BELGIAN

GLOBAL CHANGE / OMEX GEOCHEMISTRY

IMPULSE PROGAMME

RV BELGICA CRUISE 94/12

PARTICIPATING LABORATORIES FROM :

ULB - MUMM - VUB - ULg - CFR

MUMM contribution

Sampling stations, trackplot, SCTD profiles and horizontal profiles of salinity, temperature and fluorescence.

REPORT

Authors : J. BACKERS, J.P. DEBLAUWE, A. POLLENTIER.

Ministry of Public Health and Environment

Management Unit of the North Sea and
Scheldt Estuary Mathematical Model

B-8400 Oostende
3e & 23e Linieregimentsplein

Tel.:059/70.01.31
Fax.:059/70.49.35
E-mail:bmmost@camme.ac.be

Publ. 94/10-06/RV Belgica.

Belgian

GLOBAL CHANGE - OMEX BIOCHEMISTRY

Impulse Programme

R/V BELGICA CRUISE 94/12.

CONTENTS

B e l g i a n

GLOBAL CHANGE - OMEX BIOCHEMISTRY

Impulse Programme

R/V BELGICA CRUISE 94/12.

---

1. INTRODUCTION.

The RV Belgica cruise 94/12 took place from 20 April until 06 May 1994. During the first leg of the cruise 13 stations were sampled. The RV Belgica zigzagged (see Figure 2) along the French continental shelf. Meanwhile, the stations 1 to 7 and station 9 were sampled during a 2 to 4 hours stop.

At the stations 8 (La Chapelle Bank) and 10 (Meriadzek Terrace) processus studies were carried out during a respectively 22-hour and 14-hour stop. Due to bad weather conditions. the stations 11 to 13 could not be sampled. Instead, the Irish coastal stations "Holeopen Bay East" and "Celtic Sea" were sampled.

The Belgica berthed at Cork from 28 April till 01 May.

During the second leg of the OMEX cruise, the stations 15 (OMEX 1) and 17 (OMEX 2) were sampled. At the station 17 the Sea-Bird SBE911*plus* system was lost due to the break of the shackle. This meant the end of the cruise.

The R/V BELGICA arrived at Zeebrugge on 05 May.

Prof. R. Wollast was the principal scientist aboard the BELGICA for this cruise. The following laboratories have participated :

* Université Libre de Bruxelles (ULB) - Laboratoire d'Océanographie.
* Vrije Universiteit Brussel (VUB) - Laboratorium voor Analytische Scheikunde.
* Université de Liège (ULg) - Laboratoire d'Océanologie.
* CNRS/CEA (FR.) - Centre de Faibles Radioactivités (CFR).
* Ministry of Public Health and Environment - Management Unit of the North Sea and Scheldt Estuary Mathematical Model (MUMM).

MUMM was mainly charged with the automatic data acquisition and logging of oceanographic, meteorological and navigational data.

In addition to the data acquisition task, general assistance was offered in using the on board scientific instrumentation and related infrastructure, the 30l Niskin bottle sampling, etc ...

Also samples for laboratory salinity measurements were taken, and these samples have been analyzed in MUMM's laboratory at Oostende.

The present report describes the computer logged oceanographic, meteorological and navigational data gathered during this cruise. Also the results of the laboratory salinity measurements are included.

2. COMPUTER LOGGED OCEANOGRAPHIC, NAVIGATIONAL AND METEOROLOGICAL DATA.

2.1. Navigational instrumentation

During this cruise, the data from the following navigational instruments connected to the shipborn computer system were logged by the so called Oceanographic Data Acquisition Software system "ODAS" :

* MAGNAVOX 200MX GPS navigation system with an accuracy of typically 50m.
* SHIPMATE RS4000 DECCA navigation system.
* NAVSTAR 602D DECCA navigation system.
  This last 2 navigation systems have an accuracy of typically 50 to 400 meter, mostly depending on atmospheric conditions. In the centre of the Gulf of Biscay, the lack of a good DECCA coverage leads to errors of almost 1 nautical mile.
* Anshutz STD12 Gyro Compass.
* Raytheon DSN450 Doppler speed log and bathymetric depth.
* Atlas Deso 20 Scientific Echosounder.
  The Atlas Deso 20 is equipped with 2 transducers (33 kHz and 210 kHz). The 33 kHz transducer has a depth range of ca. 1500 m in good weather conditions.

2.2. Oceanographic instrumentation

The seasurface temperature was measured continuously with a Rosemount temperature sensor as well as with the remote temperature sensor of the Sea-Bird SBE21 thermosalinograph, both installed at the inlet of the special seawater circuit situated at the bow of the vessel.

The Sea-Bird SBE 21 thermosalinograph, installed in the wet lab, is connected to the special seawater circuit. The salinity was measured continuously using a personal computer with a dedicated software package from Sea-Bird. The processed data was continuously transmitted to the HP1000 data acquisition computer. The specifications of this thermosalinograph are found in table 1.

Parameter	Units	Range	Accuracy
TEMPERATURE	°C	-5 - +35	0.01 °C / 6 months
CONDUCTIVITY	S/m	0 - 7	0.001 S/m / month

Table 1. Sea-Bird SBE 21 thermosalinograph specifications.

Salinity and density are calculated from conductivity, temperature and depth, in accordance to the 1978 Practical Salinity Scale from the IEEE Journal of Oceanic Engineering, January 1980.

A Turner Designs 10-AU-005 fluorimeter, also connected to the special seawater circuit, was used to measure chlorophyll concentrations during the full campaign. The data was also transmitted to the HP1000 data acquisition system.

SCTD vertical profiles have been taken with the Sea-Bird SBE 911*plus* CTD profiler. The specifications of this CTD profiling system are given in table 2.

Parameter	Units	Range	Accuracy (guaranteed)
DEPTH	m	0 - 3000	0.1 % of full scale range
TEMPERATURE	°C	-5 - +35	0.01 °C / 6 months
CONDUCTIVITY	S/m	0 - 6	0.001 S/m / month
DIS. OXYGEN	ml/l	0 - 15	0.1 ml/l / day

Table 2. Sea-Bird SBE 911*plus* specifications.

2.3. Meteorological instrumentation

Following parameters were measured by the Friedrichs meteorological station :

- windspeed
- winddirection
- airtemperature
- atmospheric pressure

In addition a solar radiation measuring device from Kipp & Zonen was installed.

The outputs of these sensors are analogous signals that are measured with the 4 ½ digit digital voltmeter incorporated in the ODAS system. Table 3 gives a review of the specifications of the meteo sensors.

Parameter	Units	Range	Precision
WIND SPEED	m/s	0 - 41	0.2
WIND DIRECTION	degrees	0 - 360	2
ATMOSPHERIC PRESSURE	mbar	950 - 1050	1.5
AIR TEMPERATURE	°C	-35 - +45	0.2
SOLAR RADIATION	Watt/m²	0 - 1000	10

Table 3. Meteo sensor specifications.

2.4. Satellite images.

During this cruise satellite images of the surface watertemperature were received from the NERC Image Analysis Unit in Plymouth. A total of 5 satellite images were received via a Inmarsat satellite communication link. Unfortunately the weather was rather cloudy during the cruise so that the zone of interest could not always be covered with data. The appendix 7 gives 2 usefull images. Darker grey corresponds to higher surface watertemperature.The black zones are clouds. On image 1 the depth lines of 200 m and 1000 m are added to the image.

3. DATA ACQUISITION SYSTEM.

3.1. HP1000 - ODAS system.

A Hewlett Packard HP1000 minicomputer system with a HP6942 multiprogrammer and an HP3497A digital voltmeter subsystem were used to provide continuously logged data at the following intervals :

05 min. : navigational, meteorological and oceanographic data during the whole cruise.

01 min. : navigational data sea surface temperature and fluorescence during the full cruise.

1.0 sec. : incident light data (quantameter) during vertical profiles.

The Oceanographic Data Acquisition System "ODAS" software package has been used for this purpose.

This ODAS software package was designed to interrogate the different subsystems, instruments and sensors installed, and to gather in real time several groups of parameters at different time intervals. The data are stored on Winchester disc while at the same time the data can be listed or plotted in real time or off line. Selected parameters can also be distributed in real time to the video monitors installed in the laboratories and on the bridge.

The data are transferred to the shore based data processing centre of MUMM situated at Oostende using the integral cartridge backup system of the Winchester drive.

At the shore station the data is stored on a identical HP1000 system, hence the same ODAS software package can be used for further processing.

Additionally the data stored in the internal ODAS format (binary) have been converted to ASCII for transportation to a PC MS-DOS or a UNIX system, using the KERMIT data transfer package.

3.2. SCTD - Horizontal profiling system.

The Sea-Bird SBE 21 thermosalinograph is installed in the wet lab and is connected to the special seawater circuit. The data are recorded continuously to obtain horizontal salinity profiles during the trajectories or time profiles at the fixed stations. A remote temperature sensor is installed at the seawater circuit water inlet at the bulb of the R/V Belgica. The data, sampled every 6 seconds, are acquired with a personal computer. A graphical presentation of the data is available on the computer screen, while the data are sent in real-time to the HP1000 computer system.

A Turner Designs 105-AU fluorimeter is also connected to the seawater circuit. The results are transmitted to the HP1000 computer system in real-time every second.

3.3. SCTD - Vertical profiling system.

The vertical CTD profiles have been obtained with the Sea-Bird SBE 911*plus* system installed on a Sea-Bird Rosette sampler. The Sea-Bird SBE 911*plus* was equiped with 2 conductivity sensors, 2 temperature sensors, a depth sensor and an ISY oxygen sensor. The system measures the depth of the sensor package, water temperature, conductivity and dissolved oxygen at a rate of 24 samples per second. These data are averaged in the Sea-Bird deck unit over a 0.5 sec. time interval.

The averaged values are shown in real time on the PC display in a graphical way, allowing for an immediate decision of the water sampling depths. The Sea-Bird CTD software also allows to mark the SCTD data when water bottle samples are taken so that the SCTD and related parameters are known at the exact depth.

4. INVENTORY OF AUTOMATICALLY LOGGED NAVIGATIONAL, METEOROLOGICAL AND OCEANOGRAPHIC DATA.

All datafiles created during the BELGICA campaign 94/12 have been concatenated into the following data files :

Filename	Acquisition rate	Type of data	Duration
M21400	10'	navig. + meteo	Full campaign.
031400	1'	position + oceano.	Full campaign.
Q41400	0.5"	quantameter	Stations 02, 06, HO, CS, 15 and 17.
OMX9401.DAT	0.5"		CTD profiles at
OMX9401A.DAT	0.5"		
OMX9402.DAT	0.5"		the Fench Continental
OMX9402A.DAT	0.5"		
OMX9403.DAT	0.5"	CTD	shelf stations.
OMX9404.DAT	0.5"		
OMX9404A.DAT	0.5"	vertical	
OMX9405.DAT	0.5"		
OMX9406.DAT	0.5"	profile	
OMX9406A.DAT	0.5"		
OMX9407.DAT	0.5"		
OMX9408.DAT	0.5"		
OMX9408A.DAT	0.5"		
OMX9409.DAT	0.5"		
OMX9410.DAT	0.5"	CTD	
OMX9415.DAT	0.5"		
OMX9415A.DAT	0.5"	vertical	
OMX9417.DAT	0.5"		
OMX9417A.DAT	0.5"	profile	
OMX94CS.DAT	0.5"		CTD profiles at the
OMX94CSA.DAT	0.5"		
OMX94HO.DAT	0.5"		Irish coast stations.
OMX94HOA.DAT	0.5"		

Table 4. Data file inventory.

These file names or derivatives occur on the different listings and plots.

5. REMARKS CONCERNING DATA ACQUISITION AND DATA VALIDITY.

5.1. Position registration.

During the whole GLOBAL CHANGE campaign, the GPS based navigation system (Magnavox 200MX) was used as the primary positioning instrument. The DECCA based systems (Shipmate RS4000 and NAVSTAR 602D) were used as backup systems.

5.2. Salinity measurements.

5.2.1. Validation of the SCTD salinity measurements.

During the campaign vertical SCTD profiles have been taken with the SBE model 911*plus* SCTD system. The SBE911*plus* SCTD system was equiped with 2 temperature sensors and 2 conductivity sensors. The derived temperature and salinity are called primary and secondary temperature and salinity in the tables and data files.

At different locations and multiple depths water samples have taken to validate the salinity data of the SBE 911 system. The water samples have been analysed in MUMM's laboratory at Oostende with a Beckmann RB7 laboratory salinometer.

The Beckmann salinometer is calibrated using IAPSO standard seawater capsules obtained from the Institute of Oceanographic Sciences (UK).

The results of the Beckmann salinometer have been compared with the Sea-Bird SBE 9 salinity measurements (see Table 5 and Figure 1).

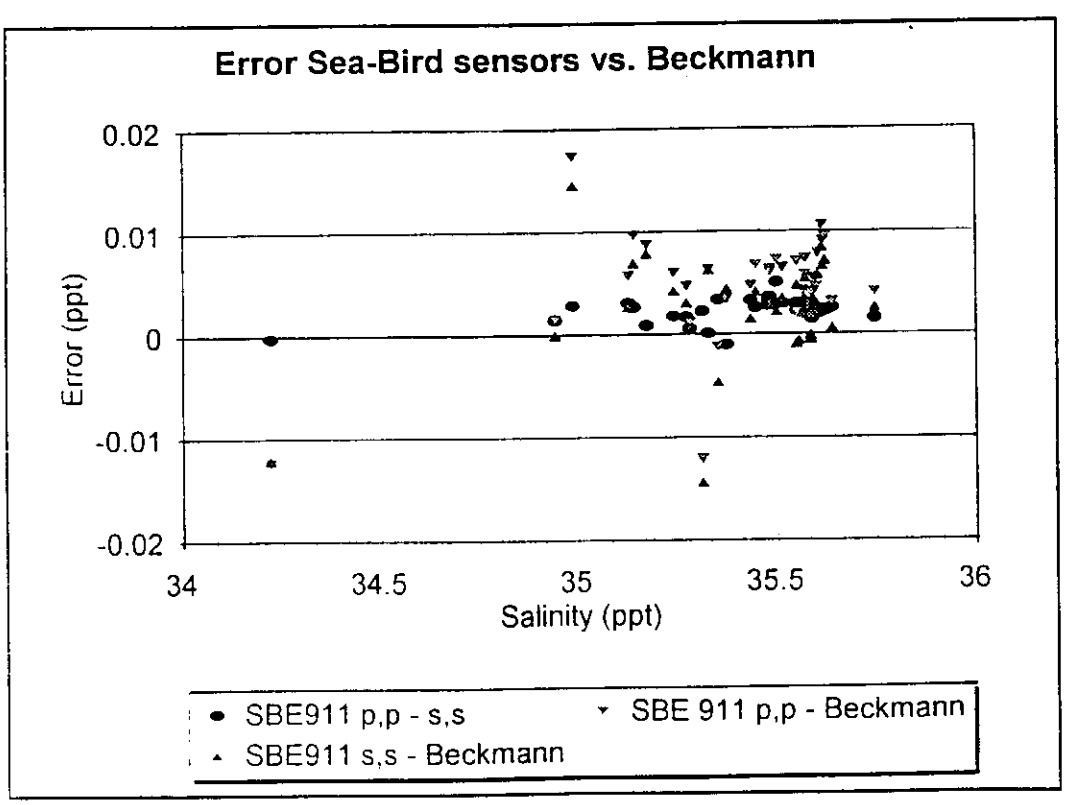
	Standard deviation ppt	Mean error ppt	Corrolation coëff.
SBE 911 p,p - SBE 911 s,s	0.00106	0.00221	0.999699
SBE 911 p,p - Beckmann	0.00499	0.00465	0.999343
SBE 911 s,s - Beckmann	0.00482	0.00236	0.999706

Table 5. Data Sea-Bird SBE 911*plus* versus Beckmann RB7 salinometer.

Station	SBE 911 p,p	SBE 911 s,s	Beckmann	Difference SBE 911 p,p - SBE 911 s,s	Difference SBE 911 p,p - Beckmann	Difference SBE 911 s,s - Beckmann
1 - 5m	34.2087	34.2089	34.2210	-0.0002	-0.0123	-0.0121
1 - 80m	35.6226	35.6205	35.6120	0.0021	0.0106	0.0085
2 - 10m	35.3785	35.3795	35.3750	-0.0010	0.0035	0.0045
2 - 200m	35.6109	35.6088	35.6030	0.0021	0.0079	0.0058
2a - 5m	35.3009	35.2986	35.3130	0.0023	-0.0121	-0.0144
2a - 600m	35.5985	35.5964	35.5930	0.0021	0.0055	0.0034
2a - 1000m	35.7501	35.7486	35.7460	0.0015	0.0041	0.0026
2a - 1470m	35.2822	35.2816	35.2810	0.0006	0.0012	0.0006
3 - 5m	34.9445	34.9430	34.9430	0.0015	0.0015	0.0000
3 - 200m	35.6231	35.6207	35.6140	0.0024	0.0091	0.0067
4 - 5m	35.5929	35.5914	35.5890	0.0015	0.0039	0.0024
4 - 200m	35.5931	35.5911	35.5890	0.0020	0.0041	0.0021
4a - 20m	35.5794	35.5775	35.5720	0.0019	0.0074	0.0055
4a - 500m	35.5581	35.5558	35.5510	0.0023	0.0071	0.0048
4a - 1000m	35.6305	35.6282	35.6210	0.0023	0.0095	0.0072
4a - 1500m	35.2471	35.2453	35.2410	0.0018	0.0061	0.0043
5 - 5m	35.3518	35.3484	35.3530	0.0034	-0.0012	-0.0046
5 - 80m	35.4894	35.4858	35.4830	0.0036	0.0064	0.0028
5 - 264m	35.6036	35.6011	35.5990	0.0025	0.0046	0.0021
6 - 10m	35.6003	35.5982	35.5950	0.0021	0.0053	0.0032
6 - 200m	35.5901	35.5880	35.5860	0.0021	0.0041	0.0020
6a - 1000m	35.6422	35.6396	35.6390	0.0026	0.0032	0.0006
6a - 300m	35.5872	35.5849	35.5850	0.0023	0.0022	-0.0001
6a - 1500m	35.2778	35.2761	35.2730	0.0017	0.0048	0.0031
7 - 5m	35.5758	35.5736	35.5700	0.0022	0.0058	0.0036
7 - 100m	35.5683	35.5660	35.5640	0.0023	0.0043	0.0020
8 - 20m	35.5889	35.5859	35.5860	0.0030	0.0029	-0.0001
8 - 100m	35.5885	35.5855	35.5860	0.0030	0.0025	-0.0005

Station	SBE 911 p,p	SBE 911 s,s	Beckmann	Difference SBE 911 p,p - SBE 911 s,s	Difference SBE 911 p,p - Beckmann	Difference SBE 911 s,s - Beckmann
9 - 20m	35.5580	35.5554	35.5560	0.0026	0.0020	-0.0006
9 - 100m	35.5521	35.5491	35.5500	0.0030	0.0021	-0.0009
hoe - 10m	35.0055	35.0026	34.9880	0.0029	0.0175	0.0146
cs -20m	35.1338	35.1307	35.1280	0.0031	0.0058	0.0027
cs - 40m	35.1507	35.1480	35.1410	0.0027	0.0097	0.0070
cs - 60m	35.1818	35.1809	35.1730	0.0009	0.0088	0.0079
15 - 10m	35.5225	35.5195	35.5160	0.0030	0.0065	0.0035
15 - 300m	35.5073	35.5022	35.5000	0.0051	0.0073	0.0022
15 - 600m	35.4408	35.4375	35.4360	0.0033	0.0048	0.0015
17 - 100m	35.4891	35.4860	35.4830	0.0031	0.0061	0.0030
17 - 600m	35.4548	35.4522	35.4480	0.0026	0.0068	0.0042
17 - 1200m	35.3354	35.3353	35.3290	0.0001	0.0064	0.0063

Figure 1. Error Sea-Bird SBE 911*plus* versus Beckmann RB7 salinometer.



5.2.2. Salinity spiking of the SCTD measurements.

In order to improve the performance of the salinity measurements, the Sea-Bird SBE 9 has a Temperature and Conductivity (TC) duct with an inertia-balanced pump flow.

The salinity spiking alignment computer program has been applied on the SCTD data (sampling speed 12 samples per second) to minimize the salinity spiking.
See also "JGOFS 90, RV BELGICA cruise 90/18, MUMM contribution Volume I : Report, J. Backers, A. Pollentier.".

5.3. Data validity.

One of the features of the ODAS package is that it verifies all subsystems, instruments and parameters interrogated.

To each parameter value, subsequently logged in the ODAS files, one byte is added to take into account these data validity checks.

The validity is also shown on the data listings and transferred to the ASCII files. The following code is used :

Code	Meaning
M	Malfunction of a subsystem.
U	No update of the data since the previous logged value.
V	Data not valid (e.g. test on data string format failed).
D	Range error of the DVM subsystem.
R	Lower/upper range test.
G	Gradient test.
=	Not used.
S	Suspected data indication given by e.g. a positioning system.

6. REVIEW OF LISTINGS AND PLOTS.

Table 1 gives the position, the waterdepth, the date and the time of the SCTD vertical profiles. All these profiles have been taken with the Sea-Bird SBE9*plus* SCTD system.

Figure 1 gives a map with the position of the sampling stations while figure 2 shows a trackplot of the cruise.

In figures 3 to 6 the air temperature, solar radiation, atmospheric pressure, absolute windspeed and direction are plotted in function of time. These data are acquired with the Friedrichs meteo system.

In figures 7 to 10 the surface watertemperature, salinity, density and fluorescence are plotted in function of time. These data are acquired with the Sea-Bird SBE21 thermosalinograph and the Turner Designs fluorometer.

The tables 2 to 19 are giving the values of the oceanographic parameters at the SCTD water sampling points.

The verical profiles of temperature, salinity and density are shown in the figures 11 to 29 while the figures 30 to 48 are giving the dissolved oxygen and the fluorescence.

The graphplots 49 to 58 are giving the incident light vs. depth for the stations 02, 06, Holeopen Bay East and Celtic Sea.

The images 1 and 2 are showing the surface watertemperature in the zones Celtic Sea and Gulf of Biscay.

Appendix 1.

Plot with station annotations and list of positions.

MAGNAVOX 200MX : position

ATLAS DESO-20 : waterdepth

Table 1. Position SCTD stations OMEX 94/12.

Station number	Date 1994	Time of V.P.(1)	Latitude	Longitude	Water Depth [m]	Data file
01A	20.04	19h46	N 45 55.29	W 03 02.55	120	OMX9401A
02	21.04	06h23	N 46 15.15	W 04 44.69	1520	OMX9402
02A	21.04	09h57	N 46 15.05	W 04 44.89	1498	OMX9402A
03	21.04	12h50	N 46 22.81	W 04 32.10	319	OMX9403
04	21.04	18h25	N 46 46.97	W 05 28.04	1870	OMX9404
04A	21.04	21h46	N 46 47.74	W 05 28.29	>2200	OMX9404A
05	22.04	06h43	N 46 53.08	W 05 15.37	274	OMX9405
06	22.04	12h46	N 47 13.04	W 06 16.80	2000	OMX9406
06A	22.04	14h06	N 47 12.59	W 06 16.24	>2200	OMX9406A
07	22.04	17h49	N 47 21.27	W 06 05.87	158	OMX9407
08	24.04	06h58	N 47 23.36	W 07 16.64	>2200	OMX9408
09	24.04	11h34	N 47 36.52	W 07 07.82	168	OMX9409
HO	26.04	05h16	N 51 37.12	W 08 31.87	18	OMX94HO
CS	27.04	07h38	N 51 33.15	W 08 15.21	87	OMX94CS
CSA	27.04	11h26	N 51 33.06	W 08 15.68	84	OMX94CSA
15	02.05	04h20	N 49 24.46	W 11 32.66	687	OMX9415
15A	02.05	06h12	N 49 24.68	W 11 32.88	686	OMX9415A
17	02.05	18h55	N 49 11.02	W 12 48.62	1435	OMX9417
17A	02.05	22h26	N 49 11.58	W 12 49.16	1452	OMX9417A

Remarks:

(1) The time noted is the starttime (GMT) of the vertical profile.

Figure 1. SCTD sampling stations R/V Belgica cruise 94/12.

