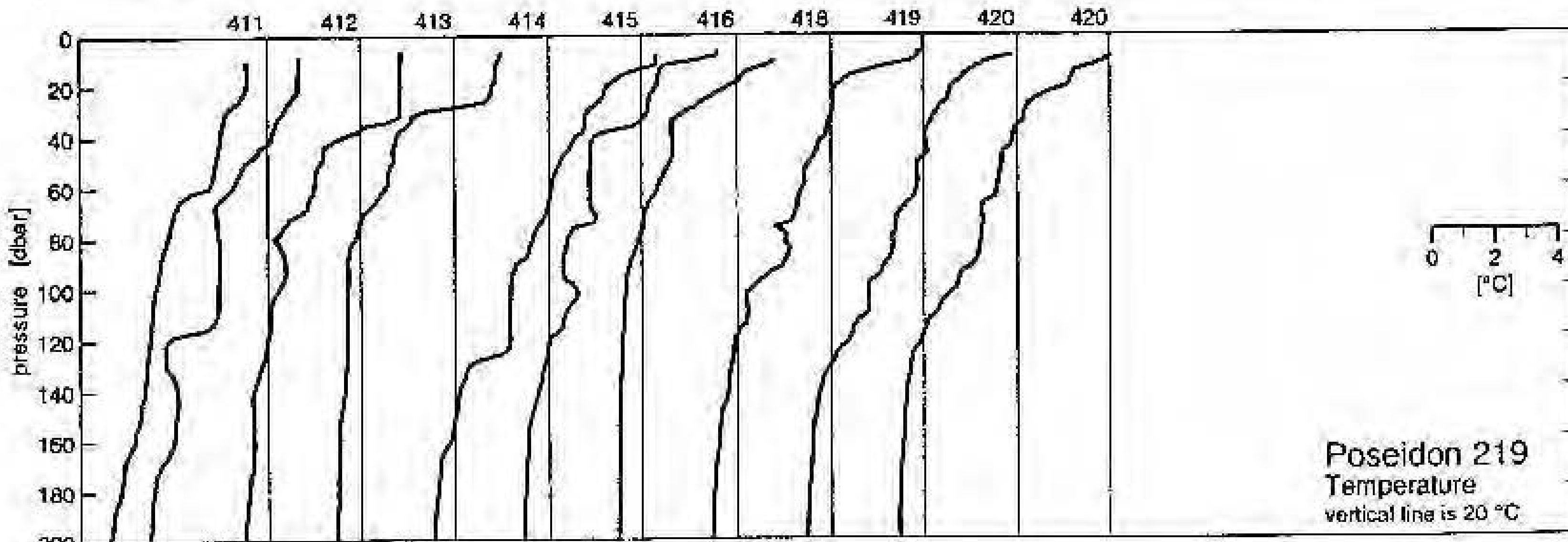

401 402 403 403 404 405 406 407 408 409 410 411
pressure [dbar]
0
500
1000
1500
2000
2500
3000
3500
4000
0 3 6
[°C]
Poseidon 219
Temperature
vertical line is 15 °C

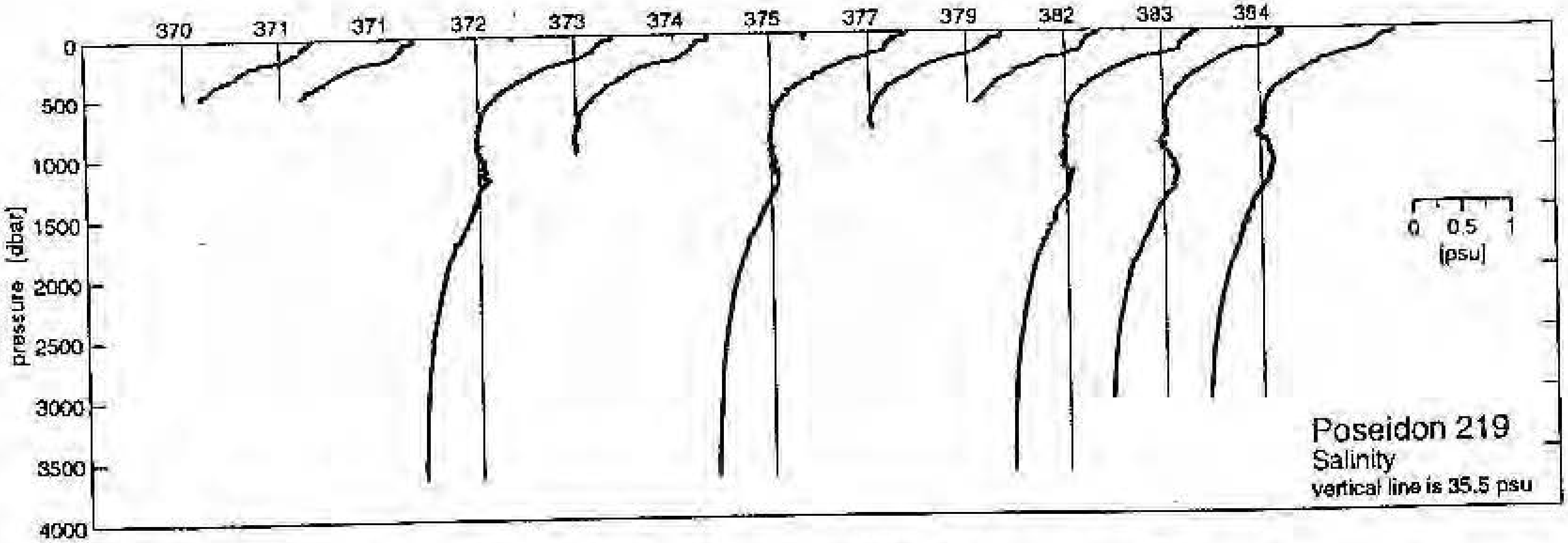

412 413 414 415 416 418 419 420 420
pressure [dbar]
0
500
1000
1500
2000
2500
3000
3500
4000
0 3 6
[°C]
Poseidon 219
Temperature
vertical line is 15 °C

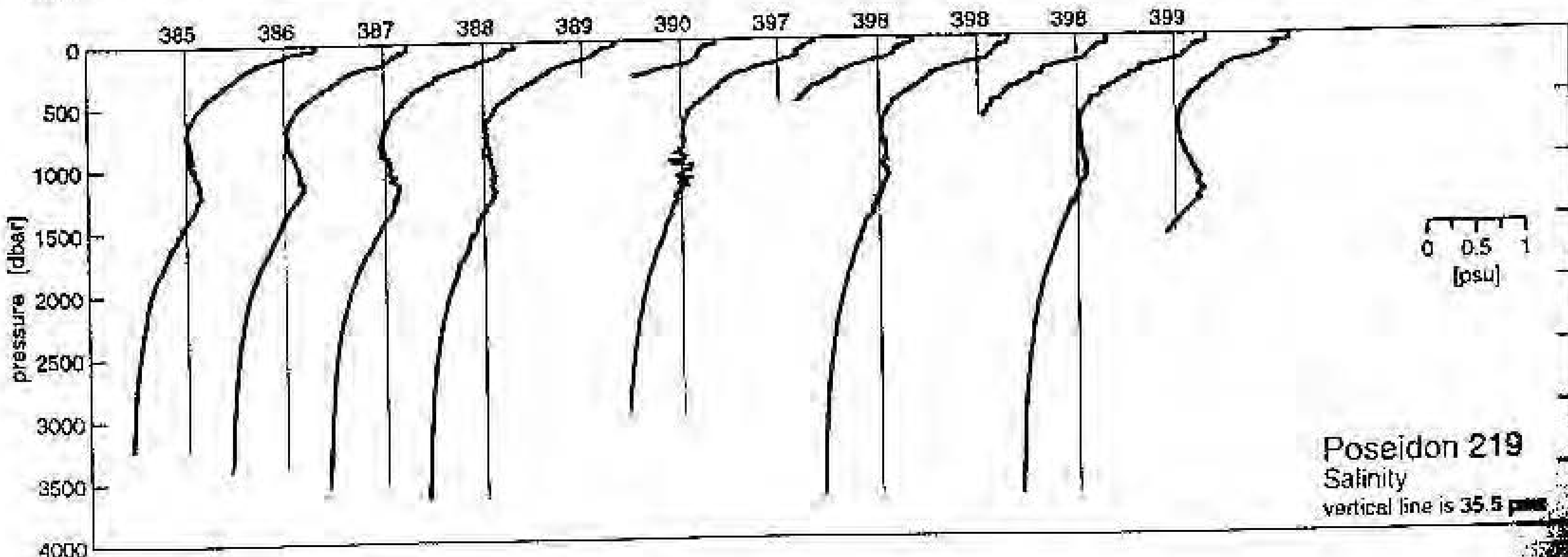

370 371 371 372 373 374 375 377 379 382 383 384
pressure [dbar]
0 20 40 60 80 100 120 140 160 180 200
0 2 4
[°C]
Poseidon 219
Temperature
vertical line is 20 °C