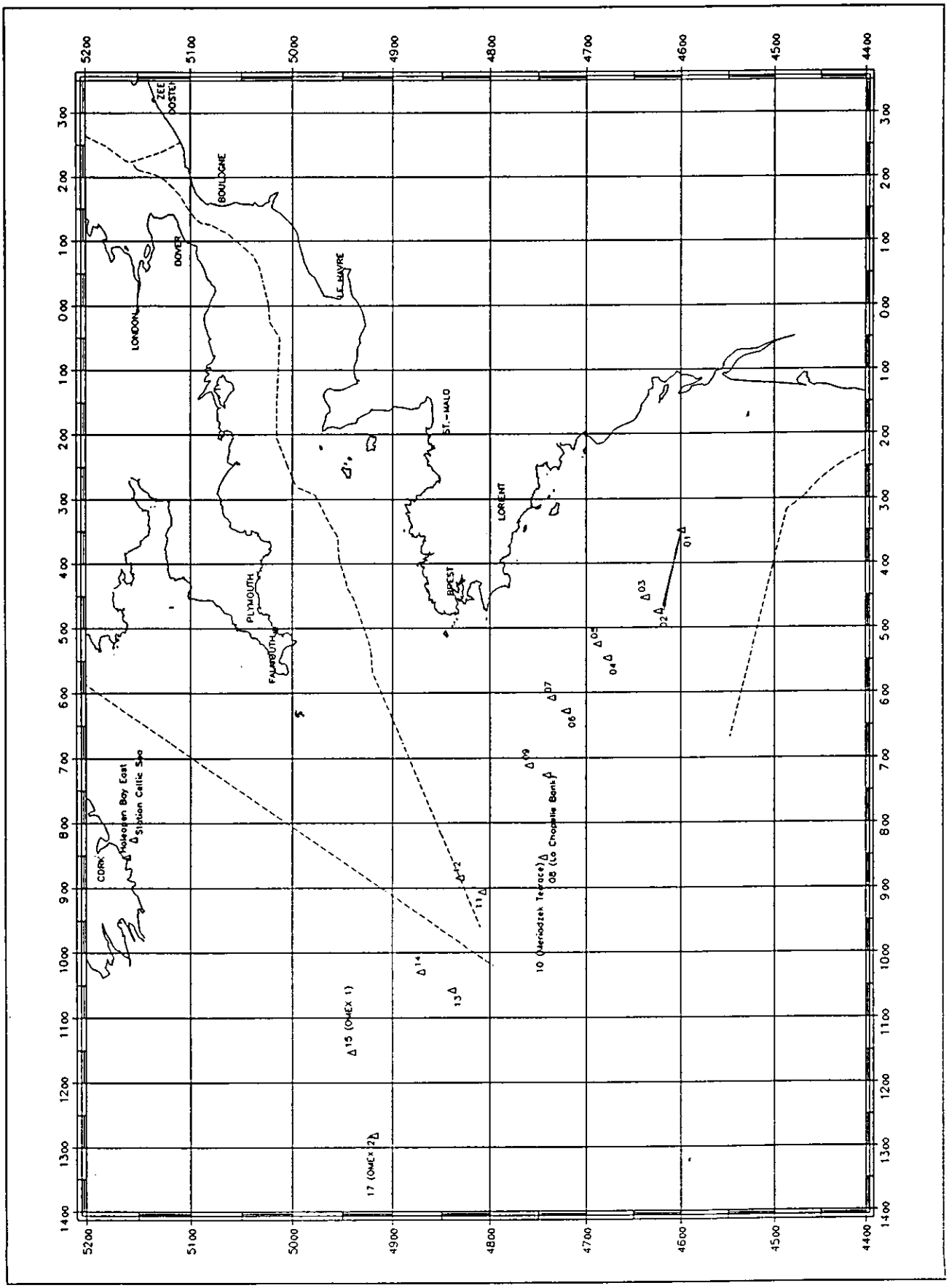
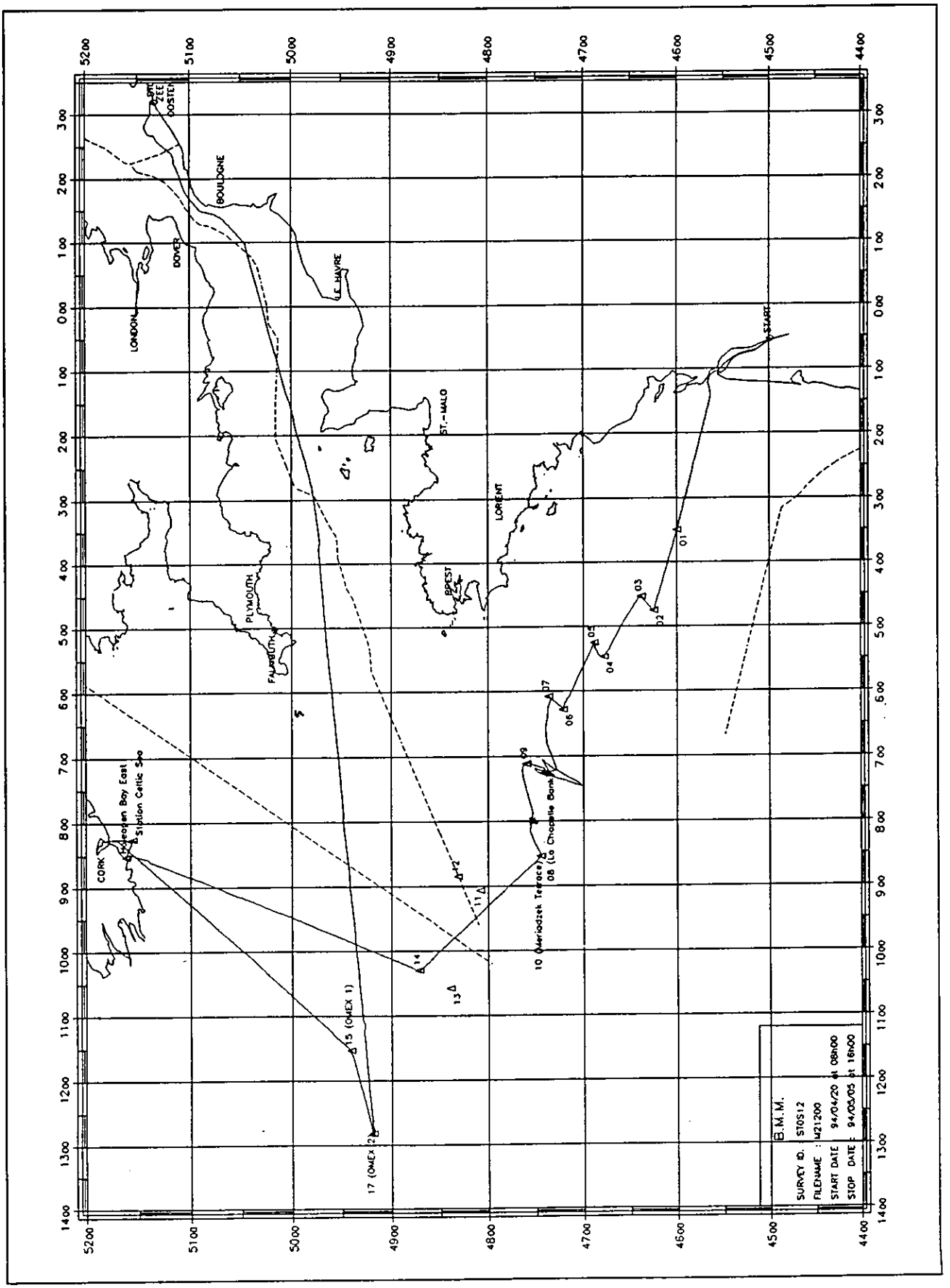


Figure 2. General Trackplot of R/V Belgica cruise 94/12.



Appendix 2.

Meteorological data during the complete campaign.

FRIEDRICHS : windspeed and -direction, airtemperature, atm. pressure

KIPP & ZONEN : solar radiation

Survey ID : OMEX 1994. Startdate : 20.04.94 **MUMM – Meetdienst Oostende.**

File name : M21200 Stopdate : 28.04.94

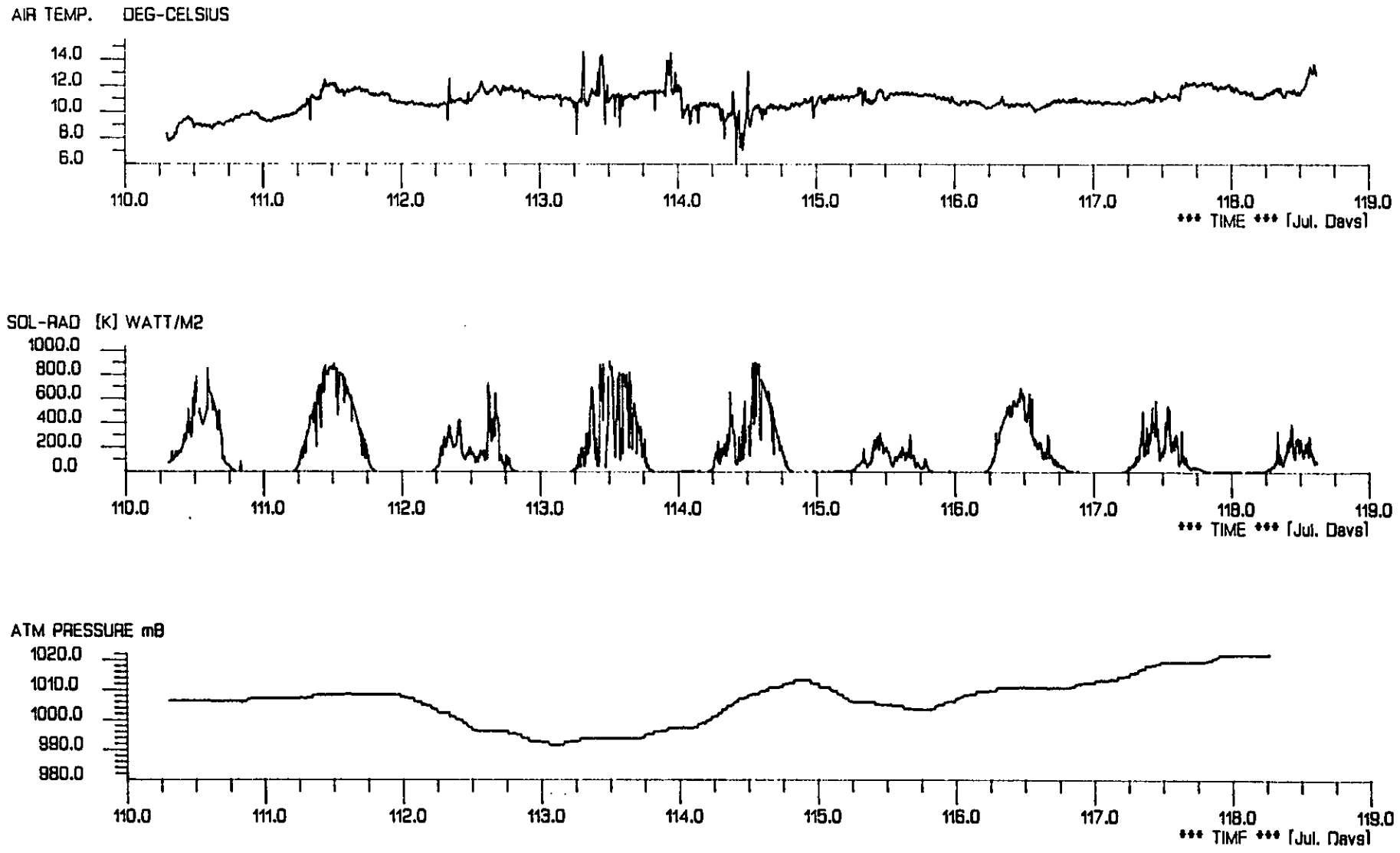


Figure 3. The passage Bordeaux - Cork

Survey ID ; OMEX 1994. Startdate : 01.05.94 **MUMM – Meetdienst Oostende.**

File name : M21200 Stopdate : 05.05.94

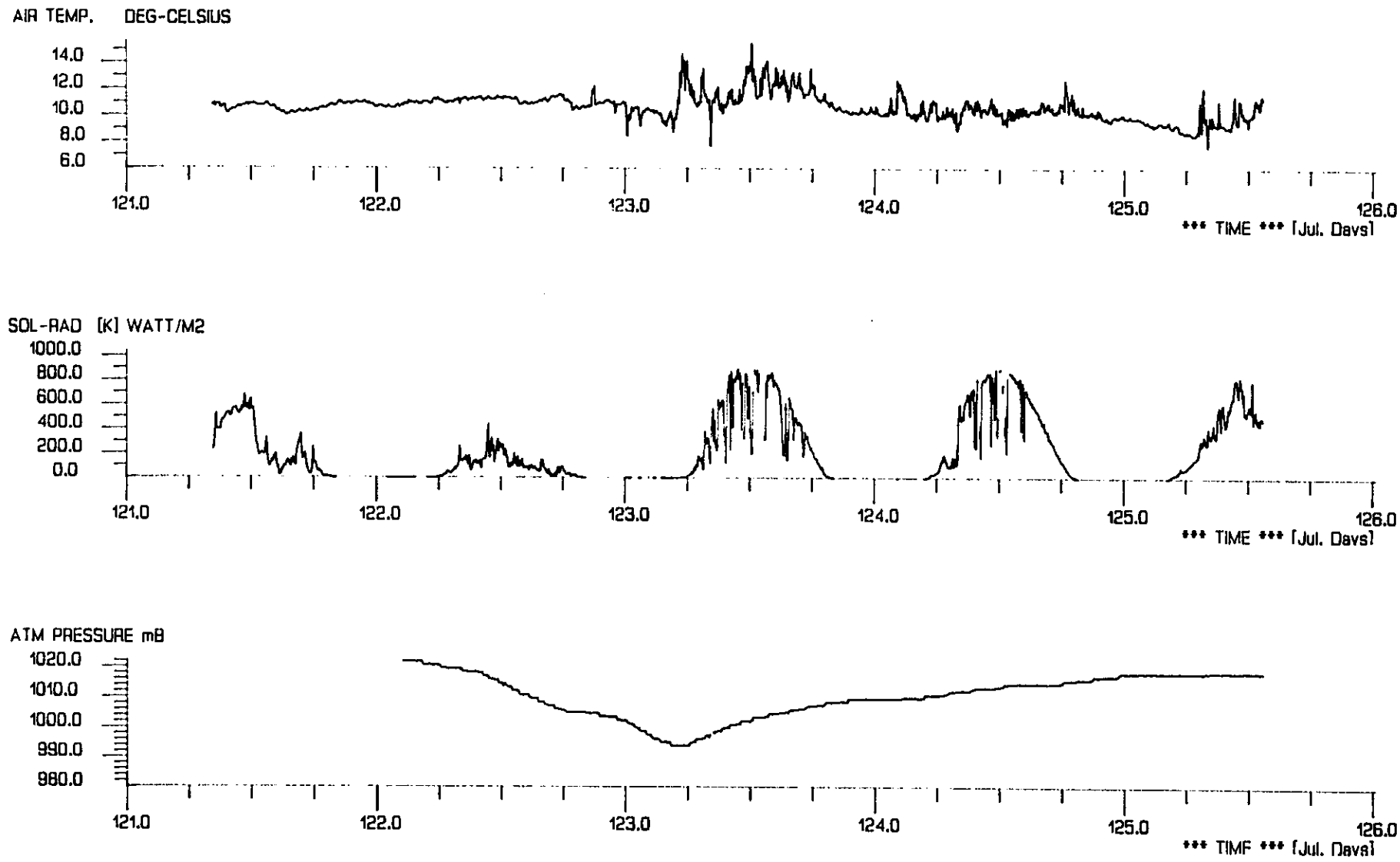


Figure 4. The passage Cork - Zeebrugge

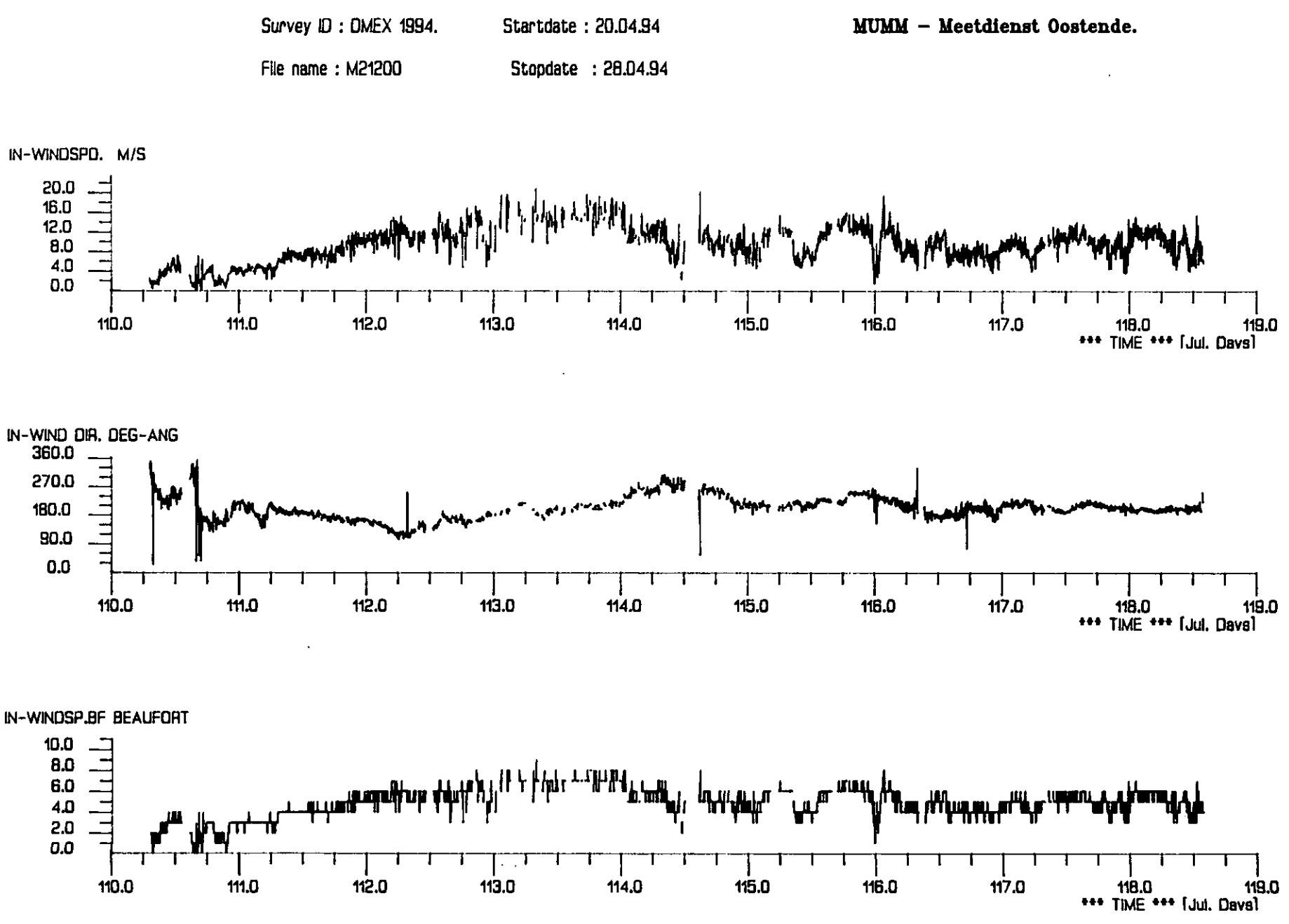


Figure 5. The passage Bordeaux - Cork

Survey ID ; OMEX 1994. Startdate : 01.05.94 **MUMM – Meetdienst Oostende.**

File name : M21200 Stopdate : 05.05.94

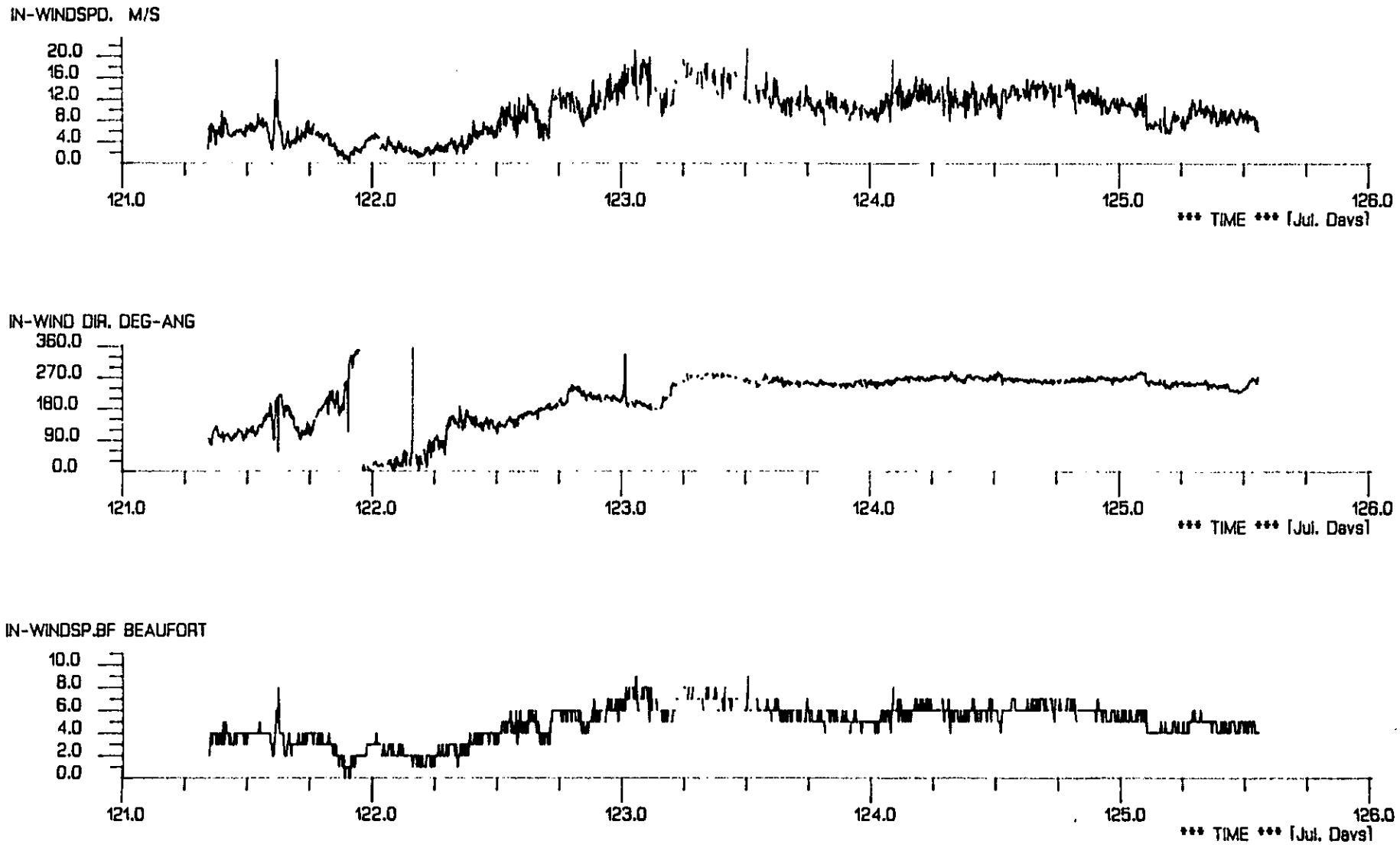


Figure 6. The passage Cork - Zeebrugge

Appendix 3.

Horizontal profiles.

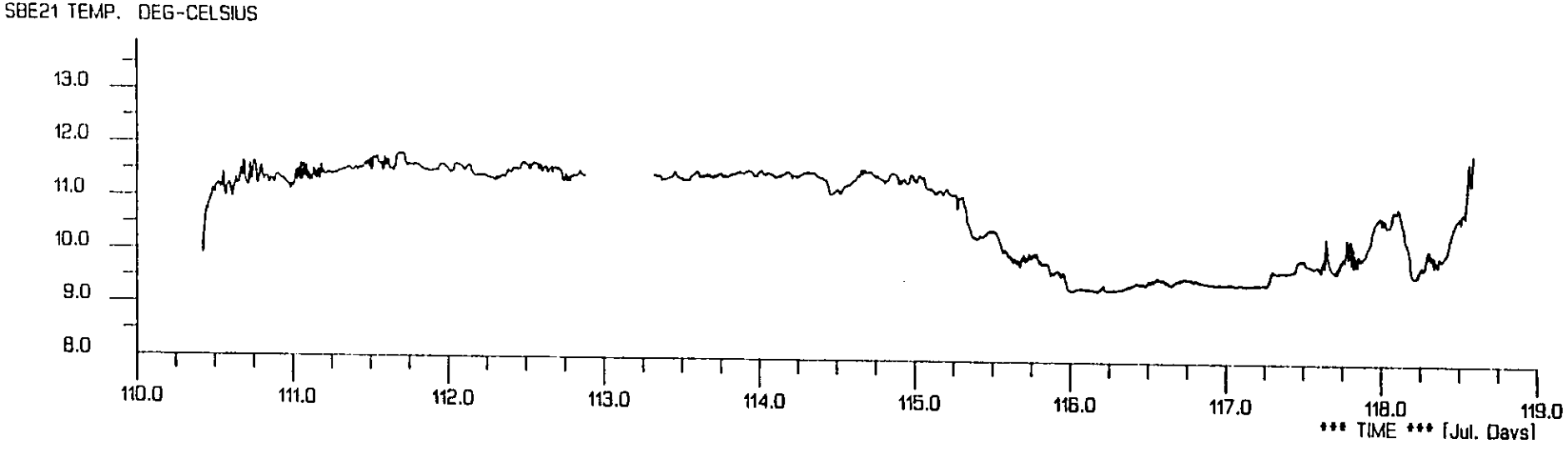
SEA-BIRD SBE 21 : watertemperature, salinity, density (sigma theta)

TURNER DESIGNS : fluorescence

Survey ID : OMEX 1994. Startdate : 20.04.94

File name : 031200 Stopdate : 28.04.94

MUMM – Meetdienst Oostende.