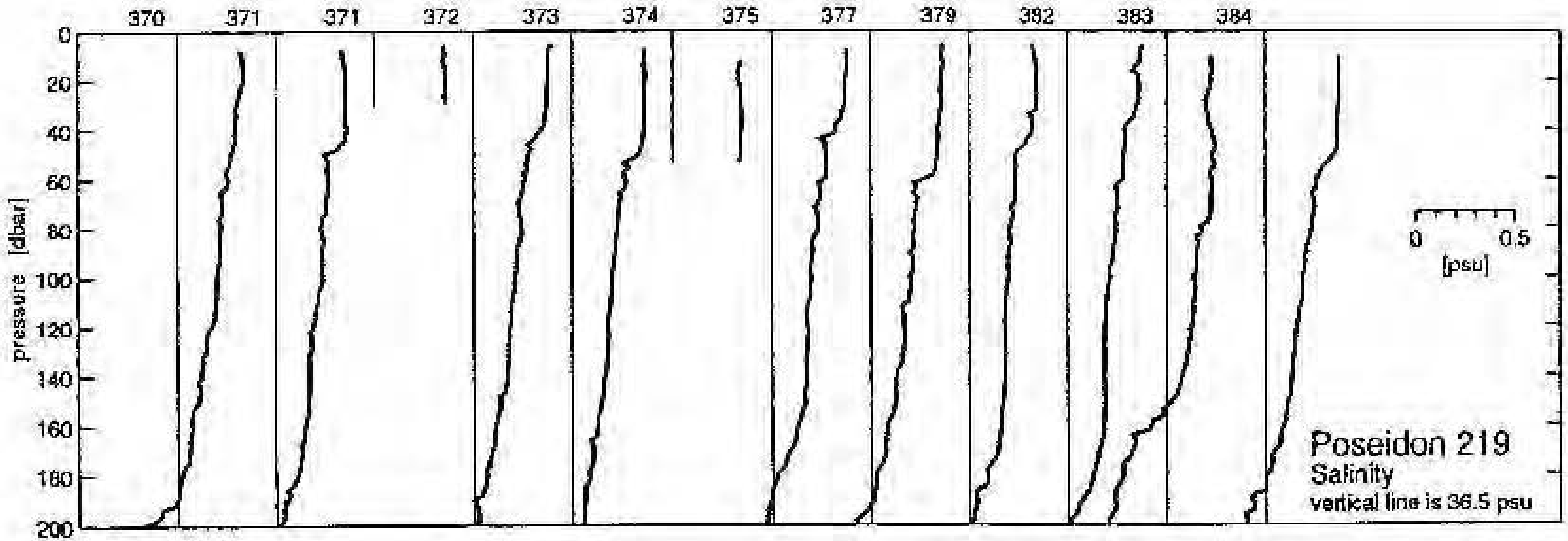

385 386 387 388 389 390 397 398 398 398 399 400
pressure [dbar]
0 20 40 60 80 100 120 140 160 180 200
0 2 4
[°C]
Poseidon 219
Temperature
vertical line is 20 °C

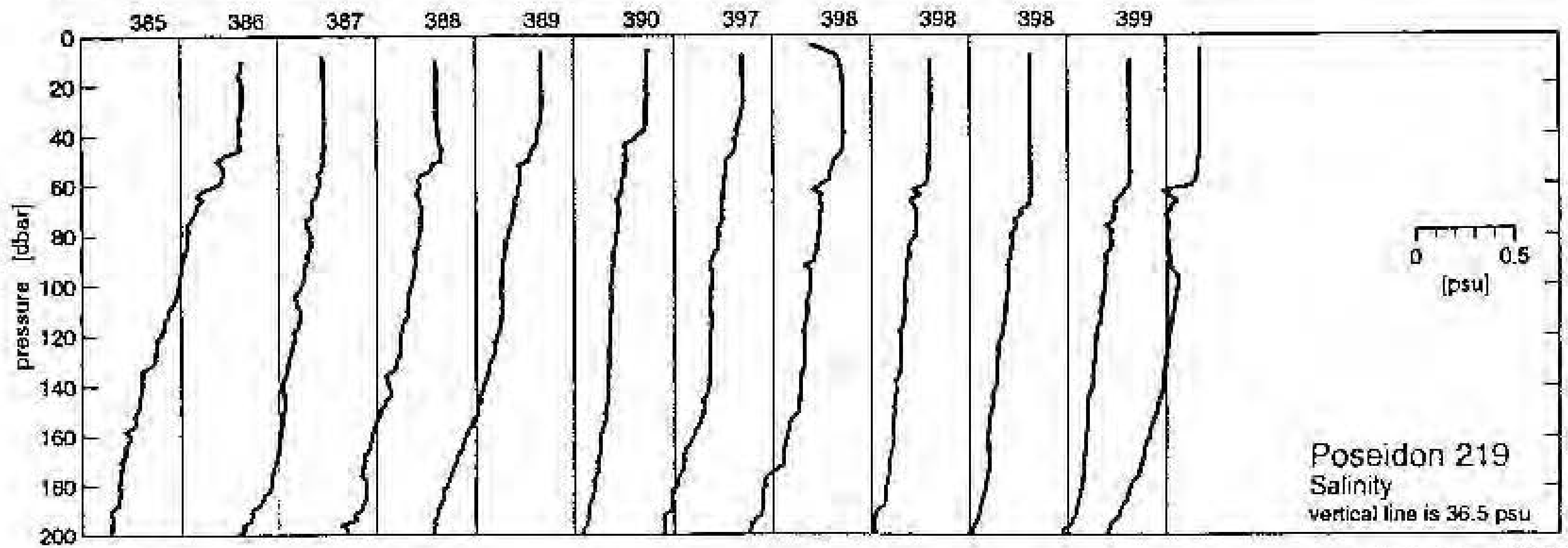

401 402 403 403 404 405 406 407 408 409 410
0 20 40 60 80 100 120 140 160 180 200
pressure [dbar]
0 2 4
[°C]
Poseidon 219
Temperature
vertical line is 20 °C


411 412 413 414 415 416 418 419 420 420
0 20 40 60 80 100 120 140 160 180 200
pressure [dbar]
0 2 4
[°C]
Poseidon 219
Temperature
vertical line is 20 °C


370
371
371
372
373
374
376
377
379
382
383
384
0
500
1000
1500
2000
2500
3000
3500
4000
pressure [dbar]
0 0.5 1
[psu]
Poseidon 219
Salinity
vertical line is 35.5 psu


385
386
387
388
389
390
397
398
398
398
399
0
500
1000
1500
2000
2500
3000
3500
4000
pressure [dbar]
0 0.5 1
[psu]
Poseidon 219
Salinity
vertical line is 35.5 psu


370 371 371 372 373 374 375 377 379 382 383 384
pressure [dbar]
0 20 40 60 80 100 120 140 160 180 200
0 0.5
[psu]
Poseidon 219
Salinity
vertical line is 36.5 psu


385 386 387 388 389 390 397 398 398 398 399
pressure [dbar]
0 20 40 60 80 100 120 140 160 180 200
0 0.5
[psu]
Poseidon 219
Salinity
vertical line is 36.5 psu