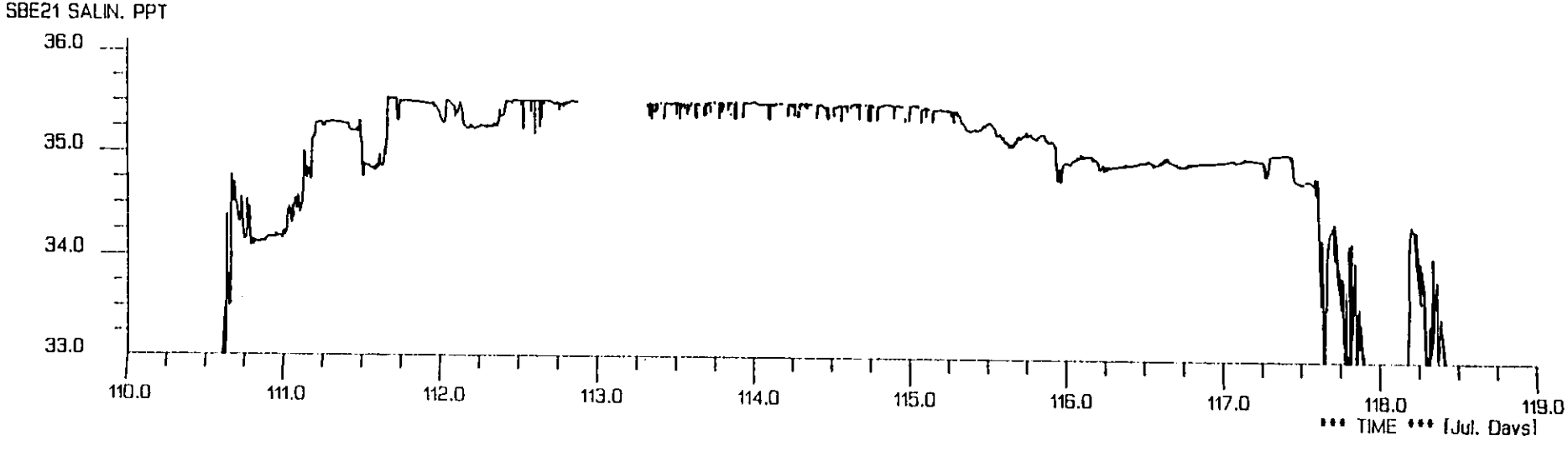
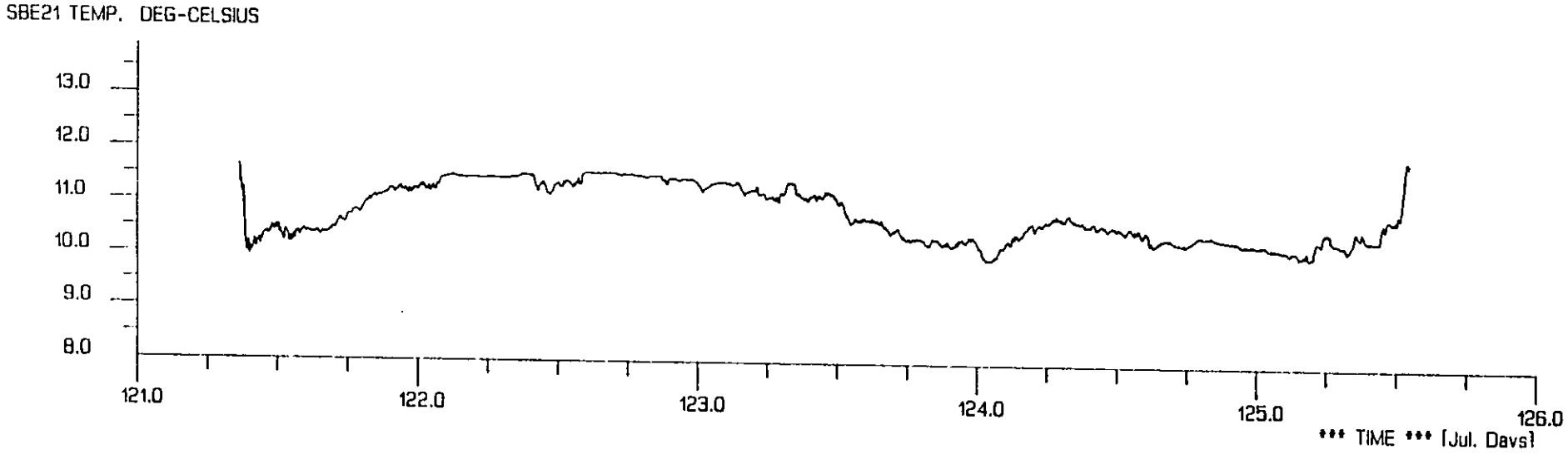


Figure 7. The passage Bordeaux - Cork

Survey ID : OMEX 1994. Startdate : 01.05.94

File name : 031204 Stopdate : 05.05.94

MUMM – Meetdienst Oostende.



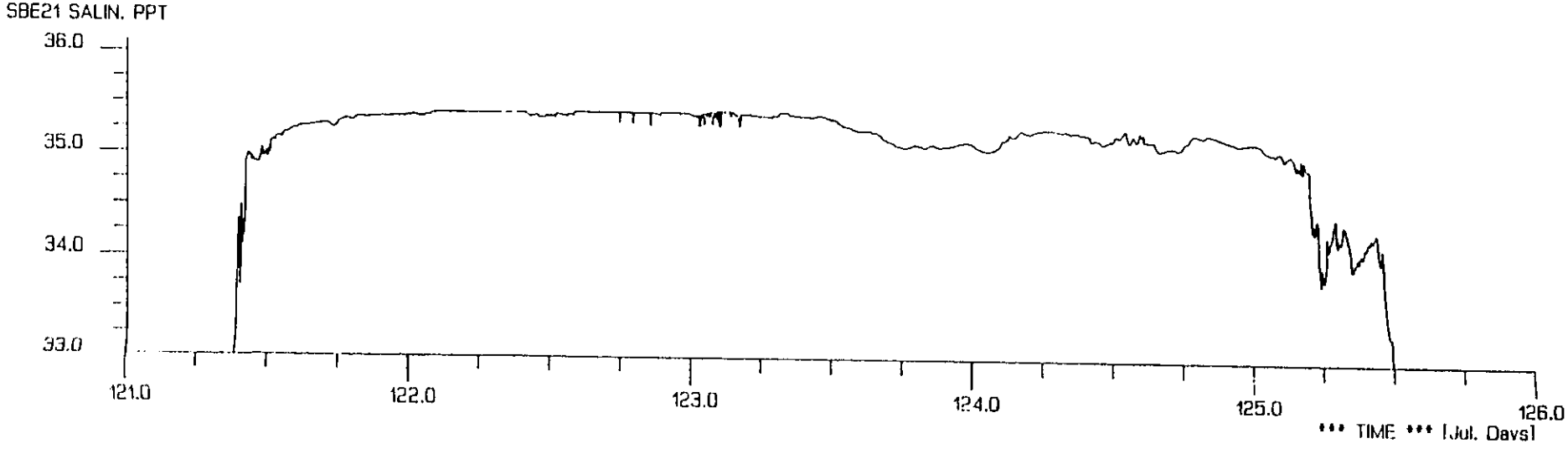


Figure 8. The passage Cork - Zeebrugge

Survey ID : OMEX 1994. Startdate : 20.04.94

File name : 031200 Stopdate : 28.04.94

MUMM – Meetdienst Oostende.

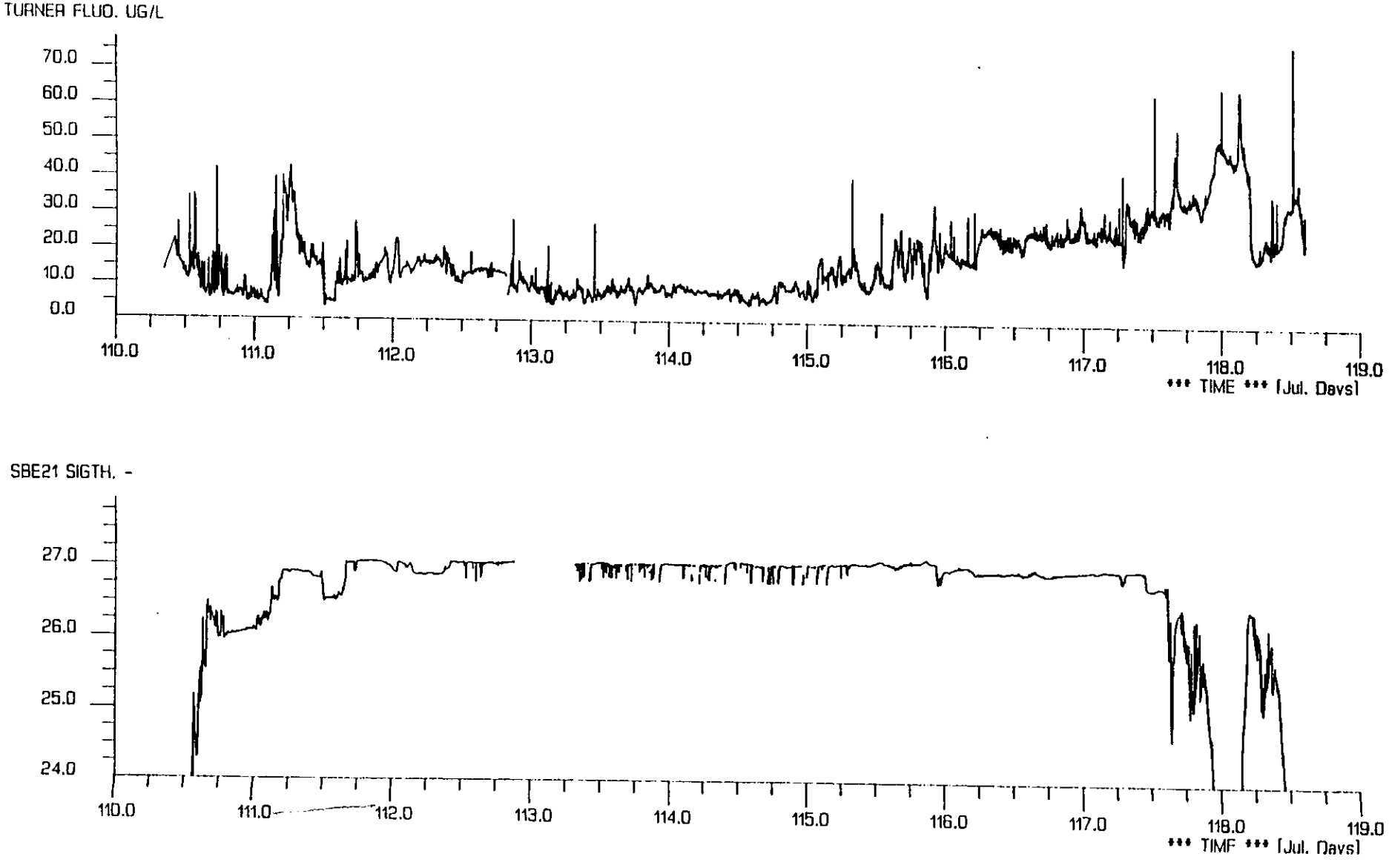


Figure 9. The passage Bordeaux - Cork

Survey ID : OMEX 1994. Startdate : 01.05.94

File name : 031204 Stopdate : 05.05.94

MUMM – Meetdienst Oostende.

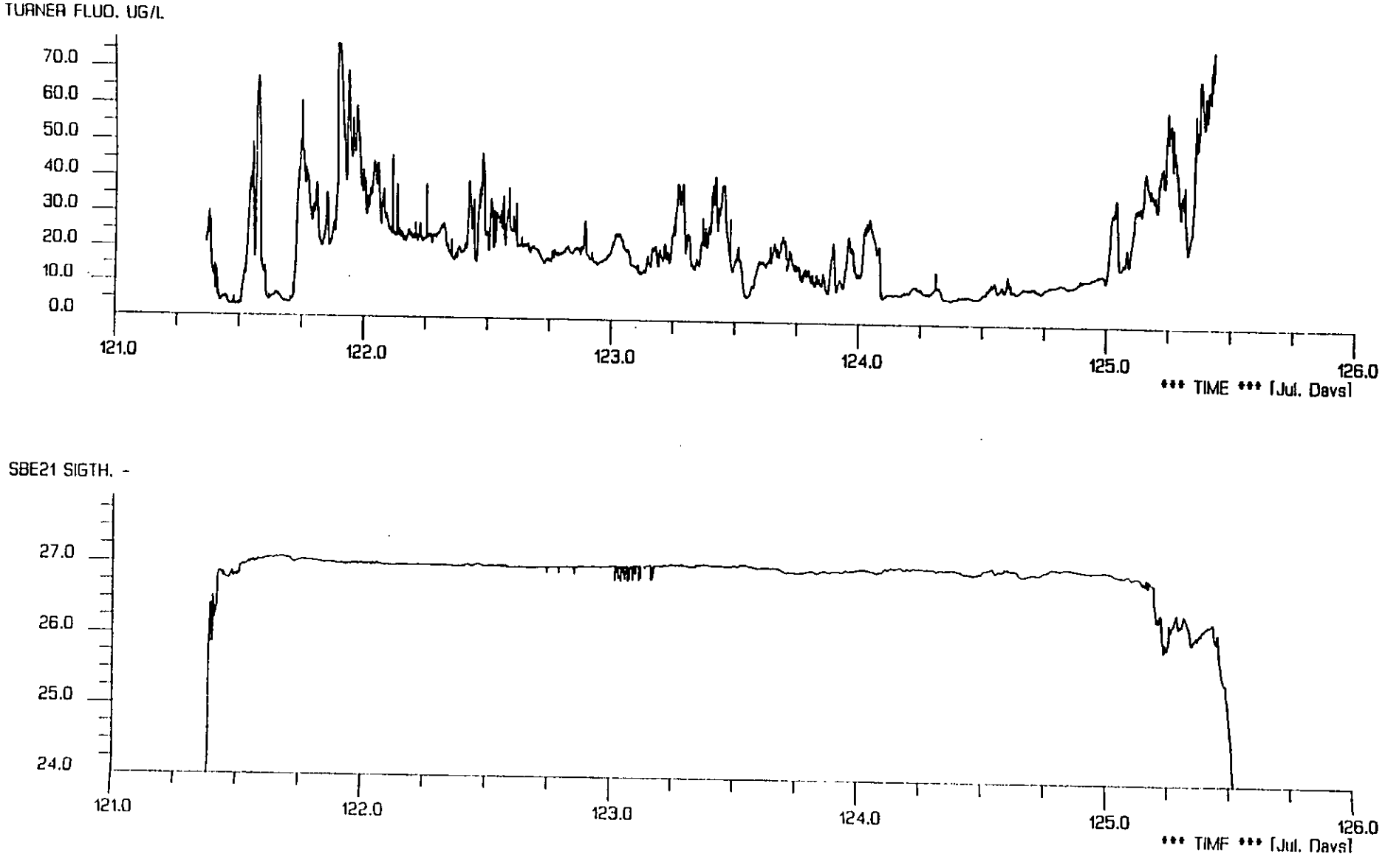


Figure 10. The passage Cork - Zeebrugge

Appendix 4.

SCTD data at the sampling depths.

SEA-BIRD SBE 911*plus* : salinity, watertemperature, density, DO

CHELSEA : fluorescence

Table 2

Profile: Station 1 A

Date: 20.04.94

DOWNCAST: starttime: 19h46 GMT

Bathy depth: 120 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
5	Go	3	5.6	11.01	34.21	0.012	244	26.16
5	Ni	1	5.6	11.01	34.21	0.012	244	26.16
10	Ni	1	10.6	10.95	34.23	0.012	244	26.19
20	Ni	2	20.2	11.01	34.28	0.016	243	26.22
40	Ni	1	40.4	11.77	34.22	0.011	220	26.80
60	Ni	1	60.5	11.97	35.62	0.011	220	27.08
80	Ni	2	80.8	11.97	35.62	0.011	220	27.08
100	Ni	1	101.1	11.97	35.62	0.011	220	27.08
Surf.			2.8	11.21	34.21	0.012	244	26.12
Bottom			108.5	11.97	35.62	0.011	221	27.08

Table 3

Profile: Station 2 Date: 21.04.94

DOWNCAST: starttime: 06h23 GMT Bathy depth: 1520 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
5	Go	2	4.7	11.25	35.38	-	252	27.03
10	Go	1	9.8	11.25	35.38	-	252	27.03
20	Ni	2	19.7	11.25	35.38	0.029	249	27.03
40	Ni	1	40.2	11.19	35.41	0.013	238	27.06
60			59.8	11.21	35.42	0.012	235	27.07
80	Ni	1	79.7	11.48	35.57	0.010	226	27.14
100	Ni	2	100.0	11.49	35.60	0.010	226	27.16
150	Ni	1	150.1	11.47	35.61	0.010	224	27.17
200	Ni	1	200.1	11.44	35.61	0.010	218	27.18
Surf.			1.4	11.26	35.36	-	252	27.01

Table 4

Profile: Station 2A

Date: 21.04.94

DOWNCAST: starttime: 09h57 GMT

Bathy depth: 1496 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
5	Go	1	5.5	11.45	35.30	-	253	26.93
60	Go	1	60.3	11.24	35.44	0.012	234	27.07
400	Go	1	400	11.14	35.60	0.010	199	27.23
500	Ni	2	501	10.86	35.59	0.010	191	27.27
600	Ni	1	601	10.53	35.60	0.010	183	27.34
800	Ni	1	801	10.12	35.72	0.010	163	27.51
1000	Ni	2	1000	9.48	35.75	0.010	163	27.65
1200	Ni	1	1200	8.16	35.59	0.010	174	27.73
1470	Ni	2	1470	5.90	35.28	0.010	194	27.81
Surf.			1.5	11.35	35.34	-	246	26.99

Table 5

Profile: Station 3 Date: 21.04.94

DOWNCAST: starttime: 12h50 GMT Bathy depth: 319 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
5	Go	2	4.8	11.46	34.94	-	243	26.65
10	Go	1	10.2	11.38	34.94	-	243	26.66
20	Ni	2	19.9	11.09	34.95	0.029	241	26.72
40	Ni	1	40.0	11.10	35.00	0.013	235	26.76
60	Ni	1	60.1	11.40	35.23	0.012	226	26.89
80	Ni	1	79.9	11.53	35.37	0.010	221	26.97
100	Ni	1	100.1	11.72	35.59	0.010	217	27.11
150	Ni	1	150.0	11.69	35.62	0.010	216	27.14
200	Ni	2	199.0	11.57	35.62	0.010	212	27.16
Surf.			2.0	11.51	35.62	-	242	26.65
Bottom			300.0	11.55	34.95	0.010	211	27.17

Table 6

Profile: Station 4

Date: 21.04.94

DOWNCAST: starttime: 18h25 GMT

Bathy depth: 1870 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
5	Go	2	4.9	11.37	35.59	-	230	27.17
20	Go	1	19.9	11.35	35.59	0.013	232	27.17
50	Ni	1	50.2	11.25	35.60	0.011	227	27.20
100	Ni	1	100.0	11.24	35.60	0.011	226	27.20
150	Ni	1	149.6	11.24	35.60	0.011	226	27.20
200	Ni	2	199.9	11.23	35.59	0.011	225	27.20
Surf.			1.8	11.39	35.59	-	230	27.17

Table 7

Profile: Station 4A

Date: 21.04.94

DOWNCAST: starttime: 21h46 GMT

Bathy depth: > 2200 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
20	Go	1	20.8	11.41	35.58	0.013	234	27.15
100	Go	1	101	11.23	35.60	0.011	224	27.20
400	Go	1	400	10.99	35.57	0.010	198	27.23
500	Ni	2	501	10.72	35.56	0.010	191	27.27
600	Ni	1	600	10.44	35.56	0.010	181	27.33
800	Ni	1	800	9.78	35.65	0.010	172	27.52
1000	Ni	2	1000	8.73	35.63	0.010	171	27.67
1200	Ni	1	1200	7.59	35.51	0.010	180	27.75
1500	Ni	2	1501	5.71	35.25	0.010	197	27.80
Surf.			2.4	11.34	35.57	0.014	233	27.16
Bottom			1602	5.48	35.22	0.010	198	27.81

Table 8

Profile: Station 5 Date: 22.04.94

DOWNCAST: starttime: 06h43 GMT Bathy depth: 274 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
5	Go	2	5.1	11.20	35.35	-	238	27.01
20	Go	1	20.0	11.22	35.36	0.013	237	27.02
20	Ni	2	20.0	11.22	35.36	0.013	237	27.02
40	Ni	1	39.9	11.28	35.43	0.012	232	27.06
60	Ni	1	59.6	11.29	35.45	0.011	229	27.07
80	Ni	1	79.9	11.32	35.49	0.011	225	27.10
100	Ni	2	98.9	11.34	35.51	0.011	223	27.11
200	Ni	1	200.4	11.41	35.58	0.010	219	27.16
264	Ni	1	264.7	11.39	35.60	0.010	215	27.18
Surf.			2.7	11.20	35.35	-	239	27.01

Table 9

Profile: Station 6 Date: 22.04.94

DOWNCAST: starttime: 12h46 GMT Bathy depth: 2000 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
5	Go	3	5.6	11.36	35.60	-	230	27.18
10	Ni	1	8.7	11.36	35.60	-	230	27.18
20	Ni	3	18.9	11.36	35.60	-	229	27.18
50	Ni	1	50.5	11.33	35.60	0.012	228	27.18
100	Ni	1	99.6	11.26	35.60	0.011	226	27.19
150	Ni	1	149	11.23	35.59	0.011	225	27.20
200	Ni	2	201	11.24	35.59	0.011	226	27.20
Surf.			5.6	11.36	35.60	-	230	27.18

Table 10

Profile: Station 6A

Date: 22.04.94

DOWNCAST: starttime: 14h06 GMT

Bathy depth: > 2200 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
300	Go	3	301	11.19	35.59	0.010	224	27.21
400	Ni	1	398	11.11	35.58	0.010	215	27.21
600	Ni	2	600	10.48	35.58	0.010	184	27.34
800	Ni	1	800	9.91	35.69	0.010	165	27.53
1000	Ni	2	1000	9.02	35.64	0.010	170	27.64
1200	Ni	1	1201	7.70	35.50	0.010	179	27.73
1500	Ni	2	1500	5.90	35.28	0.010	193	27.80
Surf.			6.1	11.37	35.60	-	231	27.18
Bottom			1579	5.48	35.23	0.010	196	27.82

Table 11

Profile: Station 7 Date: 22.04.94

DOWNCAST: starttime: 17h49 GMT Bathy depth: 158 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
5	Go	2	4.6	11.24	35.58	-	230	27.18
10	Go	1	9.3	11.24	35.57	-	229	27.18
20	Ni	2	20.2	11.24	35.58	0.013	230	27.18
40	Ni	1	41.1	11.23	35.57	0.012	230	27.18
60	Ni	1	59.1	11.17	35.57	0.011	232	27.19
80	Ni	1	78.3	11.05	35.57	0.011	234	27.21
100	Ni	2	100.1	11.06	35.57	0.011	234	27.21
140	Ni	2	141.6	11.07	35.57	0.011	234	27.21
Surf.			1.4	11.24	35.58	-	228	27.18

Table 12

Profile: Station 8 Date: 24.04.94

DOWNCAST: starttime: 06h58 GMT Bathy depth: > 2200 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
20	Go	3	20.0	11.41	35.59	0.012	233	27.16
20	Ni	1	20.0	11.41	35.59	0.012	233	27.16
40	Ni	1	39.6	11.41	35.59	0.013	233	27.16
60	Ni	1	59.0	11.41	35.59	0.012	232	27.16
80	Ni	1	81.4	11.41	35.59	0.012	232	27.16
100	Ni	2	99.7	11.42	35.59	0.012	232	27.16
150	Ni	1	149.5	11.21	35.58	0.011	228	27.19
200	Ni	2	201.9	11.16	35.58	0.010	225	27.20
Surf.			16.8	11.40	35.59	-	233	27.16

Table 13

Profile: Station 9 Date: 24.04.94

DOWNCAST: starttime: 11h34 GMT Bathy depth: 168 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
20	Go	3	19.9	11.08	35.56.	-	237	27.20
40	Ni	1	39.7	11.05	35.56	-	236	27.20
60	Ni	1	60.0	11.00	35.55	0.012	235	27.21
100	Ni	2	101.8	10.98	35.55	0.011	234	27.21
150	Ni	2	157.3	10.98	35.55	0.011	235	27.21
Surf.			7.0	11.07	35.56	-	236	27.20

Table 14

Profile: Station Holeopen Bay East

Date: 26.04.94

DOWNCAST: starttime: 05h16 GMT

Bathy depth: 18 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
10	Go	3	9.5	9.29	35.01	0.014	248	27.07
10	Ni	9	9.5	9.29	35.01	0.014	248	27.07
Surf.			2.3	9.23	34.97	-	246	27.06
Bottom			14.2	9.27	34.99	0.015	247	27.07

Table 15

Profile: Station CS (Celtic Sea)

Date: 27.04.94

DOWNCAST: starttime: 07h38 GMT

Bathy depth: 87 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
5	Go	2	4.5	9.61	35.13	-	265	27.12
20	Go	1	19.8	9.60	35.13	0.024	263	27.12
20	Ni	1	19.8	9.60	35.13	0.024	263	27.12
30	Ni	2	29.1	9.50	35.15	0.016	257	27.15
40	Ni	2	38.8	9.47	35.15	0.013	253	27.16
60	Ni	2	60.1	9.18	35.18	0.014	238	27.23
80	Ni	2	79.5	9.15	35.19	0.017	239	27.25
Surf.			4.0	9.62	35.13	-	264	27.12
Bottom			79.4	9.15	35.19	0.017	240	27.25