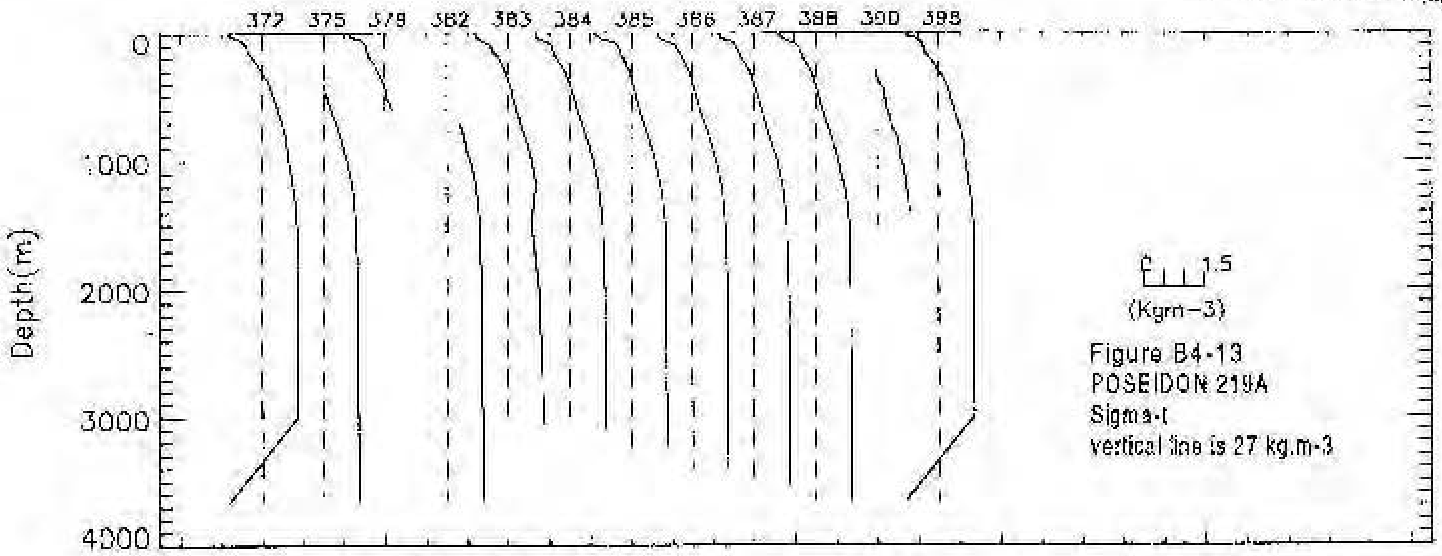


Figure B4-13
POSEIDON 219A
Sigma-t
vertical line is 27 kg.m-3

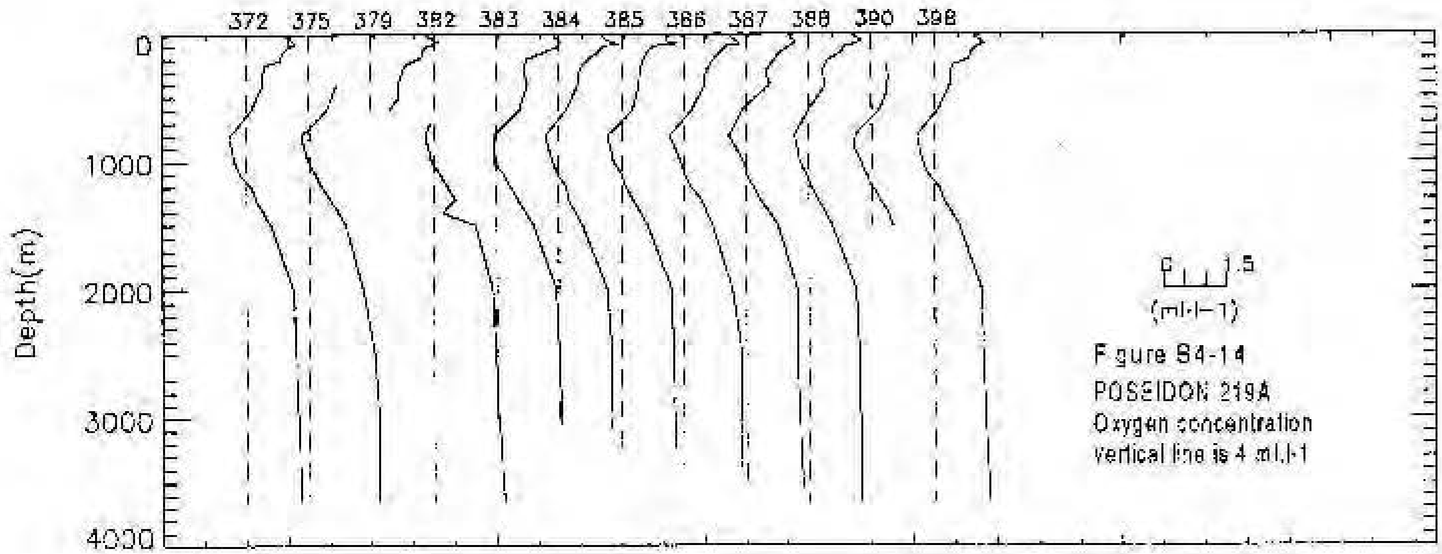


Figure B4-14
POSEIDON 219A
Oxygen concentration
vertical line is 4 ml.l-1

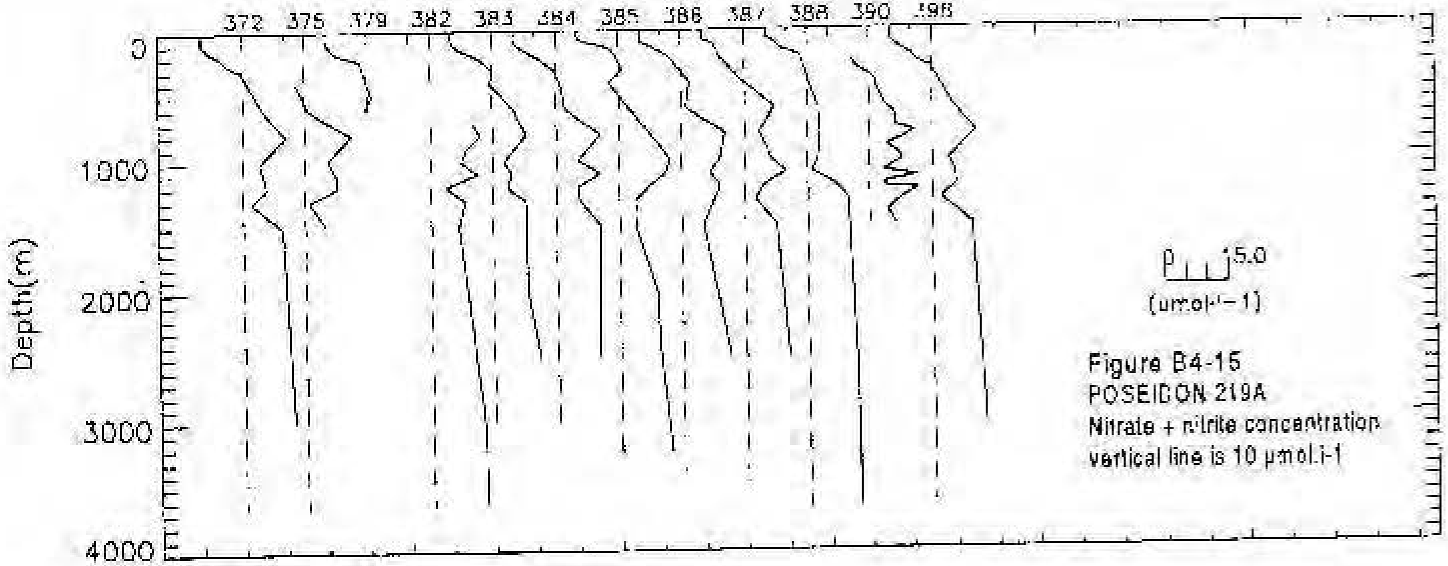


Figure B4-15
POSEIDON 219A
Nitrate + nitrite concentration
vertical line is 10 µmol.l-1