Table 16

Profile: Station CS (Celtic Sea) A

Date: 27.04.94

DOWNCAST: starttime: 11h26 GMT

Bathy depth: 84 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
5	Go	2	4.0	9.82	34.87	-	281	26.89
20	Go	1	19.4	9.51	35.12	0.019	263	27.13
20	Ni	1	19.4	9.51	35.12	0.019	263	27.13
30	Ni	2	29.4	9.51	35.14	0.014	258	27.15
40	Ni	2	40.7	9.47	35.15	0.016	254	27.16
60	Ni	2	58.8	9.19	35.19	0.016	237	27.24
80	Ni	2	75.0	9.17	35.20	0.018	240	27.25
Surf.			7.2	9.62	34.88	-	280	26.89

Table 17

Profile: Station 15 Date: 02.05.94

DOWNCAST: starttime: 04h20 GMT Bathy depth: 687 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
10	Go	1	9.7	11.16	35.52	0.014	227	27.15
30	Go	1	29.6	11.05	35.53	0.013	223	27.18
40	Go	1	38.2	10.99	35.53	0.011	222	27.19
60	Ni	1	59.0	11.01	35.53	0.011	221	27.19
80	Ni	1	77.7	10.98	35.54	0.011	221	27.20
100	Ni	1	100	10.95	35.53	0.011	220	27.21
200	Ni	1	199	10.91	35.52	0.010	219	27.21
300	Ni	1	300	10.78	35.51	0.010	215	27.22
400	Ni	1	400	10.55	35.48	0.010	217	27.24
500	Ni	1	500	10.48	35.47	0.010	206	27.25
600	Ni	1	599	9.94	35.44	0.010	181	27.32
660	Ni	1	660	9.90	35.46	0.011	179	27.35
Surf.			3.0	11.37	35.52	0.028	229	27.11

Table 18

Profile: Station 15 A

Date: 02.05.94

DOWNCAST: starttime: 06h12 GMT

Bathy depth: 686 m

sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
20	Go	3	20.2	11.15	35.52	0.014	230	27.16
20	Ni	8	20.2	11.15	35.52	0.014	230	27.16
100	Ni	1	99.7	10.93	35.53	0.011	228	27.20
Surf.			3.0	11.37	35.52	-	235	27.11

Table 19

Profile: Station 17 Date: 02.05.94

DOWNCAST: starttime: 18h55 GMT Bathy depth: 1450 m

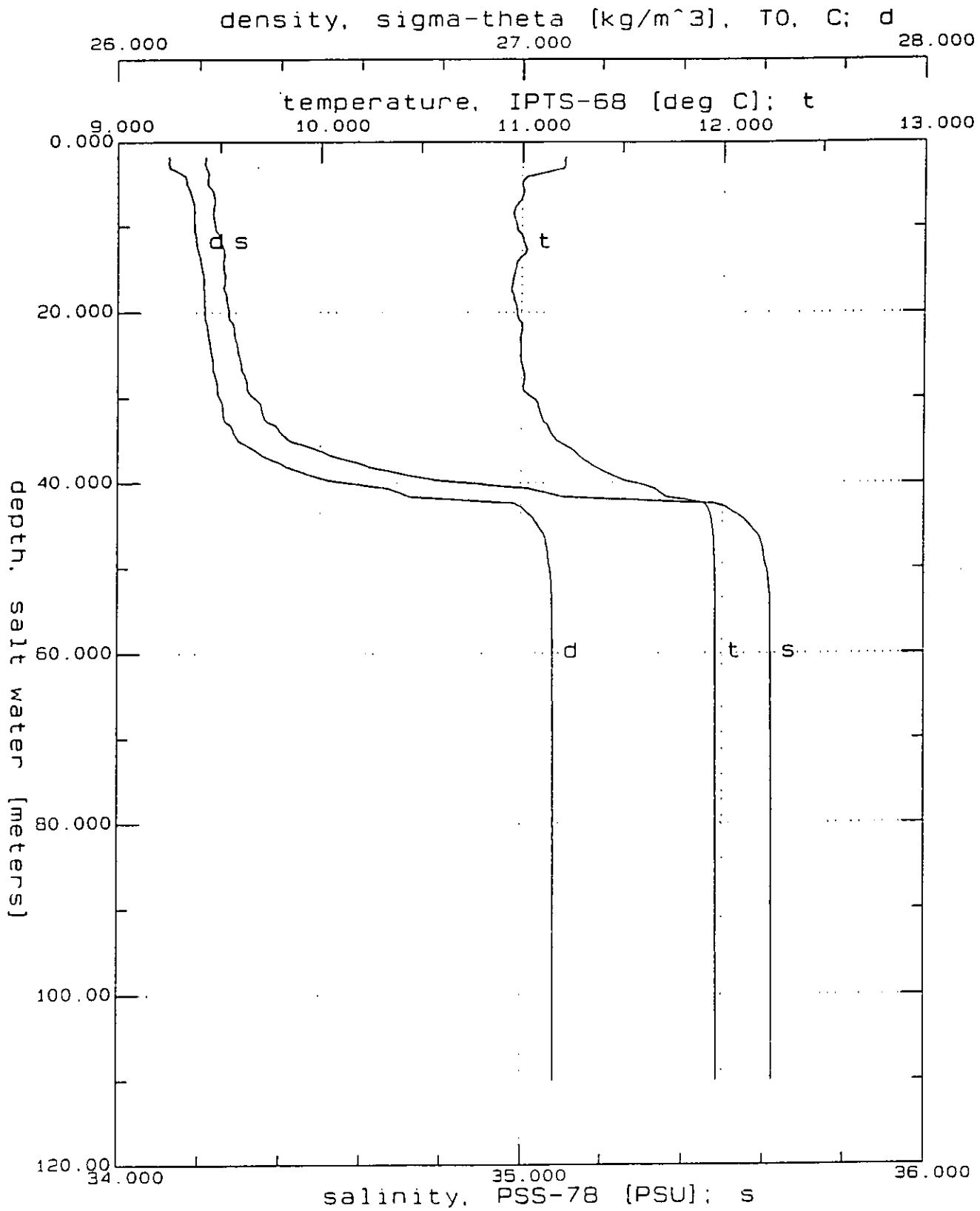
sampling			SCTD values					
depth	bottle type	no of bottles	depth m	temp. °C	salinity ppt	fluo. chelsea	DO µmol/kg	density sig. Θ
100	Go	1	99.4	10.97	35.49	0.014	229	27.17
150	Go	1	149	10.77	35.48	0.012	225	27.20
250	Go	1	250	10.60	35.48	0.010	221	27.23
350	Ni	1	352	10.49	35.47	0.010	204	27.24
500	Ni	1	501	10.38	35.46	0.010	209	27.26
600	Ni	1	599	10.27	35.45	0.010	209	27.27
700	Ni	1	701	10.07	35.44	0.010	198	27.30
800	Ni	1	804	9.67	35.46	0.010	173	27.39
900	Ni	1	901	9.10	35.44	0.010	167	27.46
1000	Ni	1	1000	8.98	35.52	0.010	166	27.55
1200	Ni	1	1197	7.10	35.34	0.010	181	27.69
1350	Ni	1	1347	6.59	35.33	0.010	187	27.75
Surf.			9.7	11.07	35.53	-	228	27.11

Appendix 5.

Vertical profiles with SCTD.

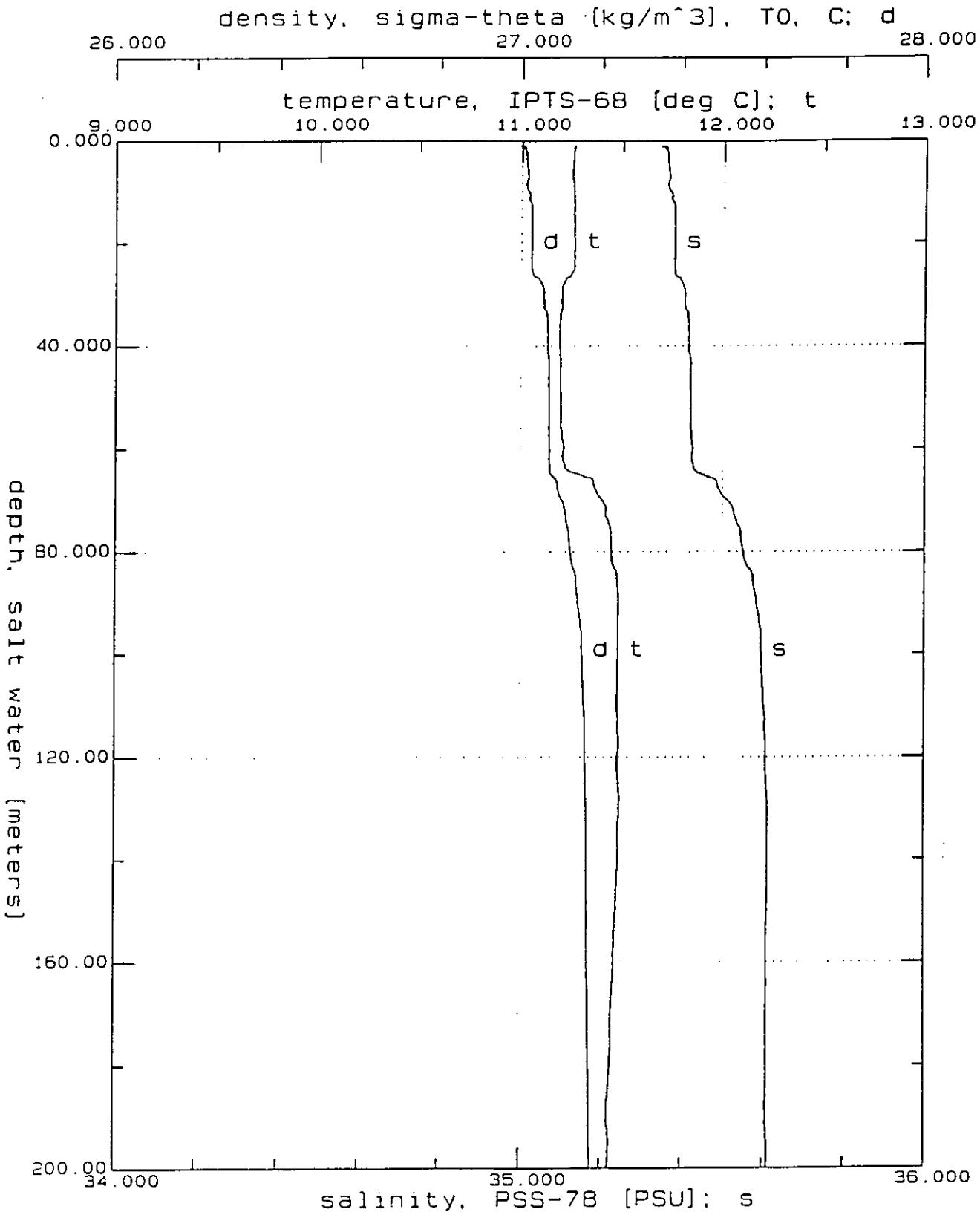
SEA-BIRD SBE 911*plus* : salinity, watertemperature, density, DO

CHELSEA : fluorescence



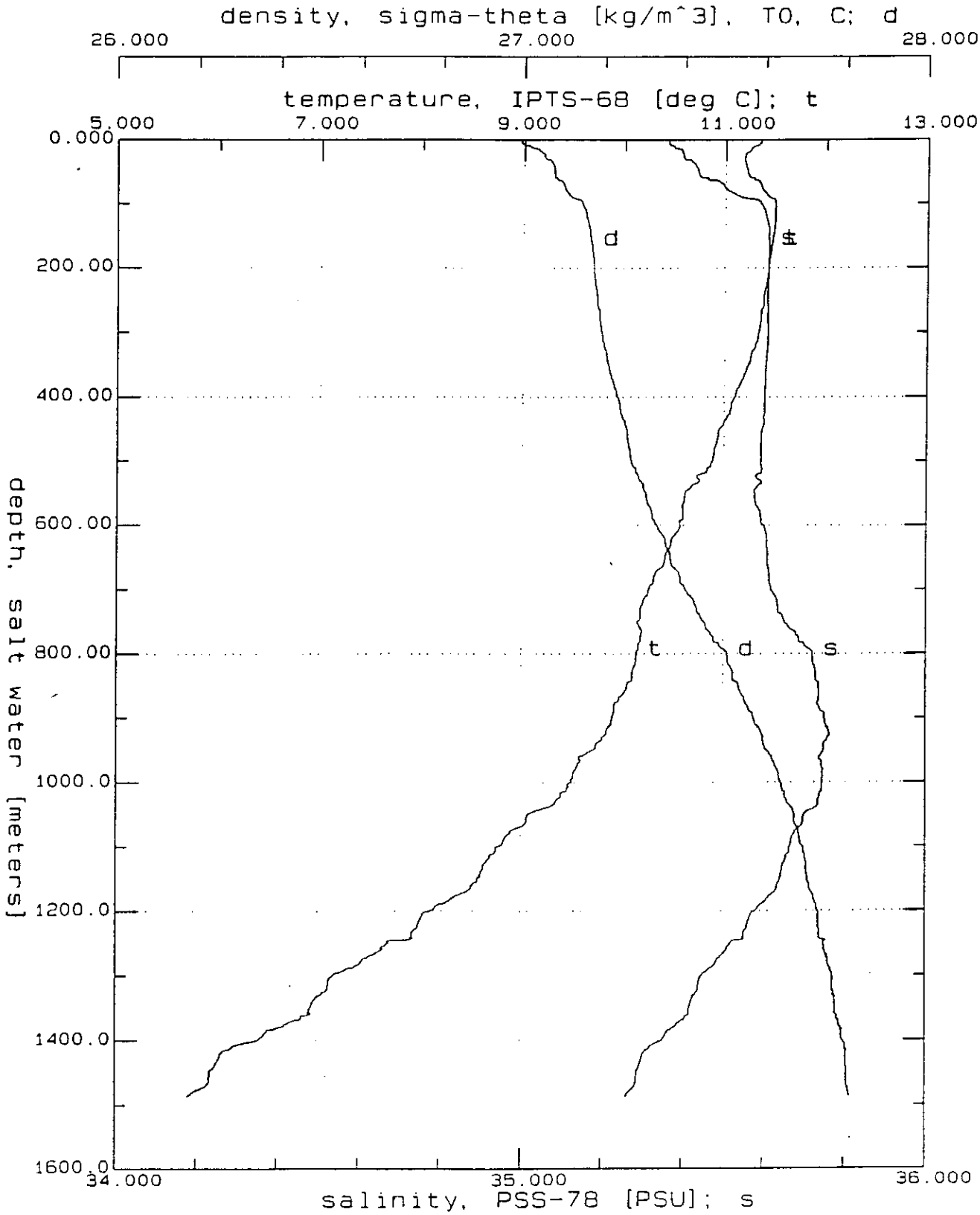
OMX9401A.CNV: OMEX 94/12 Station 1A 20.04.94 at 19h46.

Figure 11



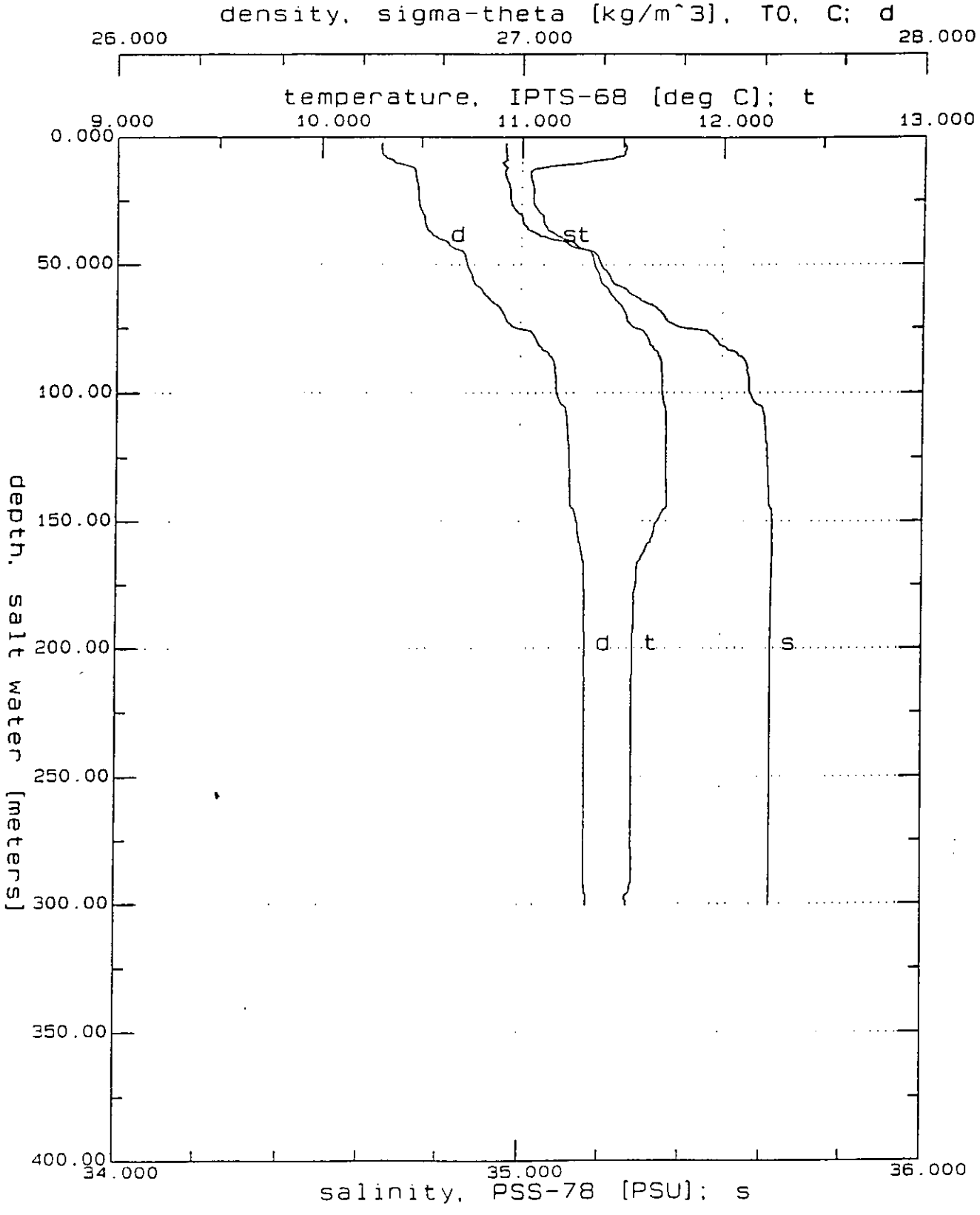
OMX9402.CNV: OMEX 94/12 Station 2 21.04.94 at 06h23.

Figure 12



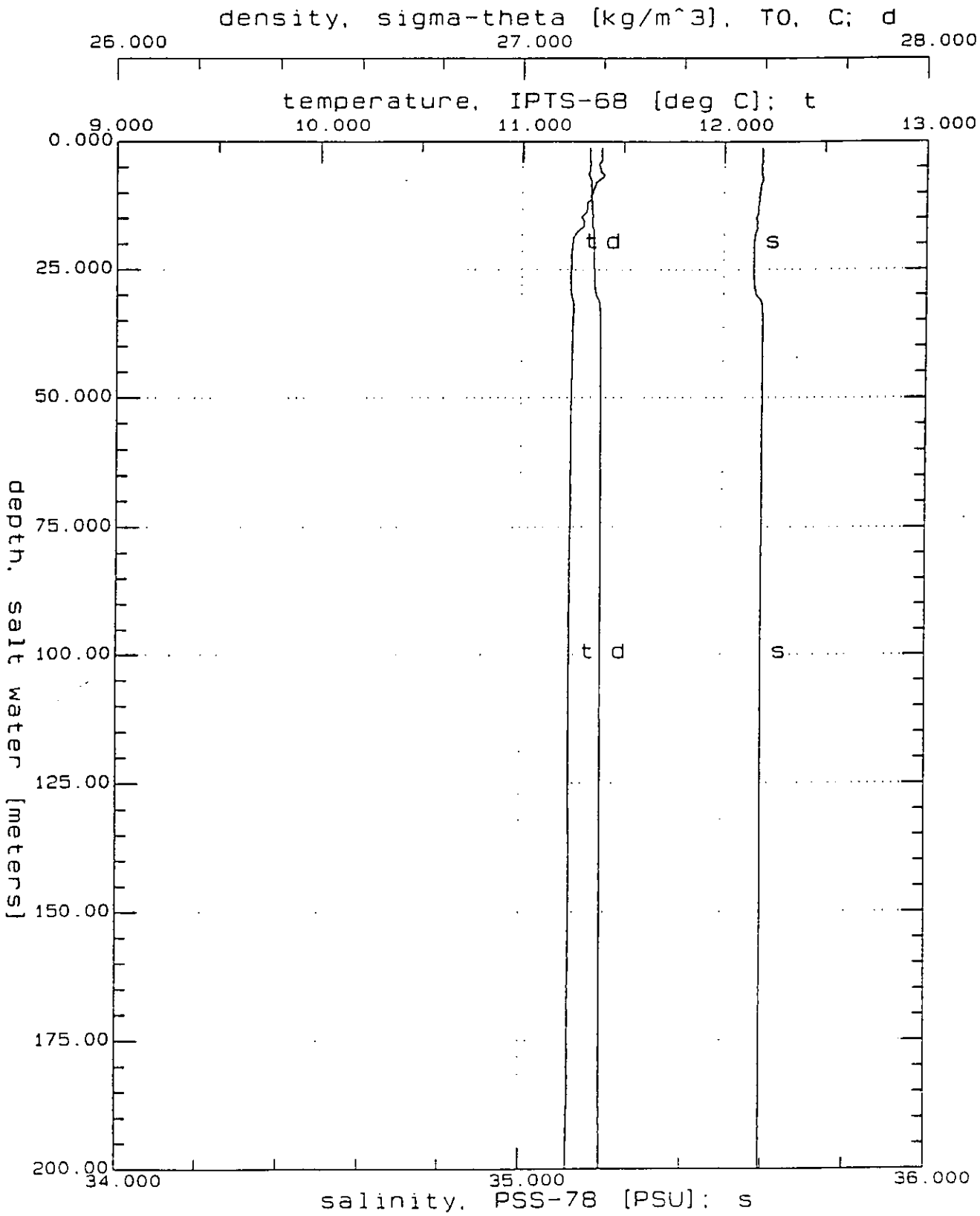
OMX9402A.CNV: OMEX 94/12 Station 2A 21.04.94 at 09h57.

Figure 13



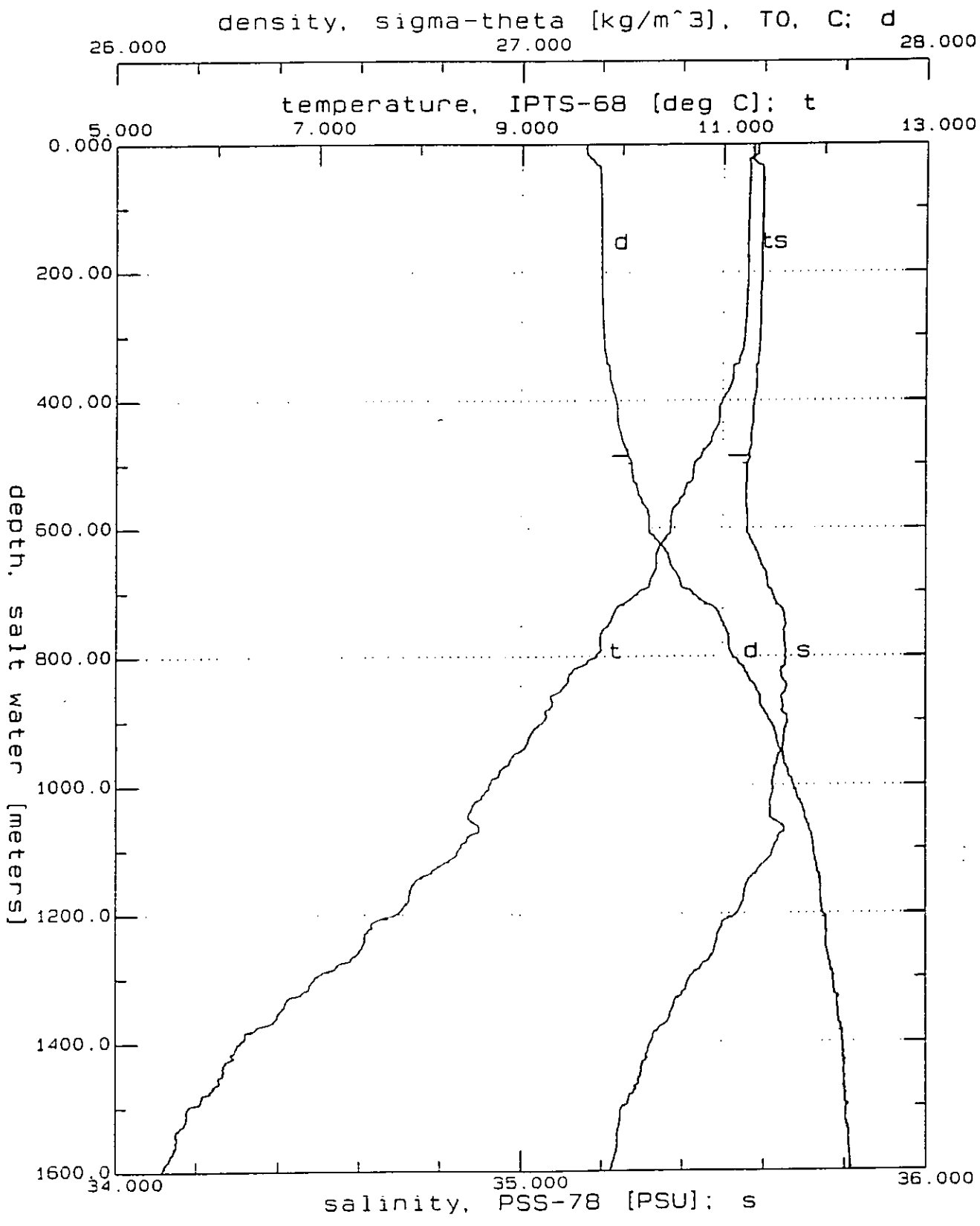
OMX9403.CNV: OMEX 94/12 Station 3 21.04.94 at 12h50.