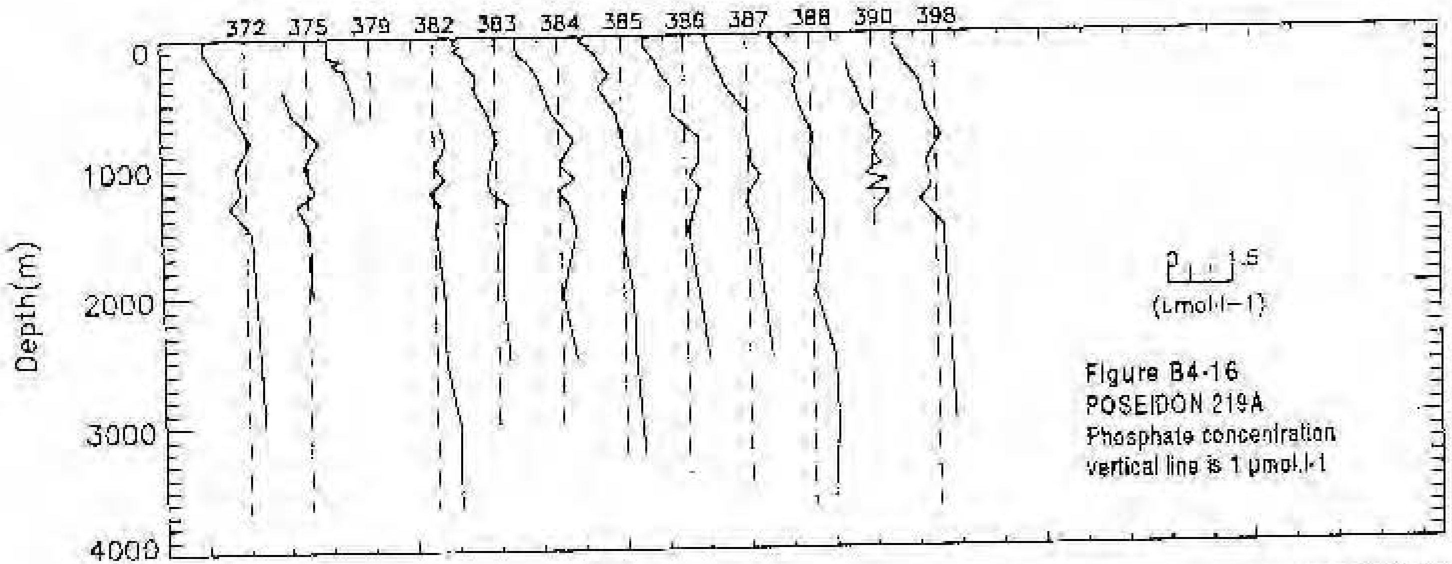


Figure B4-16
POSEIDON 219A
Phosphate concentration
vertical line is 1 µmol.l-1

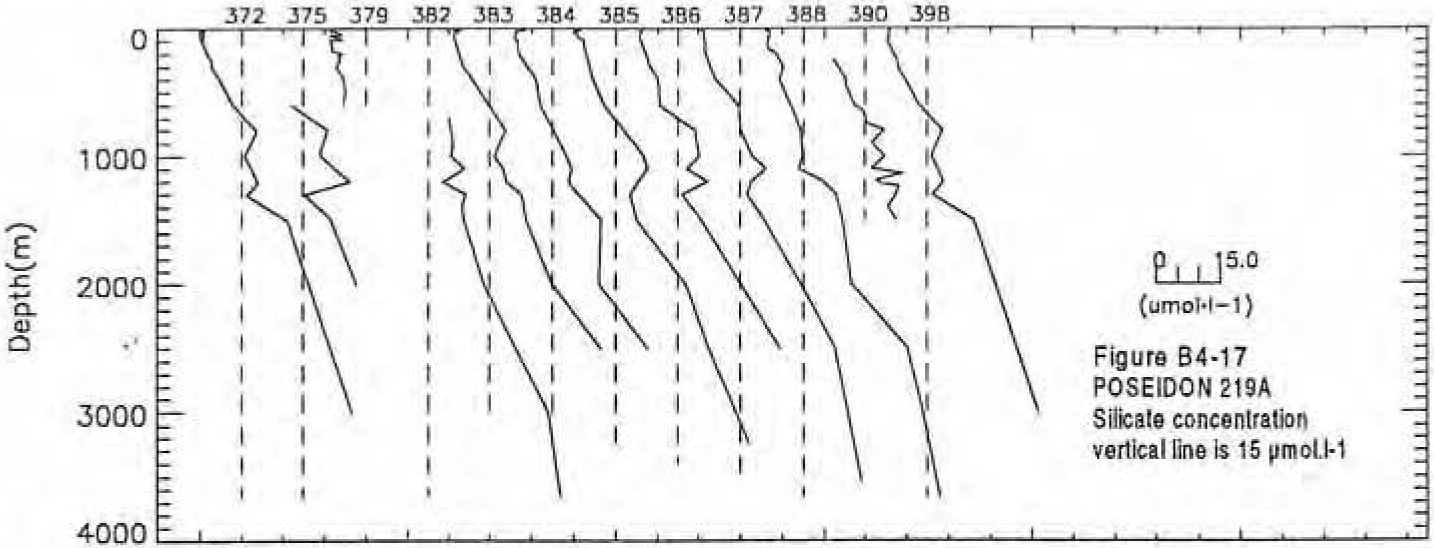


Figure B4-17
POSEIDON 219A
Silicate concentration
vertical line is 15 µmol.l-1

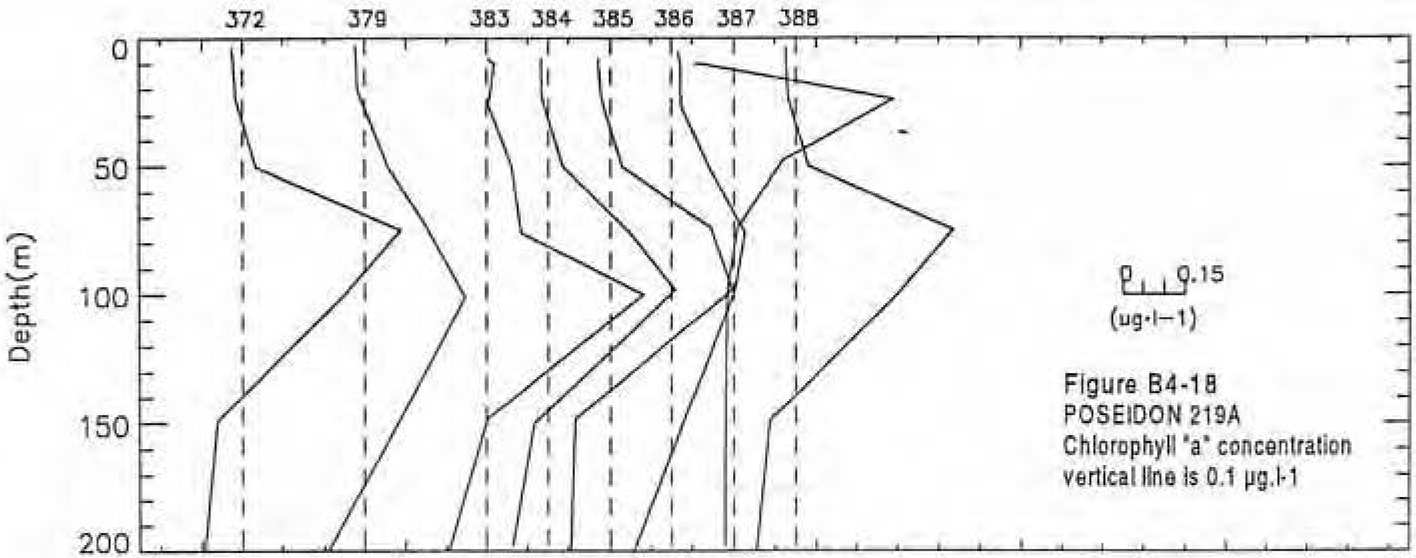


Figure B4-18
POSEIDON 219A
Chlorophyll "a" concentration
vertical line is 0.1 µg.l-1