Figure 14



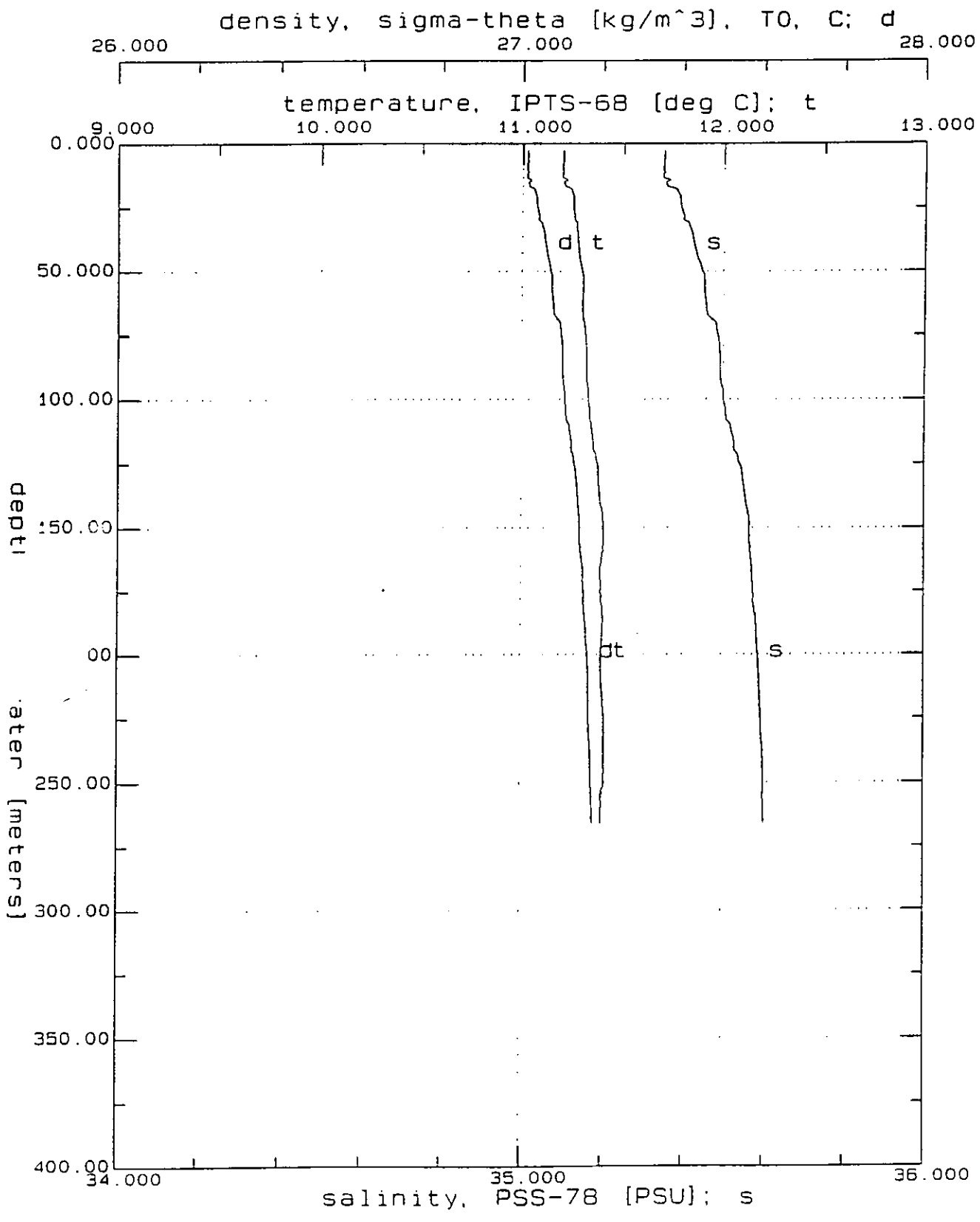
OMX9404.CNV: OMEX 94/12 Station 4 21.04.94 at 18h25.

Figure 15



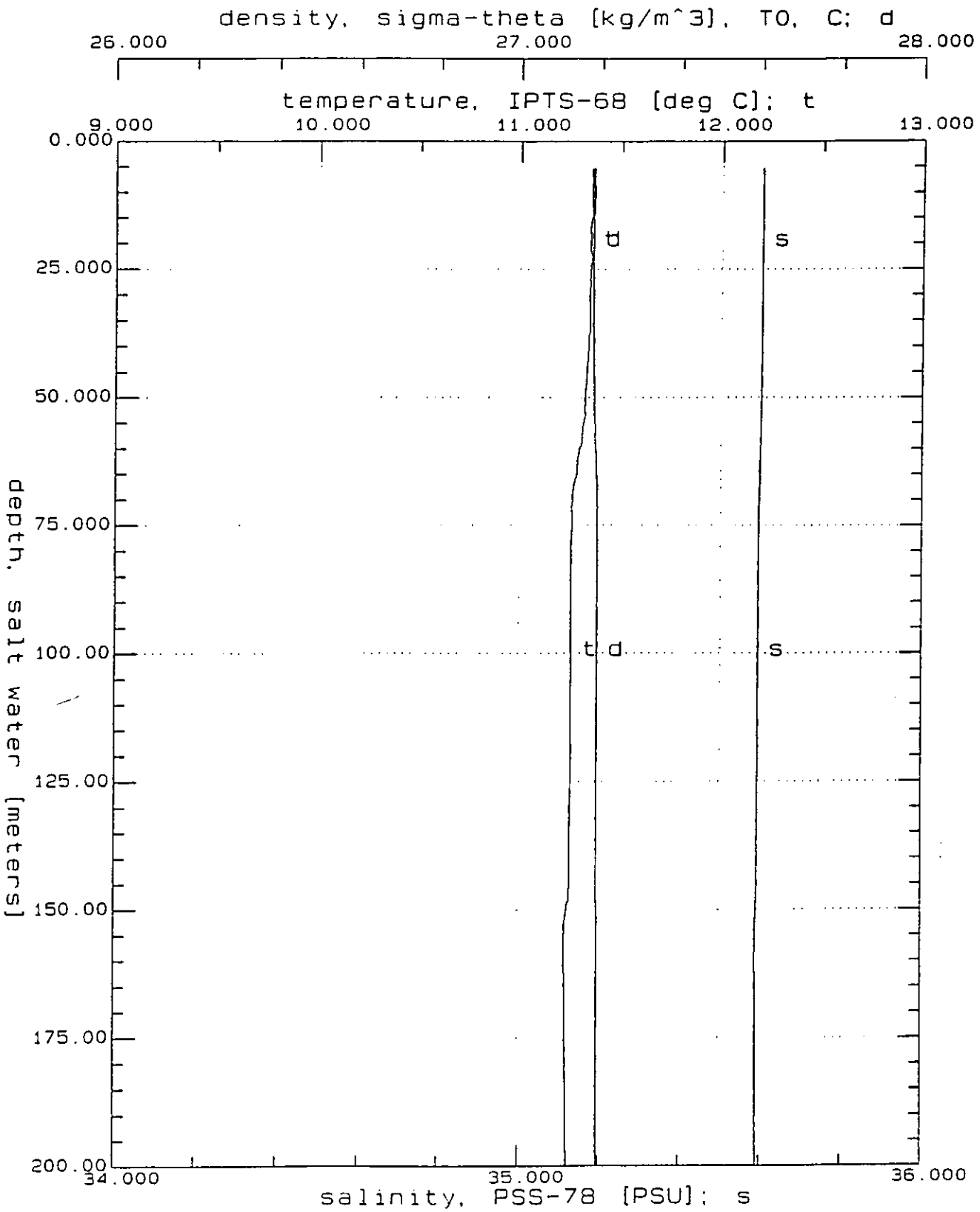
OMX9404A.CNV: OMEX 94/12 Station 4A 21.04.94 at 21h46.

Figure 16



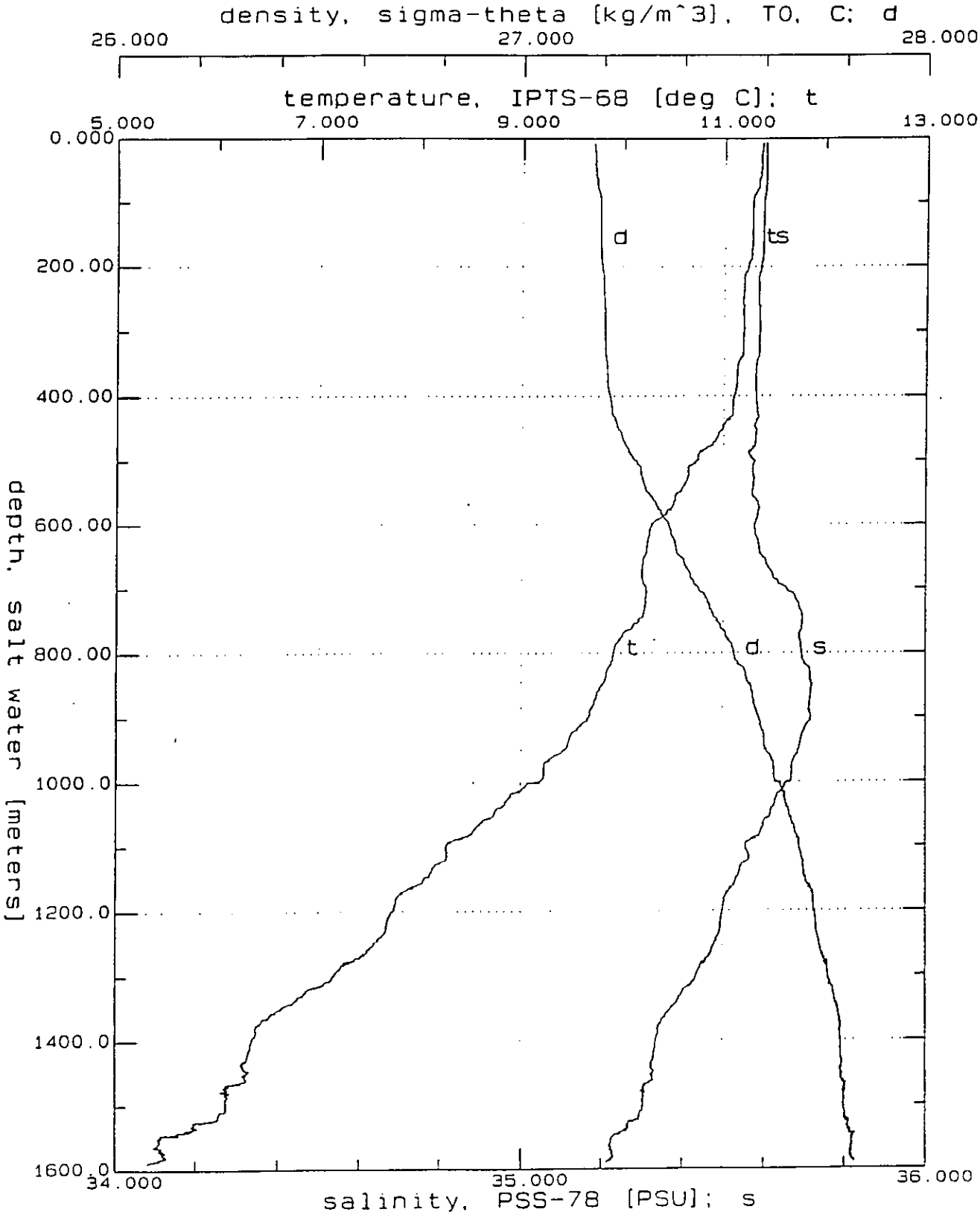
OMX9405.CNV: OMEX 94/12 Station 5 22.04.94 at 06h43.

Figure 17



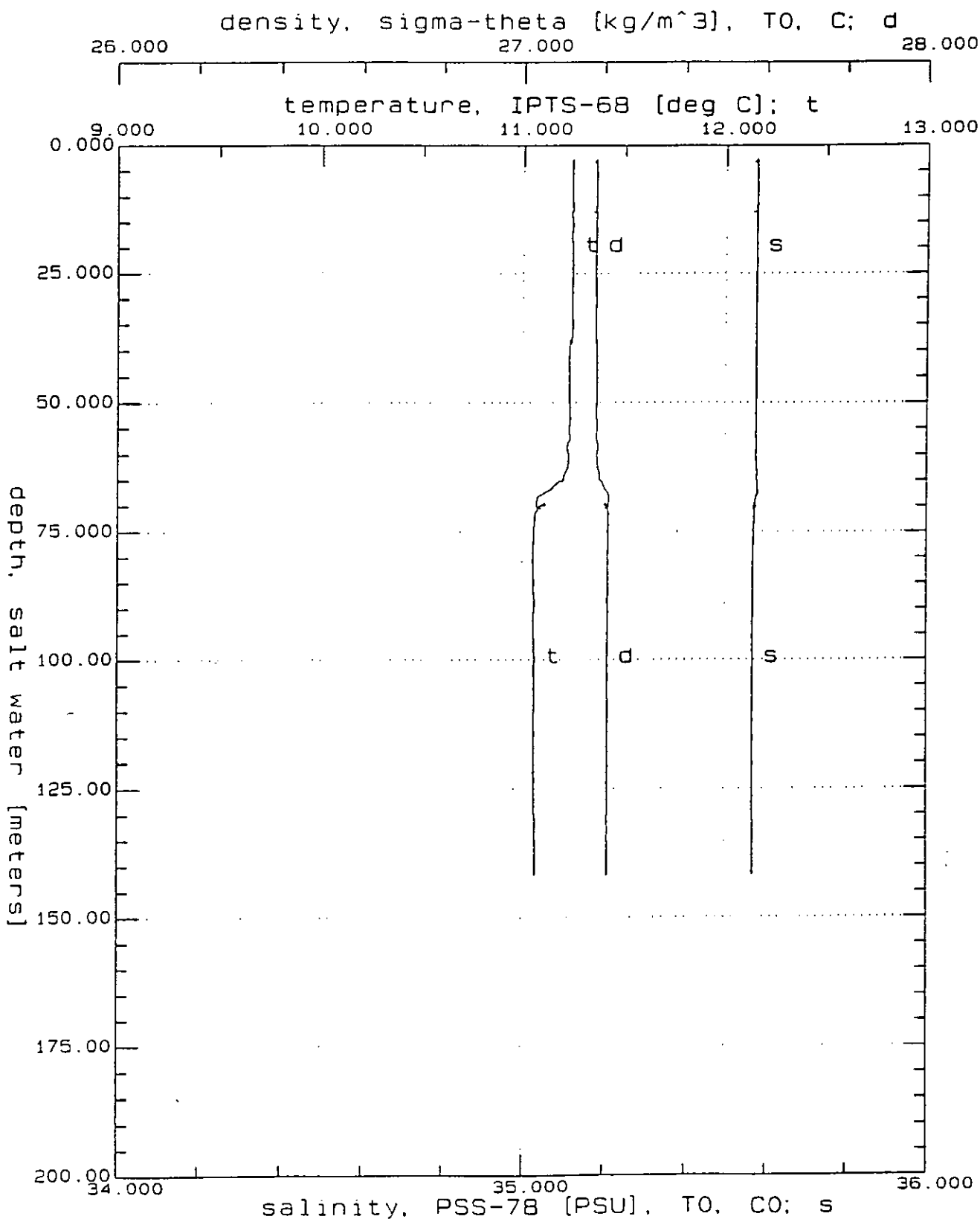
OMX9406.CNV: OMEX 94/12 Station 6 22.04.94 at 12h46.

Figure 18



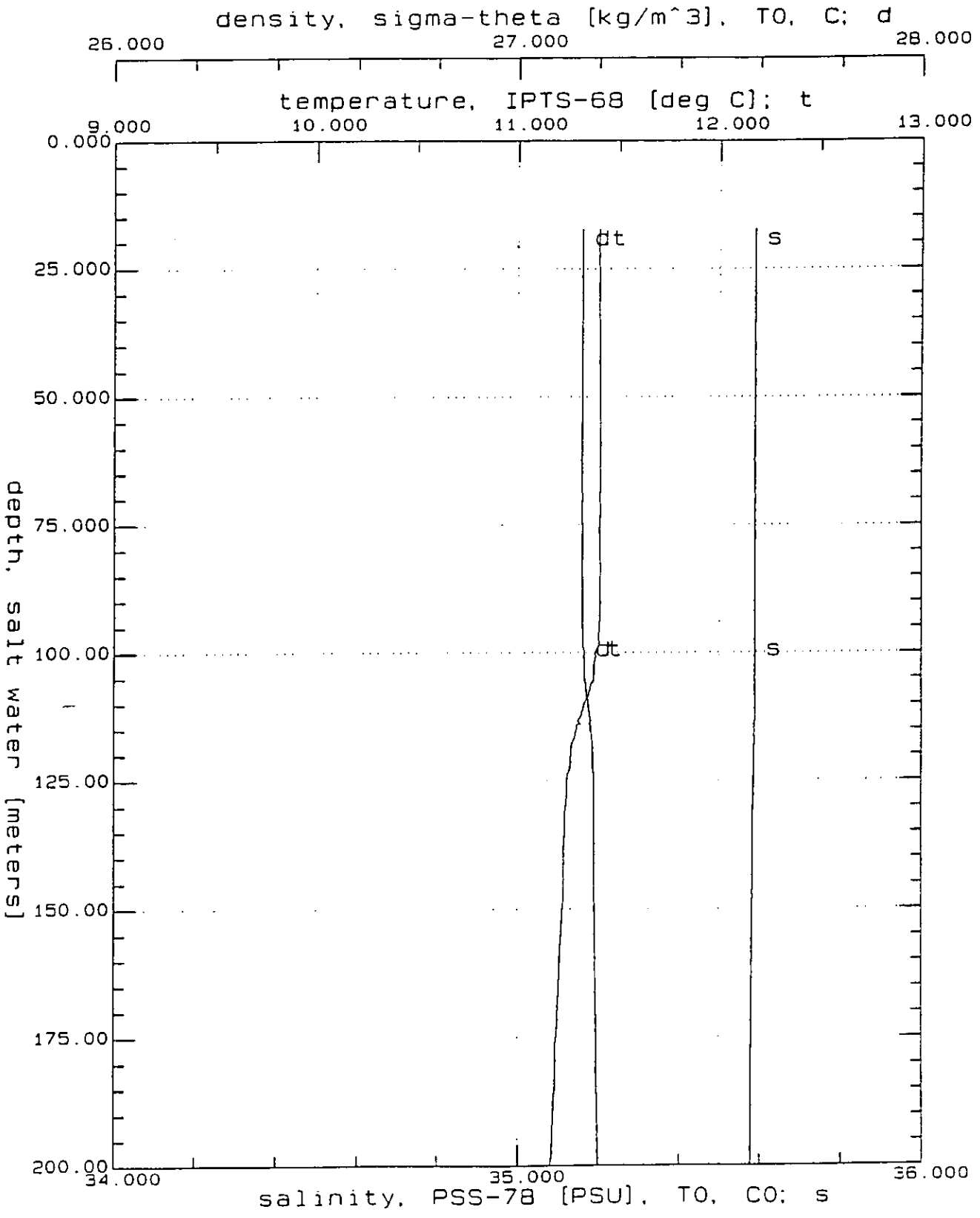
OMX9406A.CNV: OMEX 94/12 Station 6A 22.04.94 at 14h06.

Figure 19



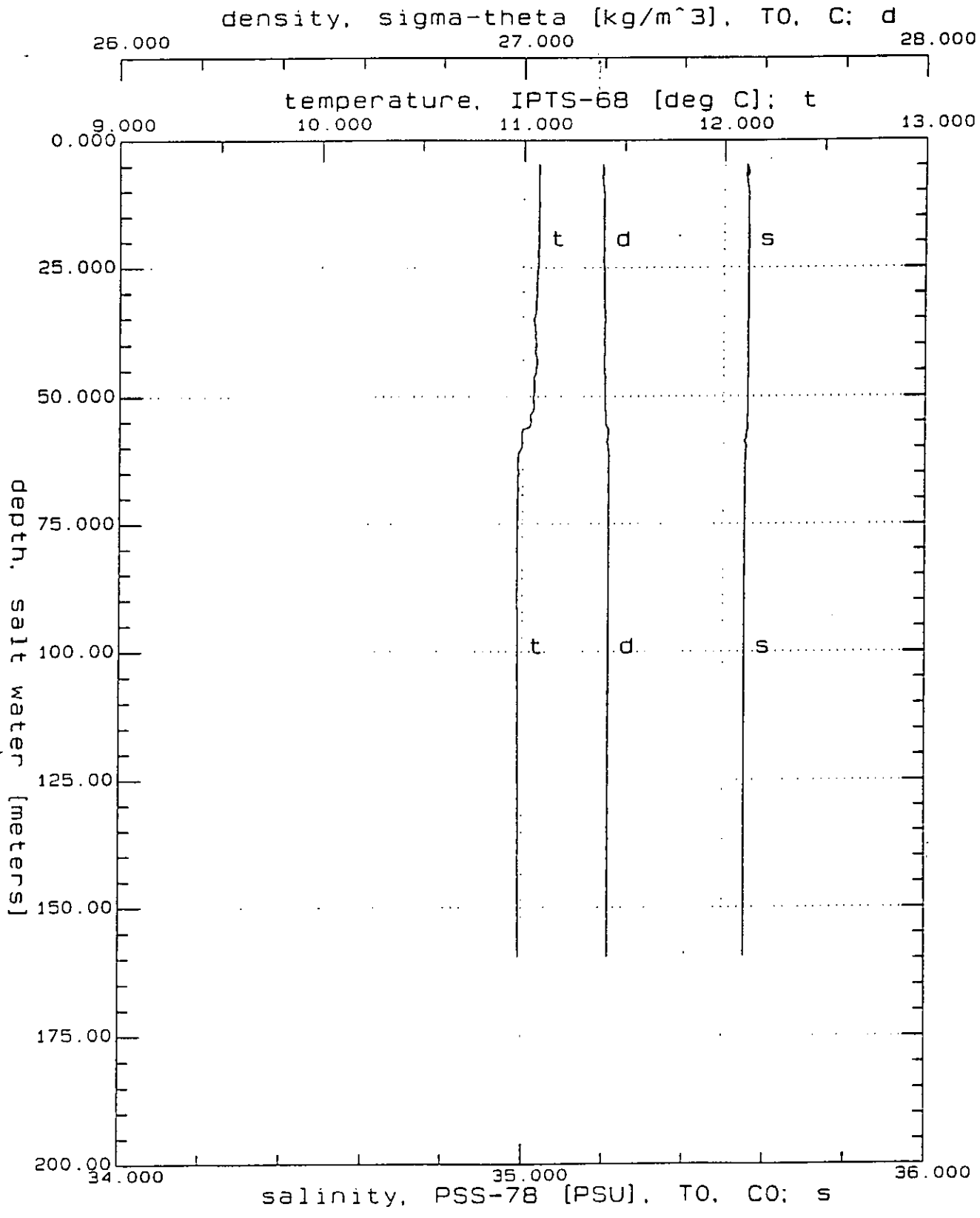
OMX9407.CNV: OMEX 94/12 Station 7 22.04.94 at 17h49.