C. List of acronyms

AAIW	Antarctic Intermediate Water
ADCP	Acoustic Doppler Current Profiler
AMAP	Arctic Monitoring and Assessment Programme
AOT	Aerosol Optical Thickness
ATSR	Along Track Scanning Radiometer
AVHRR	Advanced Very High Resolution Radiometer
AWI	Alfred Wegener Institut für Polar und Meeresforschung
BO	Buque Oceanográfico
BMBF	German Ministry for Education, Science, Research and Technology, Bonn, Germany
BOD	Biological Oxygen Demand
CPC	Chlorophyll-Like Pigment Concentration
CREPAD	Centro de Recepción, Proceso, Archivo y Distribución de Datos de Observación de la Tierra, Maspalomas, Gran Canaria
CTD	Conductivity Temperature Depth
CZCS	Coastal Zone Colour Scanner
DOC	Dissolved Organic Carbon
EAL	European Cooperation for Accredited Laboratories
EMF	Electromotoric Force
ERS	European Remote-sensing Satellite
ESA	European Space Agency
ESTOC	Estación de Series Temporales Oceánicas de Canarias European Station for Time-Series in the Ocean Canary Islands
ETH	Eidgenössische Technische Hochschule, Zürich
FS	Forschungsschiff
GAC	Global Area Coverage
GeoB	Fachbereich für Geowissenschaften, Universität Bremen
GF/F	Glass Microfibre Filter Type F
GPS	Global Positioning System
HELCOM	Helsinki Commission
HMDE	Hanging Mercury Drop Electrode
HSCSV	High Speed Cathodic Stripping Voltametry
IAPSO	International Association for the Physical Sciences of the Ocean
IBGM	Institut für Biogeochemie und Meereschemie, Hamburg
ICCM	Instituto Canario de Ciencias Marinas, Telde, Gran Canaria
ICES	International Council for the Exploration of the Sea
IEO	Instituto Español de Oceanografía
IFMH	Institut für Biogeochemie und Meereschemie, Hamburg

IFMK	Institut für Meereskunde, Kiel
IRS	Indian Remote-sensing Satellite
ISO	International Standards Organisation
IUPAC	International Union of Pure and Applied Chemistry
JGOFS	Joint Global Ocean Flux Study
LADCP	Lower Acoustic Doppler Current Profile
LPS	Laboratory Performance Studies
MEDPOL	Mediterranean Pollution Monitoring and Research Program
MOS	Marine Optical Sensor
MW	Mediterrranean Water
NACW	North Atlantic Central Water
NOAA	National Oceanic and Atmospheric Administration
OSPAR	Oslo and Paris Commissions
POC	Particulate Organic Carbon
PSU	Practical Salinity Units
QUASIMEME	Quality Assurance of Information for Marine Environmental Monitoring in Europe
RAFOS	Ranging And Fixing Of Sound
RAL	Rutherford Appelton Laboratory, United Kingdom
RSMAS	Rosenstiel School of Atmospheric and Marine Science, Miami
RV	Research Vessel
SACW	South Atlantic Central Water
SeaWIFS	Sea-Viewing Wide Field-of-View Sensor
SOAEFD	Scottish Agriculture, Environment and Fisheries Department
SST	Sea Surface Temperature
TracerB	Tracerphysik, Universität Bremen
UBG	Universität Bremen Geowissenschaften
ULPGC	Universidad de Las Palmas de Gran Canaria
UOL	Universität Oldenburg
WHP	WOCE Hydrographic Program
WOCE	World Ocean Circulation Experiment
XBT	Expendable Bathythermograph

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Figuras B4- 1 a B4-13. Variación temporal con la profundidad de los diferentes parámetros físicos, temperatura (figuras 1 a 8), salinidad (fig. 9 a 12), sigma-t (fig. 13) medidos en las estaciones muestreadas durante la campaña P219/1 del "Poseidon".

Figures B4-14 to B4-18. Variación temporal con la profundidad de los diferentes parámetros químicos (oxígeno, nitratos+nitritos, fosfatos, clorofila "a" y silicatos) medidos en las estaciones muestreadas durante la campaña P219/1 del "Poseidon".

INSTRUCTIONS TO AUTHORS (For papers in English)

TEXT

Original manuscripts should be typed on one side of A4 (21 x 29.7 cm) pages, Times New Roman 13 pt letter type, single-spaced, with a margin of 2.5 cm (1 inch) on the top, bottom and sides of each page. Pages should be centrally numbered in the bottom margin. The desired organization of a paper is as follows:

SUMMARY, RESUMEN
INDEX
INTRODUCTION
MATERIAL AND METHODS
RESULTS AND DISCUSSION
CONCLUSIONS
ACKNOWLEDGEMENTS
REFERENCES
APPENDIXES

The first page (not numbered) should include the title of the work (capital, bold letters); the full name of the author(s) (bold letter type, small for names and capital for surnames); the author(s) affiliation(s) and the address(es) (capital letters). Date of submission and reference of the work should appear at the lower end of the page, in bold, capital, italic letters.

The **SUMMARY** and **INDEX** should be typed in two separate, not numbered sheets, with centred headings (bold, capital letters). **INDEX** should include the different headings and sub-headings, with their corresponding starting page numbers. Text shall be numbered from page 4 (**INTRODUCTION**), with centred headings (bold, capital letters). One tab should be used at the start of every paragraph, and double space between different sections. No tabs will be required for sub-headings (capital, bold letters).

The full Latin specific name, including the authority with correct taxonomic disposition, should appear at least once for each species when first mentioned in the text or elsewhere, thus: Parrot fish *Sparisoma cretense* (Linnaeus, 1758). Latin names should appear in italic.

References in the text should be cited as: SMITH AND BROWN (1995) or (SMITH AND BROWN, 1995). Use only recommended SI units, e.g., mm, mm^3, s, g, $m\ l^{-1}$, with no plural "s" and full stops. Scientific Publication abbreviations should follow the guidelines of "World List of Scientific Publications". Decimal numbers should be typed with a period (0.25), numbers with more than three digits should be typed with a space (1 034), and calendar years without space (1995).

REFERENCES

The list of references should be arranged alphabetically according to the following order: author (surname, name initials- in capital letters); year of publication (if more than one reference by the same author published in the same year is cited, use "a"," b", etc after the year in both text and list, e.g. (1994a, 1994b); full name of the work; name of the Publication in italics (full or abreviated), number and pages. When books are cited, their titles should appear in italics, and editors and city should also be typed.

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Figures, tables and maps should not be larger than 17 x 22.5 cm once reduced, including legends. Figures, tables and map legends will be submitted in separate sheets if not included in the reduction. Headings and footnotes of figures, tables and maps should be single-spaced (italic letters). Figures and tables should be numbered in arabic. Extra footnotes to tables should be typed single-spaced (Times New Roman 10 pt letters).

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All manuscripts will be subject to referee and editorial review. When a manuscript is returned to the author for corrections prior to final acceptance, the revised manuscript must be submitted within 10 days of the authors' receipt of the referees' report. First authors will receive 10 free reprints of their papers.

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Le texte sera dactylographié sur DIN-A4, en lettre Times New Roman 13 pt, à 1 espace, laissant une marge de 2.5 cm de chaque côté. Les pages seront numéroté au centre de la marge inférieure. Les lettres majuscules seront aussi accentuées. La structure des rapports doit s'ajuster le plus possible aux suivants chapitres:

RÉSUMÉ-RESUMEN
INDEX
INTRODUCTION
MATÉRIEL ET MÉTHODES
RÉSULTATS ET DISCUSSION
CONCLUSIONS
REMERCIEMENTS
BIBLIOGRAPHIE
ANNEXES

En première pages iront le titre du rapport (en caractère gras et majuscule) et le(les) nom(s) de l'(des) auteur(s) (en caractère gras, minuscule le prénom et petite capitale le nom); leur(s) addresse(s), institution, addresse, ville, pays (en majuscule), date d'envoi et la référence du Rapport au bas de la page en caractère gras, majuscule et italique.

Le **RÉSUMÉ** et le **RESUMEN** iront seul, les titres centrés (en français et en espagnol) et sans numérotage. **L'INDEX**, aussi sans numérotage, contiendra les titres des chapitres et sous-chapitres et le numéro de page où ils commencent. Le numérotage commencera dans la page 4 avec l'**INTRODUCTION**. Les titres des chapitres iront centrés, en caractère gras et majuscule. L'écriture commencera avec une tabulation. On laissera une ligne blanche après les points à la ligne et deux lignes blanches entre chapitres. Les sous-chapitres seront numéroté selon leur ordre, et s'écriront en caractère gras, majuscule et sans tabulation.

Quand le nom vulgaire d'une espèce est cité pour la première fois dans le texte, il devra être suivit par son nom scientifique, l'auteur et l'année entre parenthèse (la pêche artisanale du poisson perroquet *Sparisoma cretense* (Linnaeus, 1758)). Les noms scientifique doivent s'écrire en italique (*Sparisoma*).

Les références à d'autres travaux seront faites en citant entre parenthèse uniquement le nom du(des) auteur(s) en petite capitale et l'année de la publication, separés par une virgule (GONZALEZ ET LOZANO, 1992).

Les symboles et signaux chimique, physiques ou mathématiques, seront écrits suivant les règles internationales en vigueur, sans points et sans pluriel. SI (Système d'Unités International). Les abreviations des publications scientifiques s'ajusteront aux indications de la "World List of Scientific Publications". Les nombres décimales s'écriront avec un point (0.25), les nombres de plus de trois chiffres au lieu d'un point auront un espace (1 034) et les années n'auront ni point ni espace (1995).

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INTRODUCCIÓN
MATERIAL Y MÉTODOS
RESULTADOS Y DISCUSIÓN
CONCLUSIONES
AGRADECIMIENTOS
BIBLIOGRAFÍA
ANEXOS

En la primera página irá el título del Informe (en negrita y mayúscula) y el(los) nombre(s) del (los) autor(es) (en negrita, minúscula el nombre y versalita el apellido); su(s) dirección(es), institución, dirección, ciudad, país (en mayúscula), la fecha de envío y la referencia del Informe a pie de página en negrita, mayúscula y cursiva.

El **RESUMEN** y **SUMMARY** irán solos, con los títulos centrados (en español e inglés) y sin numeración. El **ÍNDICE** va sin numerar y contendrá los títulos de los apartados y subapartados con la página donde comienzan. La numeración comenzará en la página 4 con la **INTRODUCCIÓN**. Los títulos de los apartados irán centrados, en negrita y mayúscula. Se comenzará a escribir dejando una tabulación. En los puntos y aparte se dejará un espacio y entre apartados se dejarán dos espacios. Entre un título y el texto se dejará un espacio. Los subapartados se numerarán siguiendo su orden correspondiente. Se mecanografiarán en mayúscula, negrita y sin tabulación.

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