Figure 20



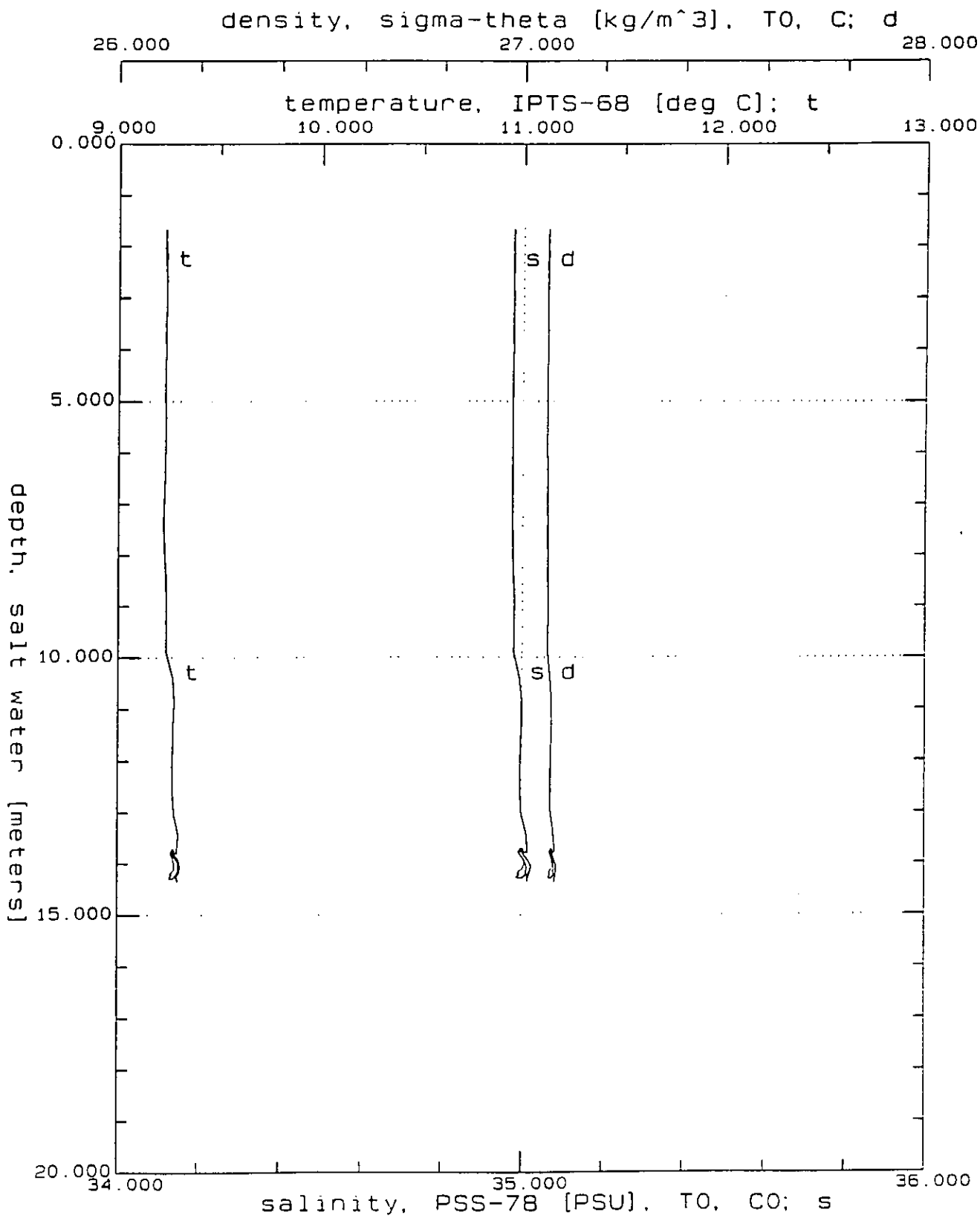
OMX9408.CNV: OMEX 94/12 Station 8 24.04.94 at 06h58.

Figure 21



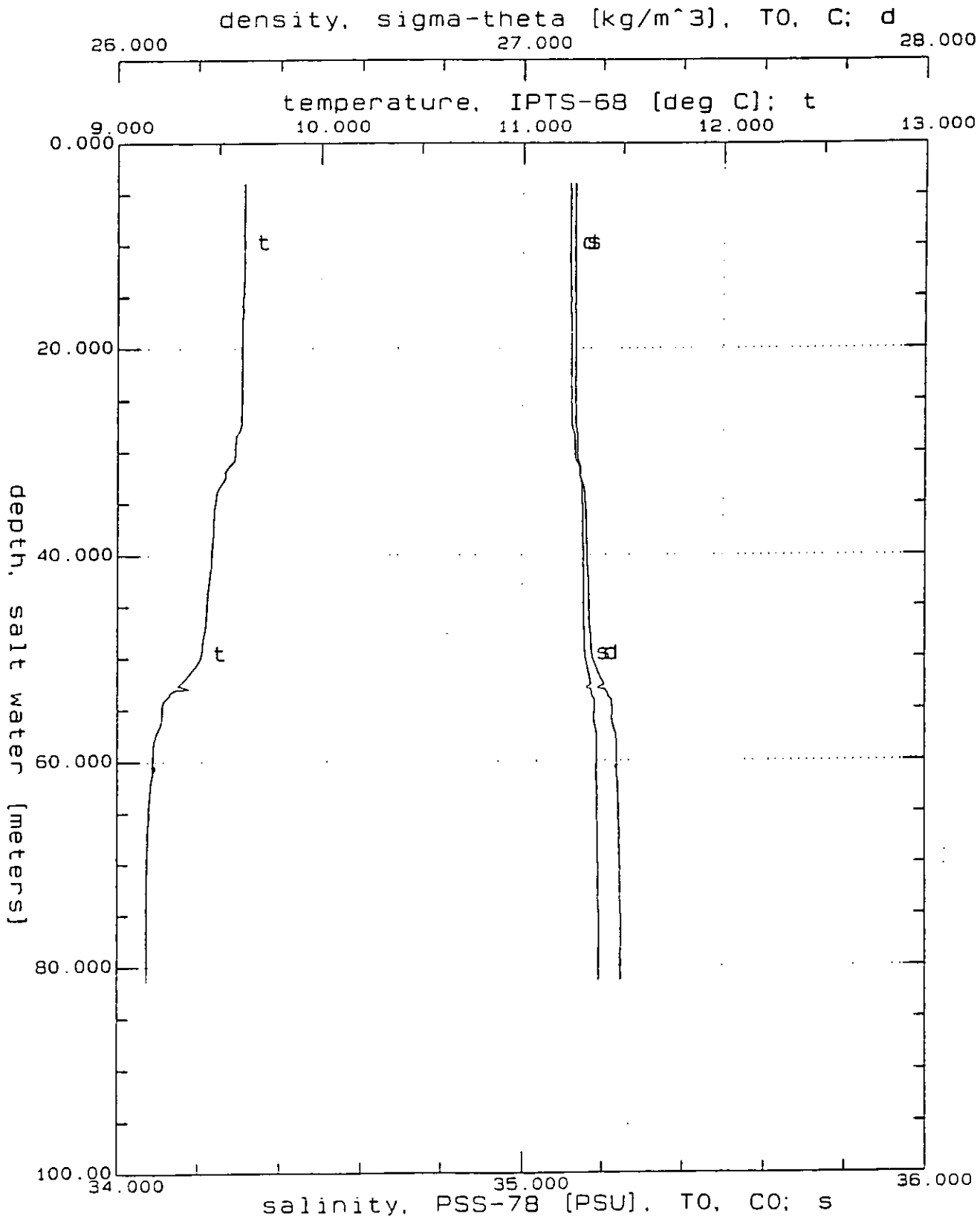
OMX9409.CNV: OMEX 94/12 Station 9 24.04.94 at 11h34.

Figure 22



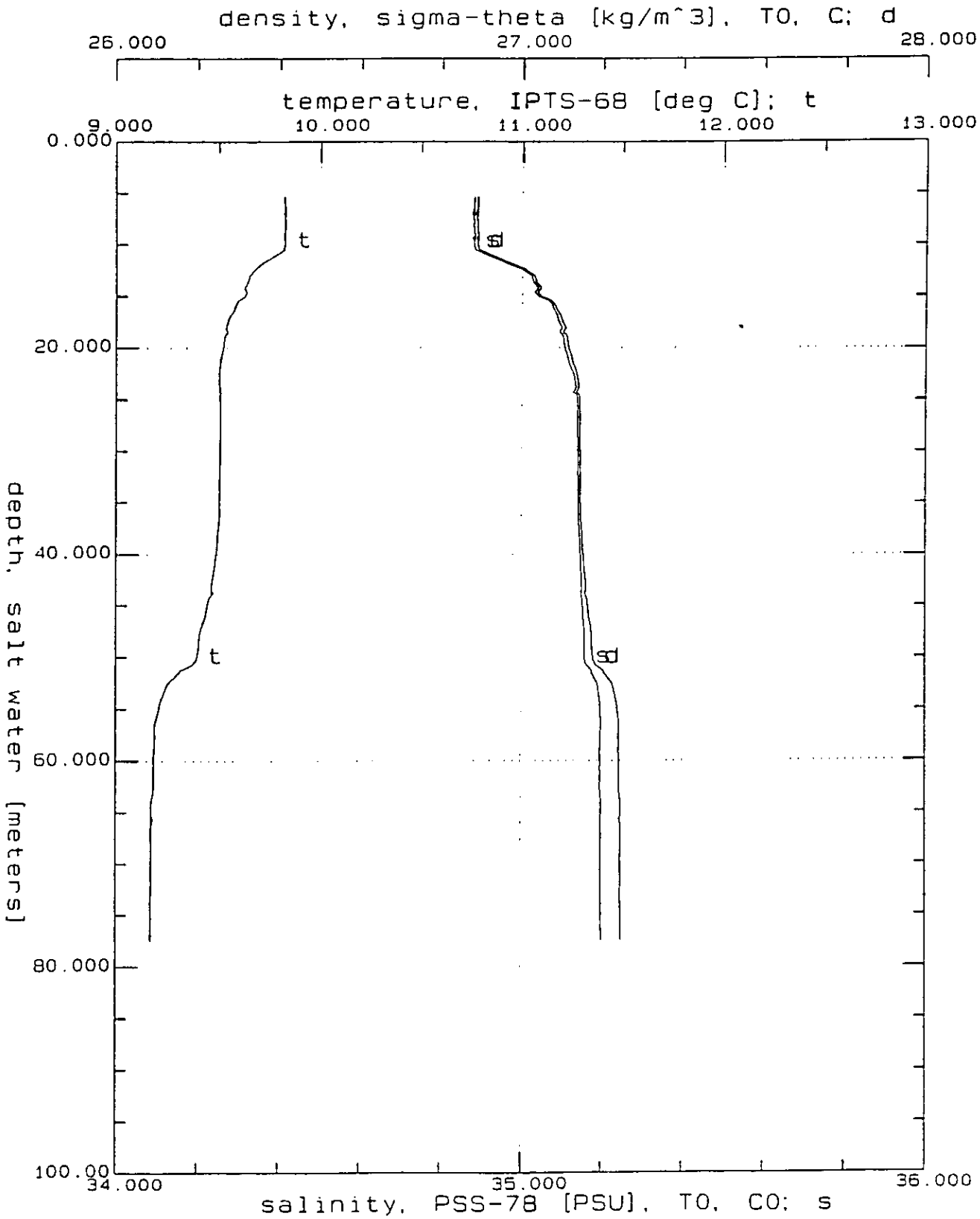
OMX94H0.CNV: OMEX 94/12 Station H0 26.04.94 at 05h16.

Figure 23



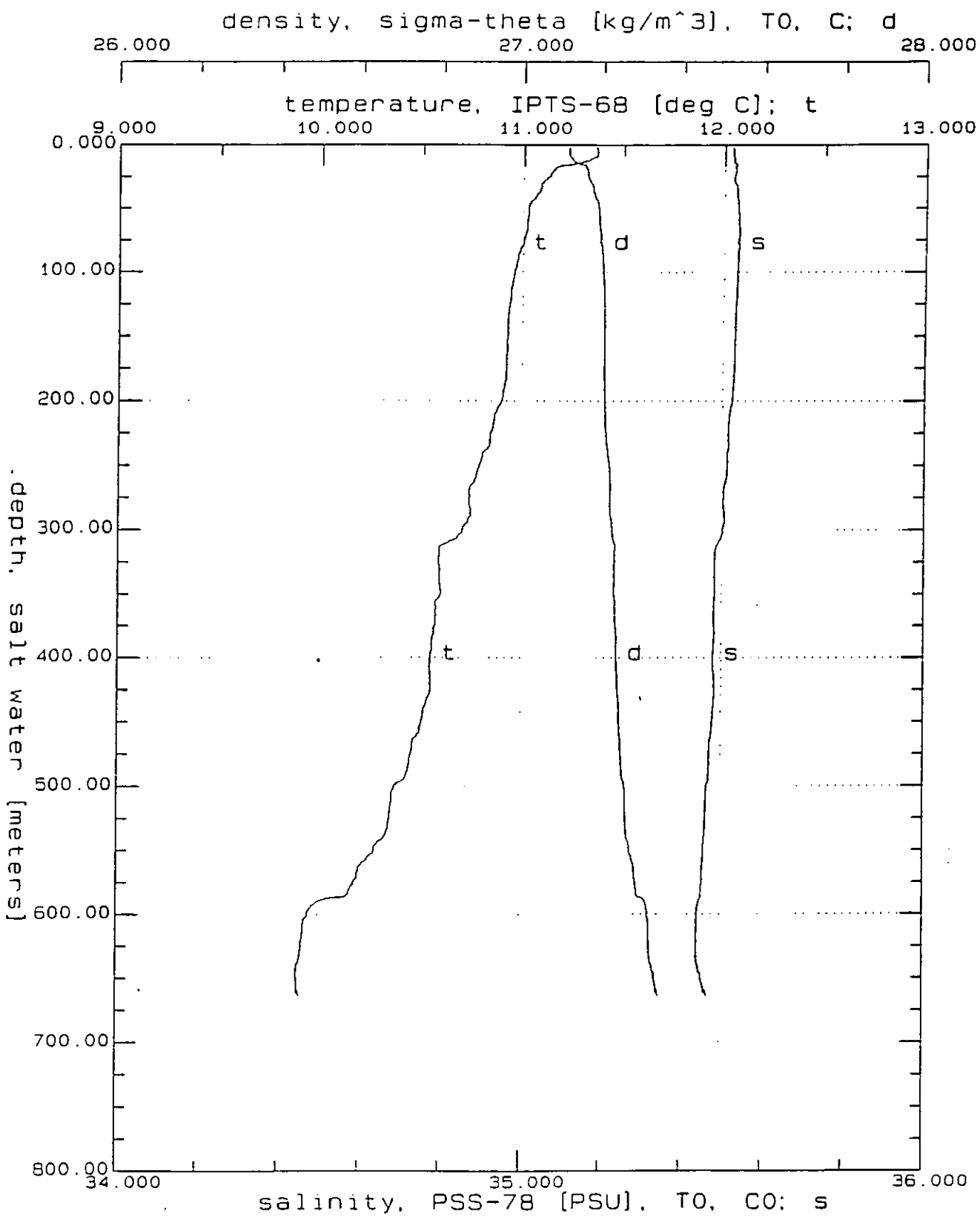
OMX94CS.CNV: OMEX 94/12 Station CS 27.04.94 at 07h38.

Figure 24



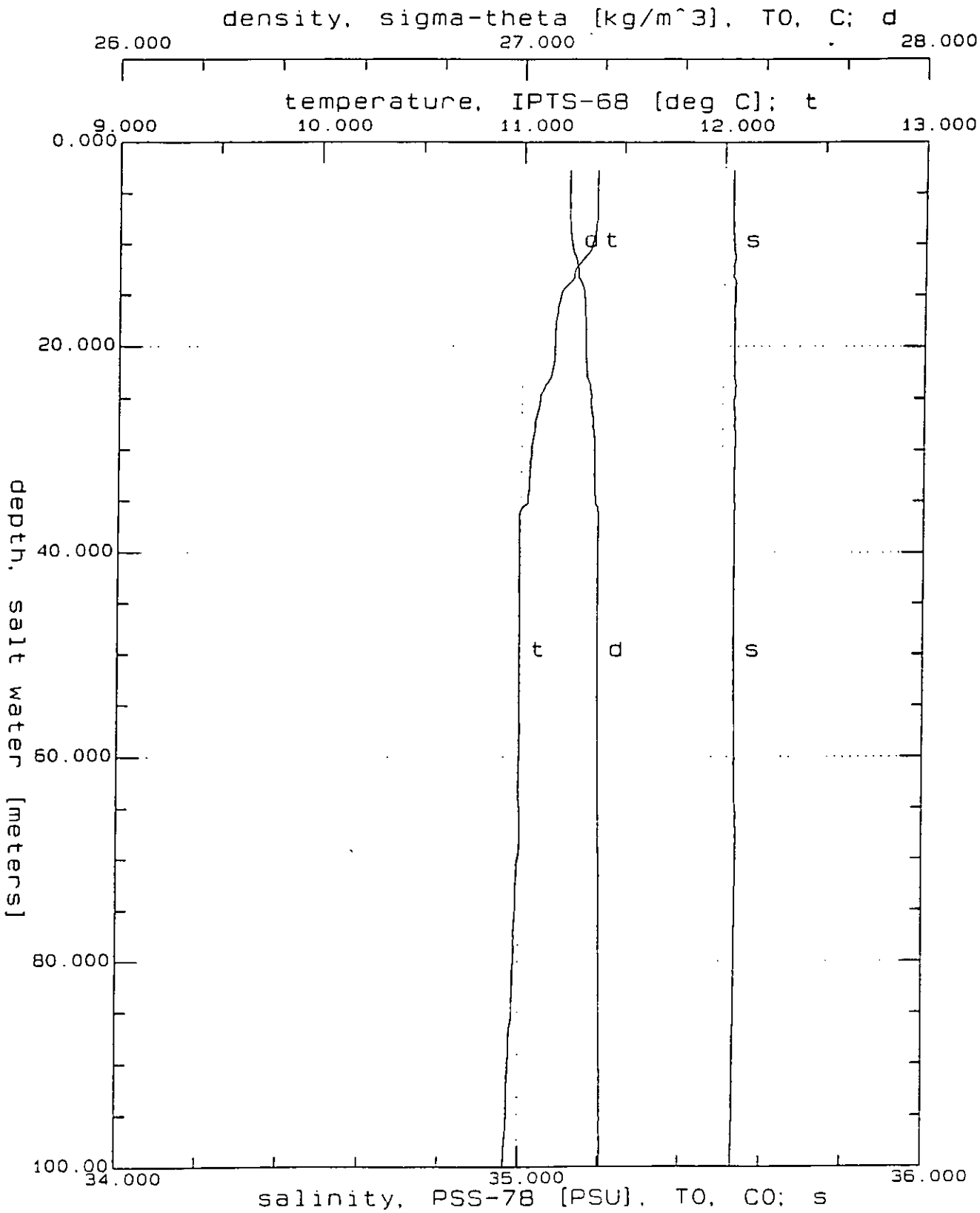
OMX94CSA.CNV: OMEX 94/12 Station CSA 27.04.94 at 11h26.

Figure 25



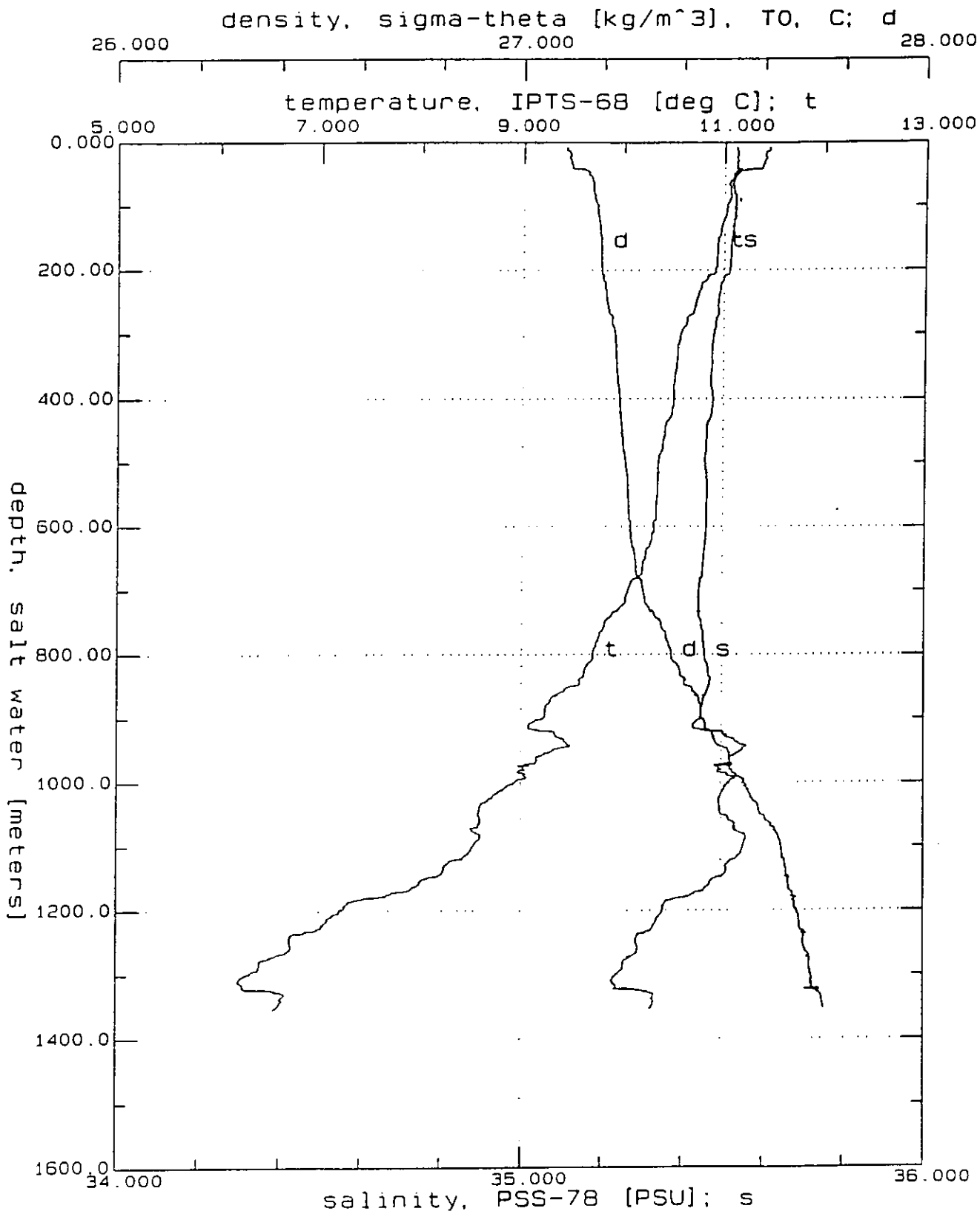
OMX9415.CNV: OMEX 94/12 Station 15 02.05.94 at 04h20.

Figure 26



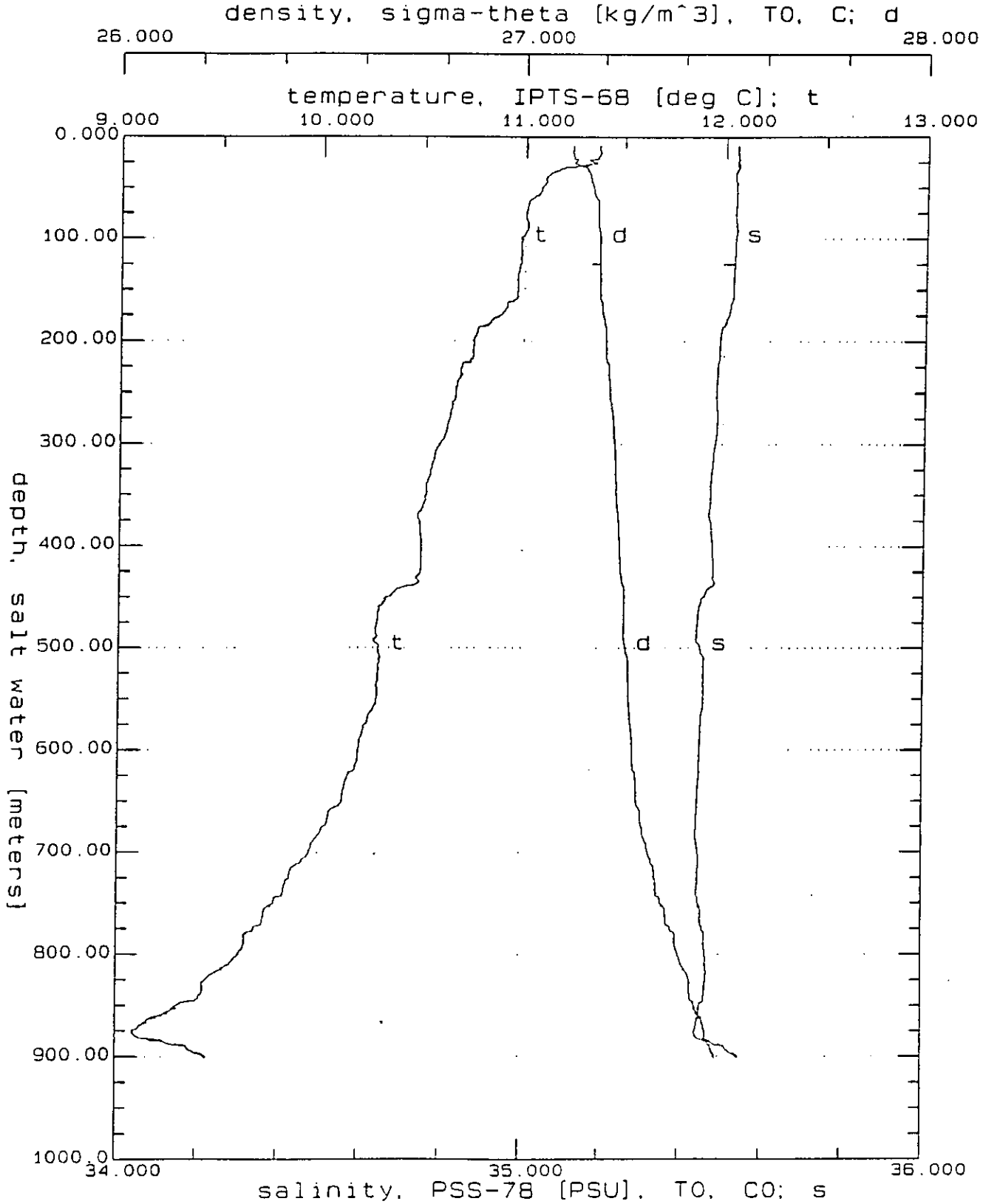
OMX9415A.CNV: OMEX 94/12 Station 15A 02.05.94 at 06h12.

Figure 27



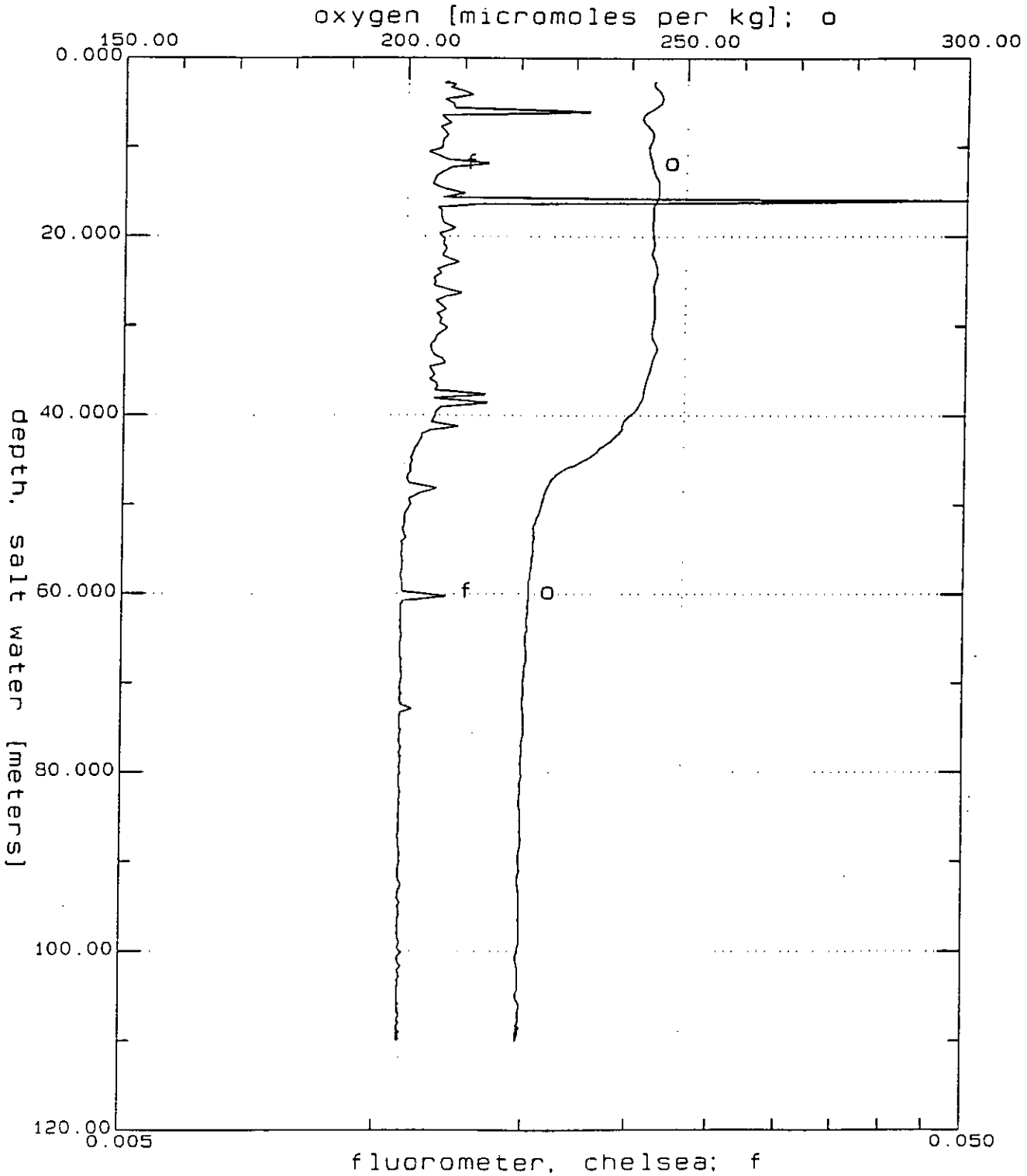
OMX9417.CNV: OMEX 94/12 Station 17 02.05.94 at 18h55.

Figure 28



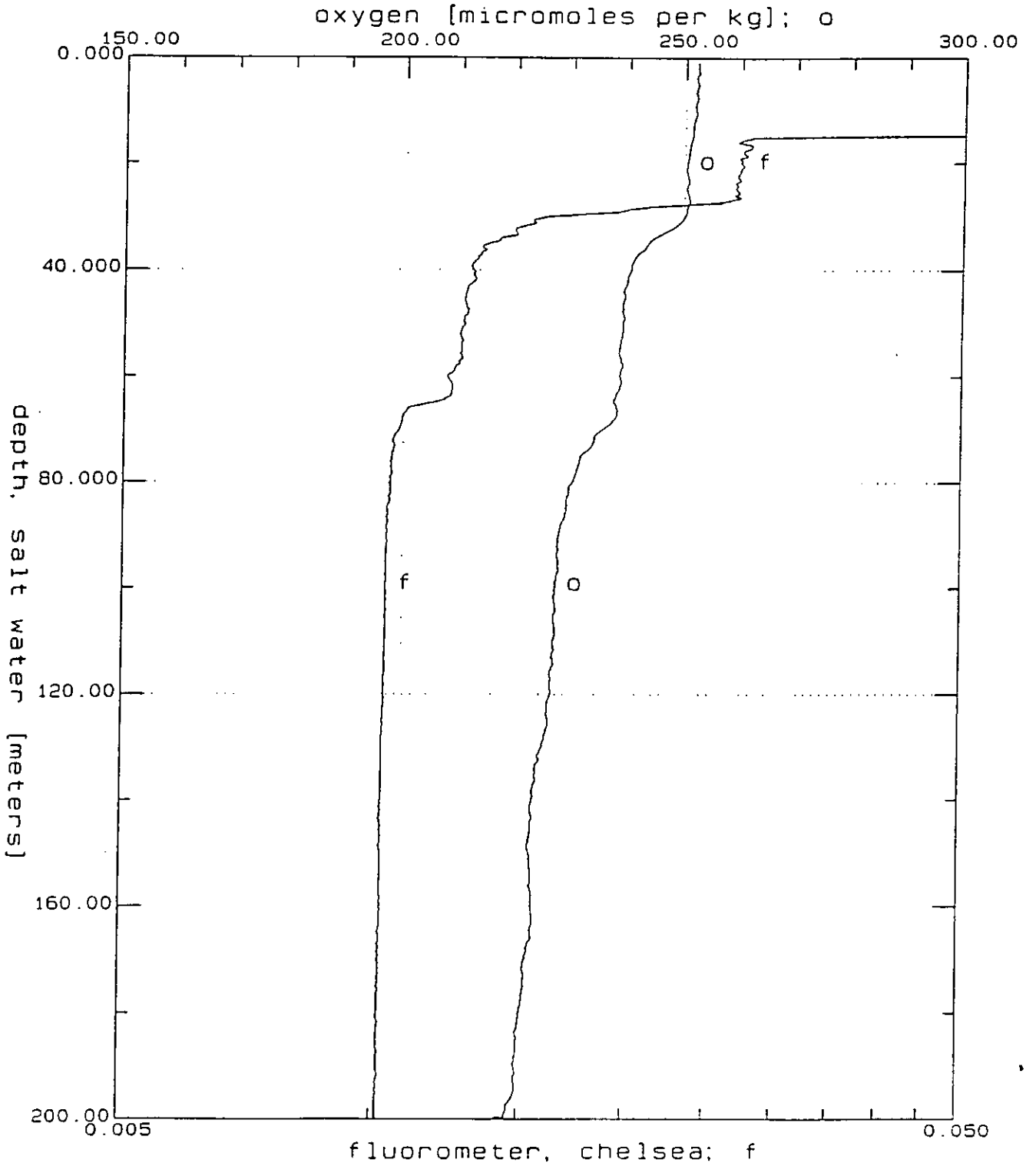
OMX9417A.CNV: OMEX 94/12 Station 17A 02.05.94 at 22h26.

Figure 29



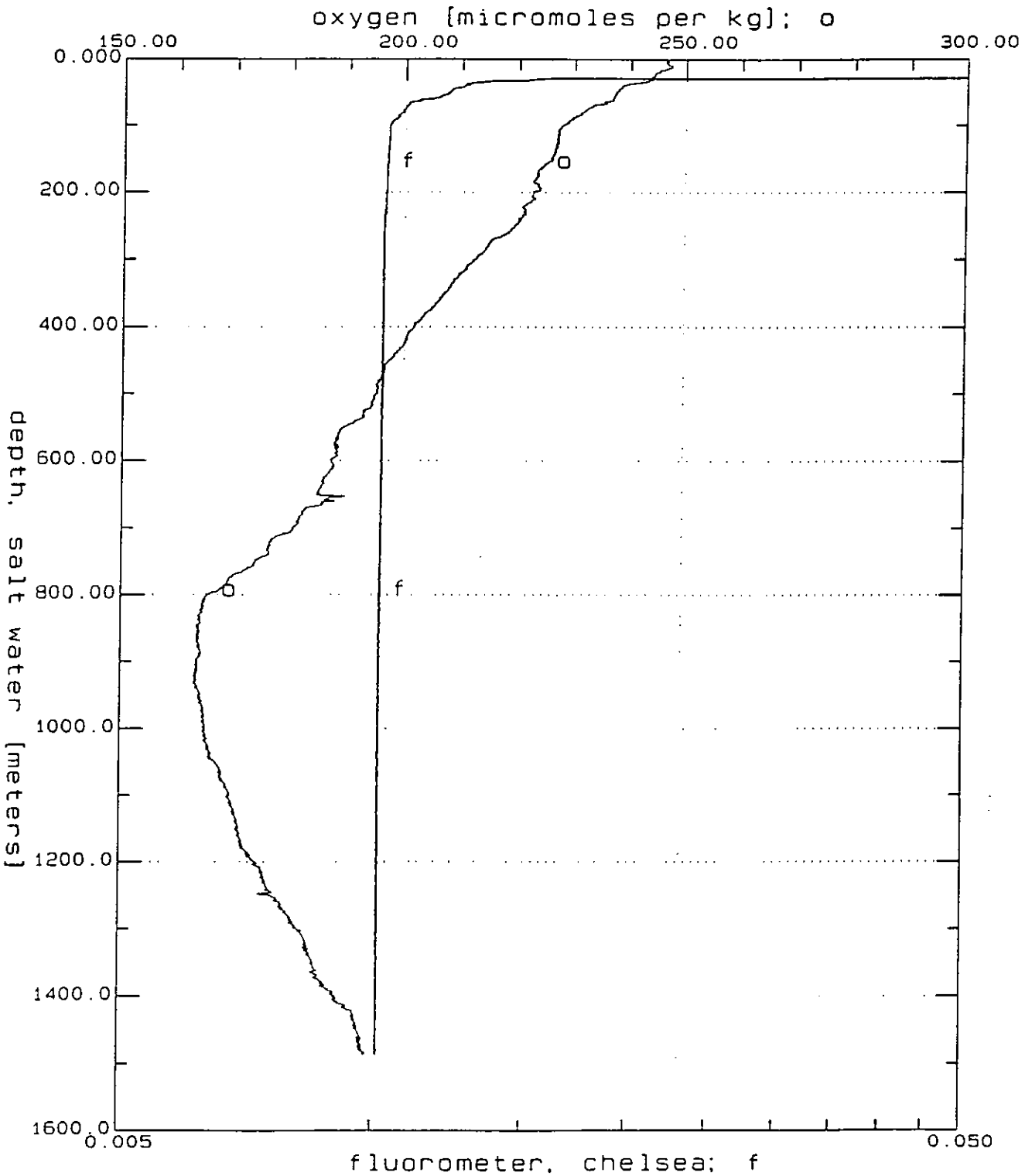
OMX9401A.CNV: OMEX 94/12 Station 1A 20.04.94 at 19h46.

Figure 30



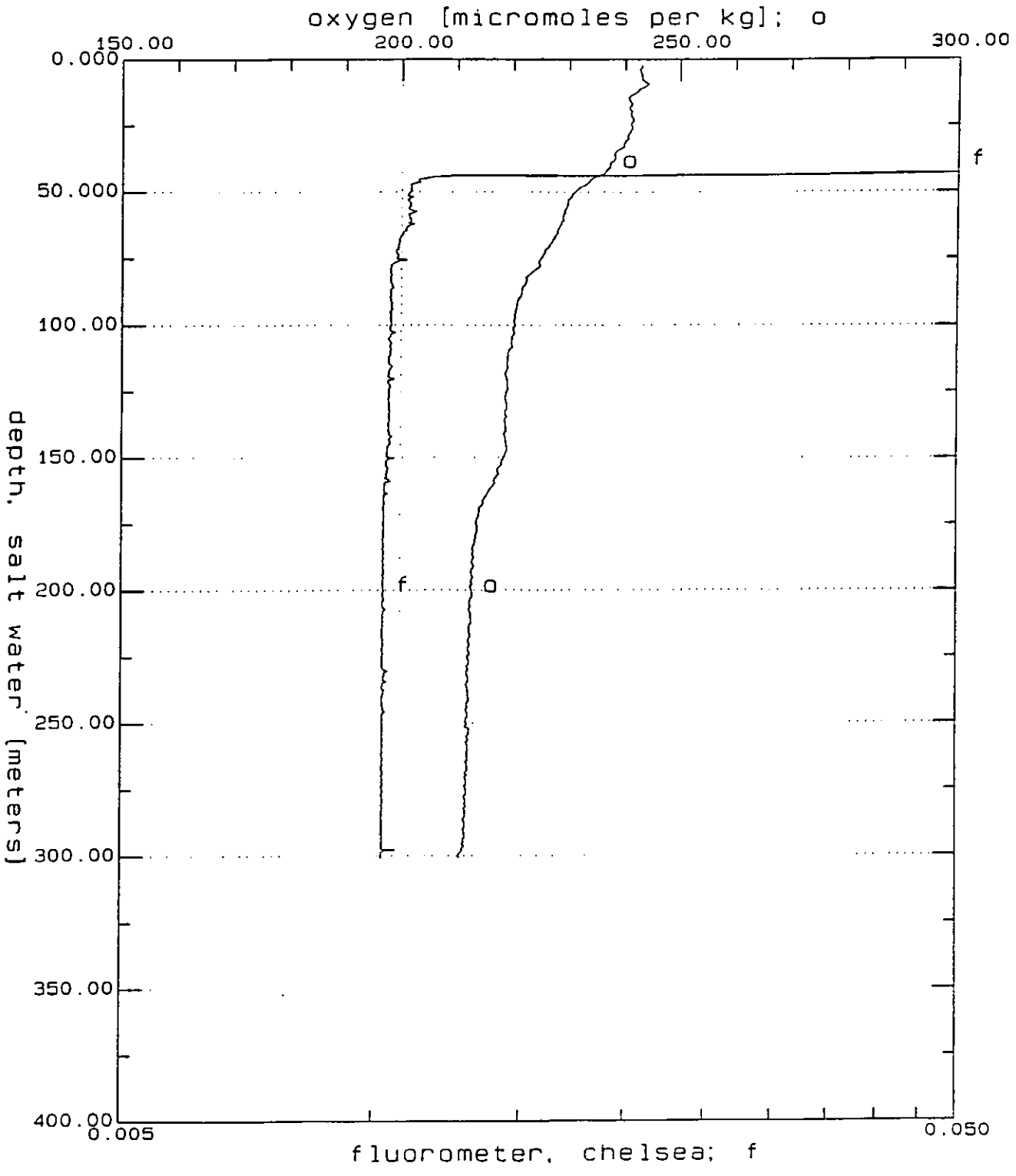
OMX9402.CNV: OMEX 94/12 Station 2 21.04.94 at 06h23.

Figure 31



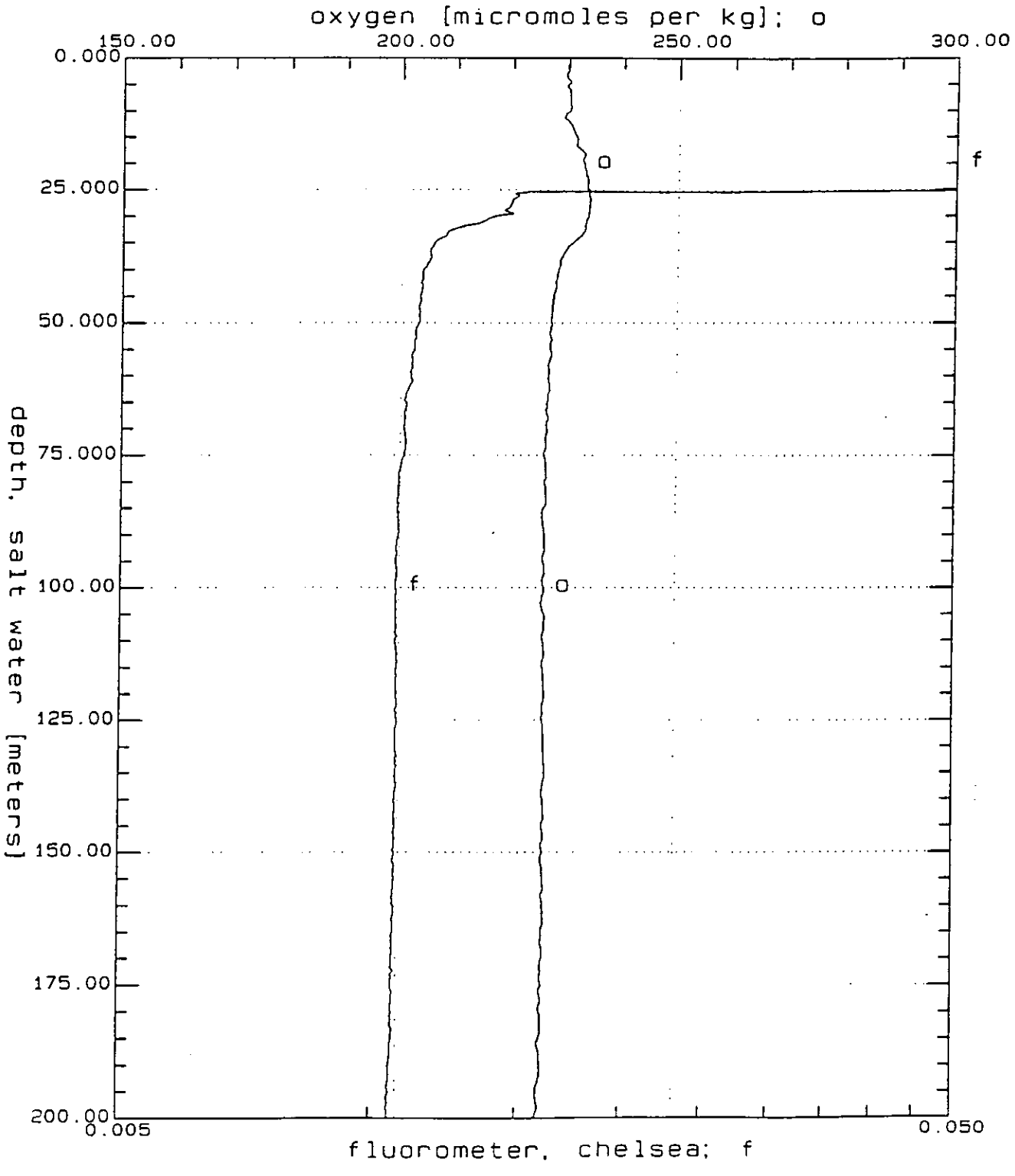
OMX9402A.CNV: OMEX 94/12 Station 2A 21.04.94 at 09h57.

Figure 32



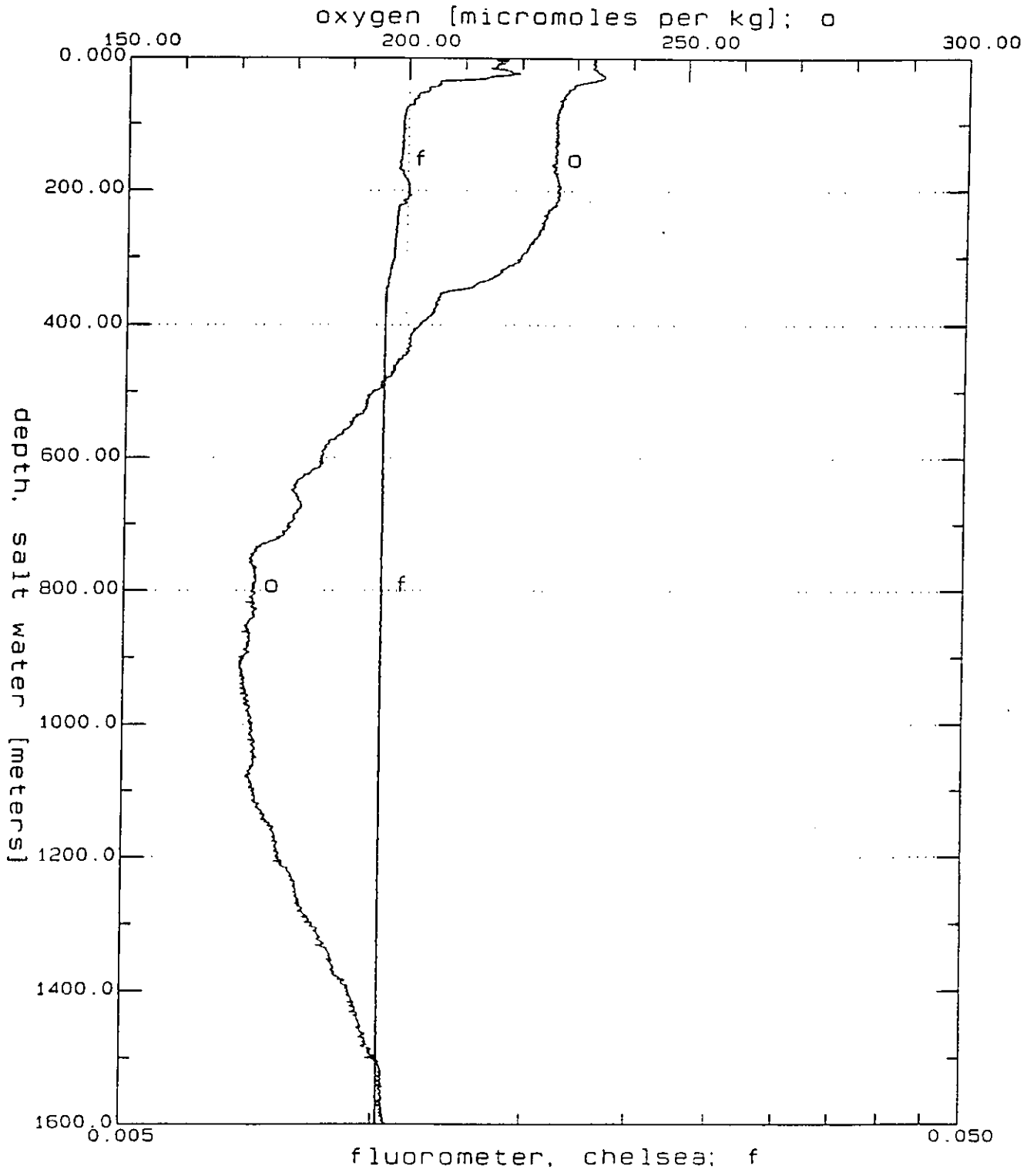
OMX9403.CNV: OMEX 94/12 Station 3 21.04.94 at 12h50.

Figure 33



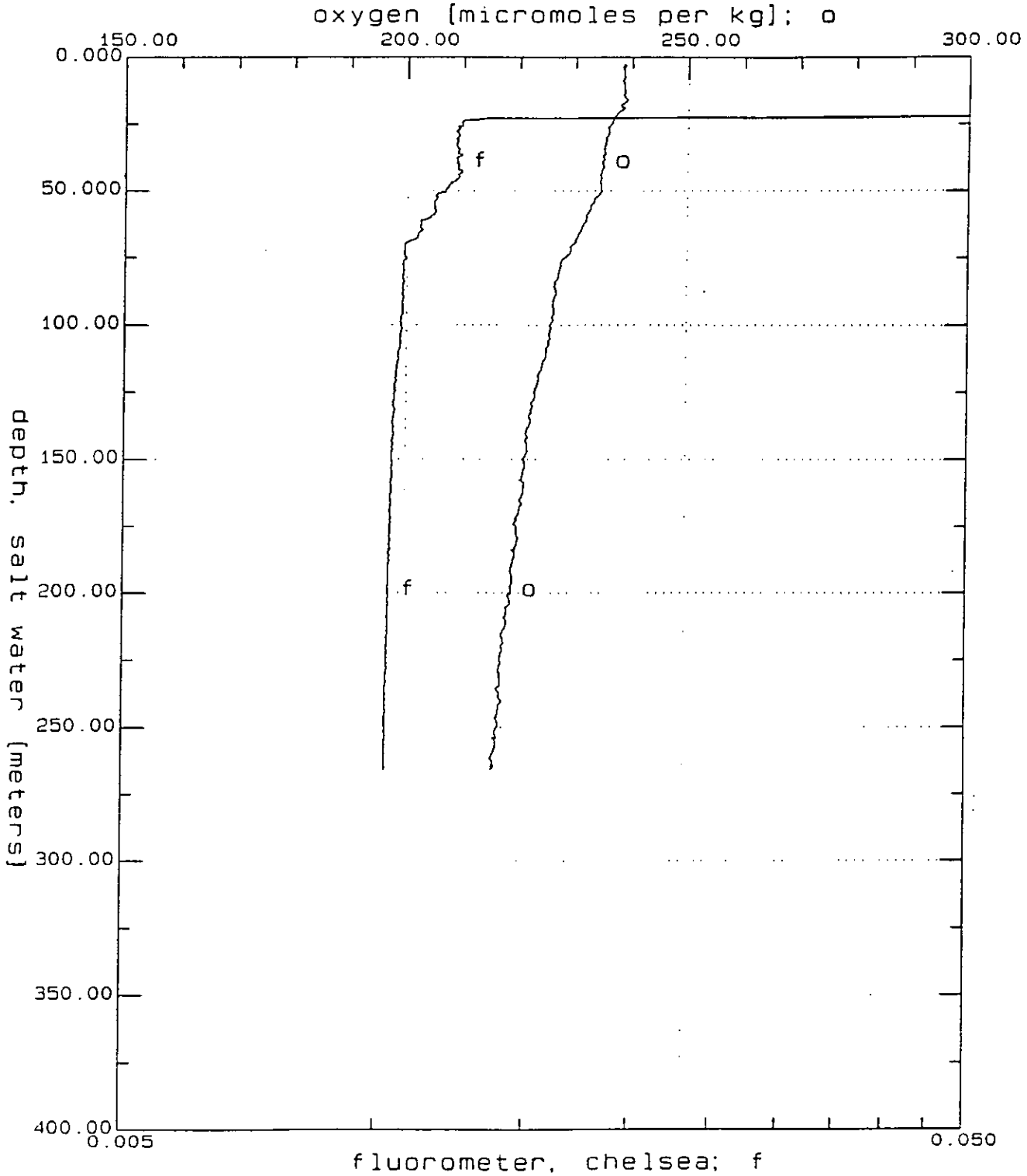
OMX9404.CNV: OMEX 94/12 Station 4 21.04.94 at 18h25.

Figure 34



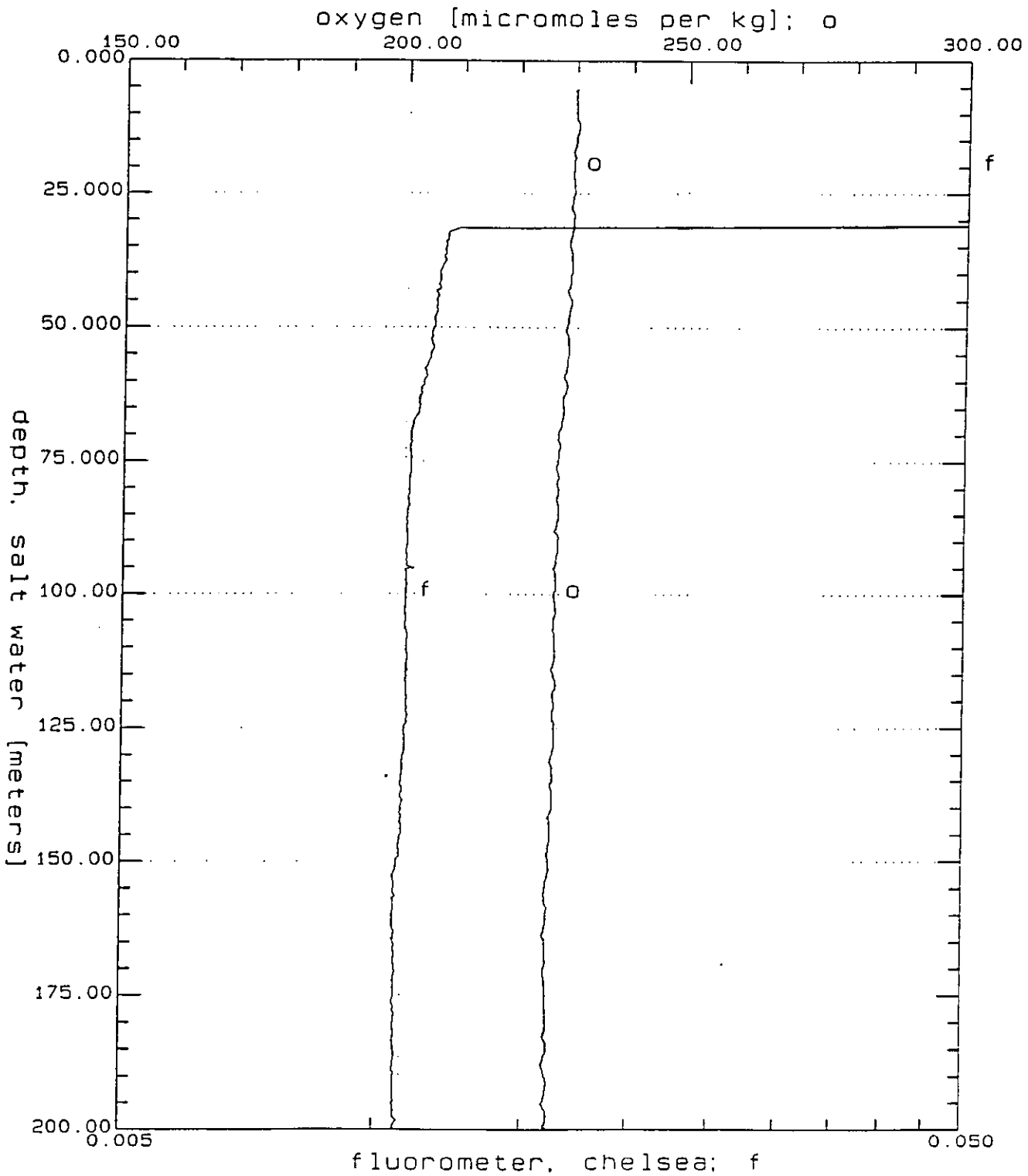
OMX9404A.CNV: OMEX 94/12 Station 4A 21.04.94 at 21h46.

Figure 35



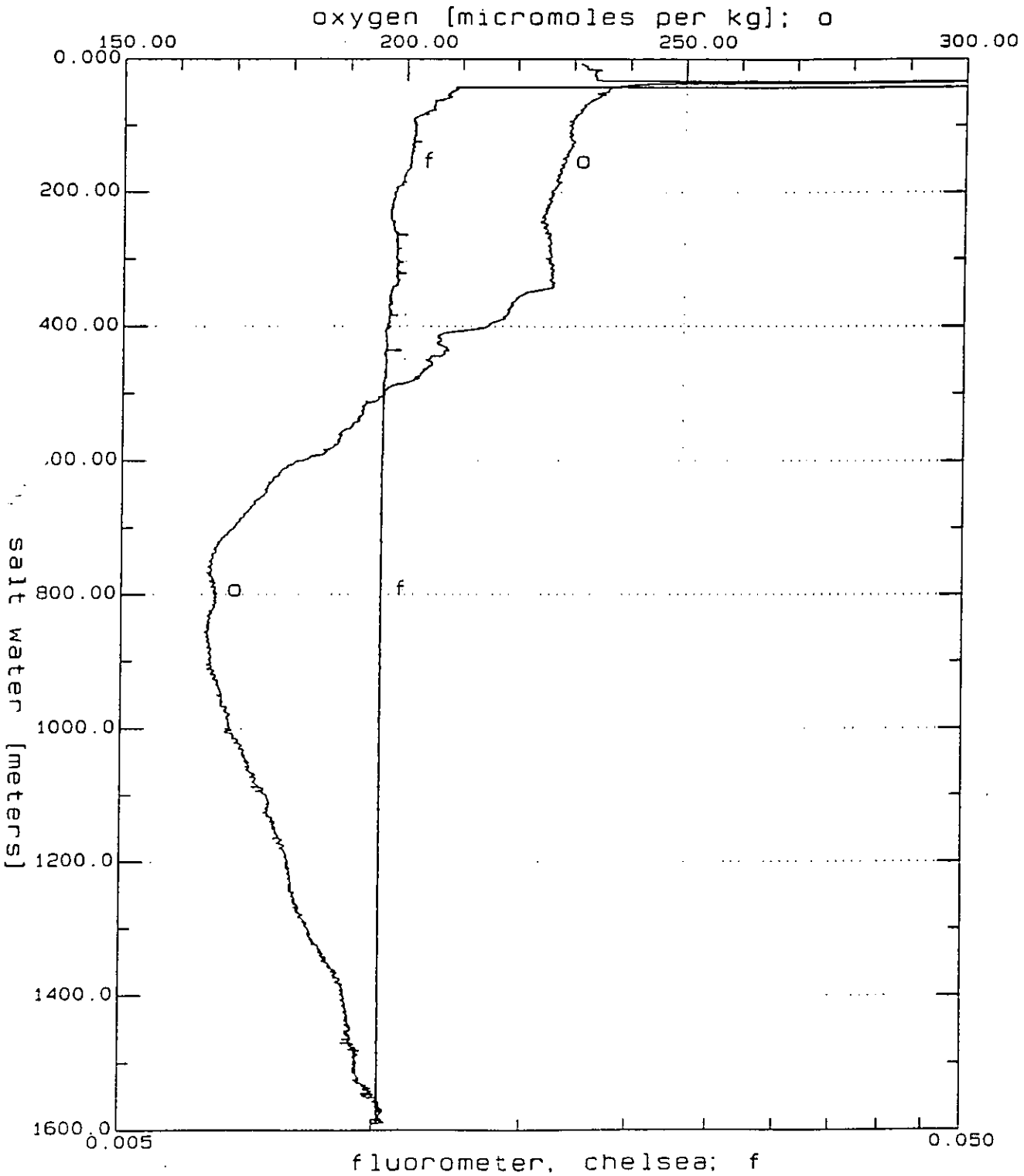
OMX9405.CNV: OMEX 94/12 Station 5 22.04.94 at 06h43.

Figure 36



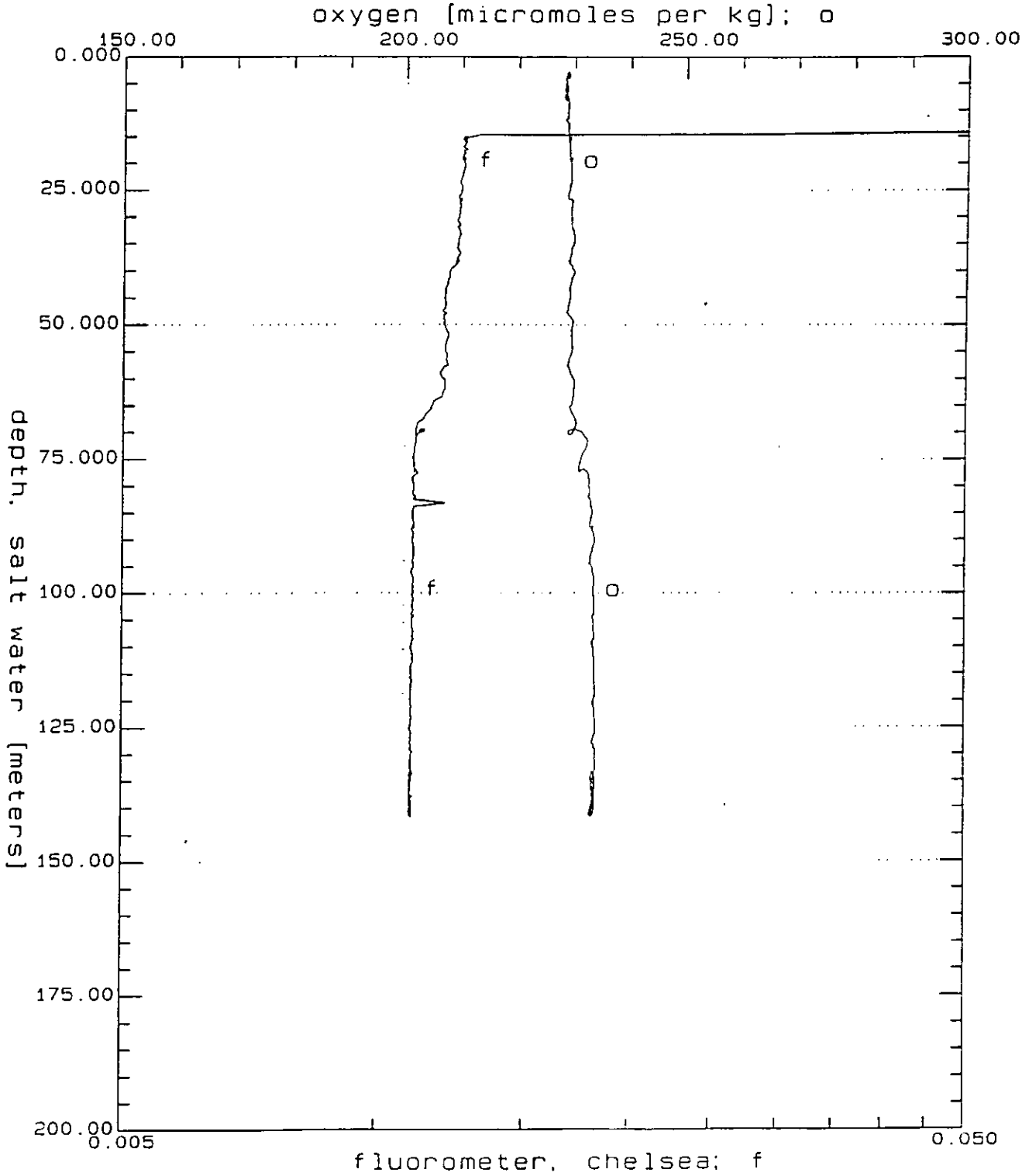
OMX9406.CNV: OMEX 94/12 Station 6 22.04.94 at 12h46.

Figure 37



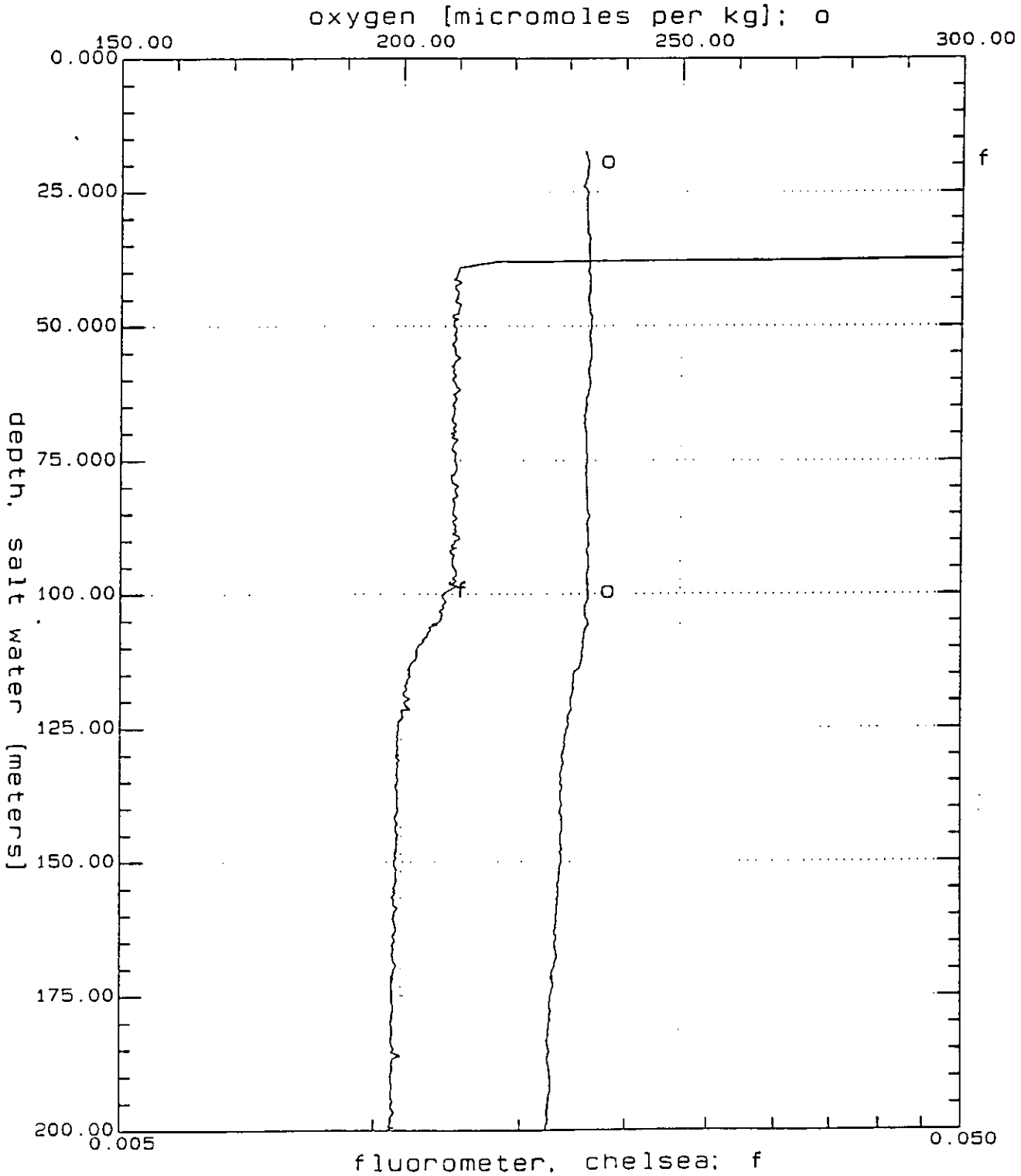
OMX9406A.CNV: OMEX 94/12 Station 6A 22.04.94 at 14h06.

Figure 38



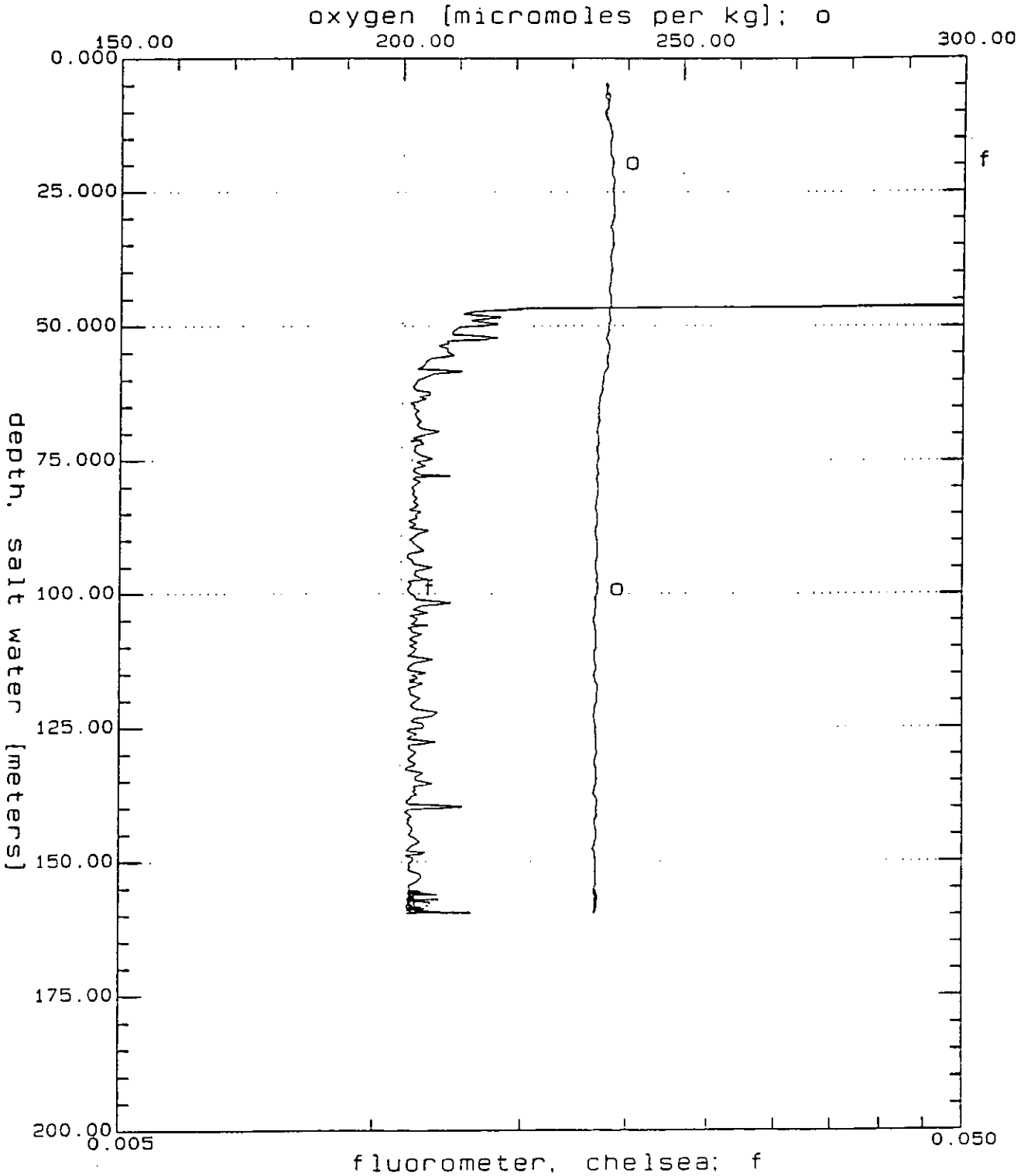
OMX9407.CNV: OMEX 94/12 Station 7 22.04.94 at 17h49.

Figure 39



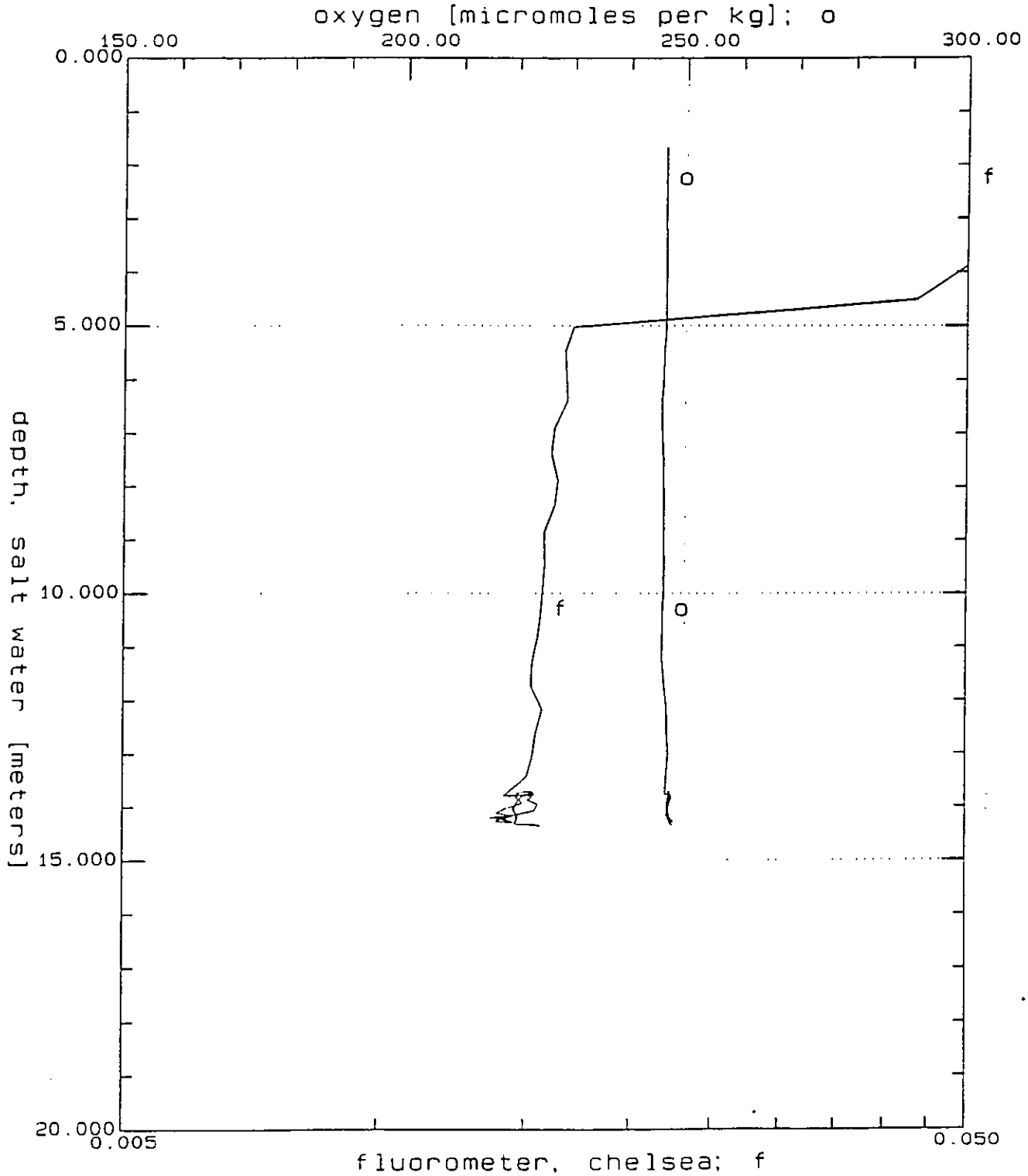
OMX9408.CNV: OMEX 94/12 Station 8 24.04.94 at 06h58.

Figure 40



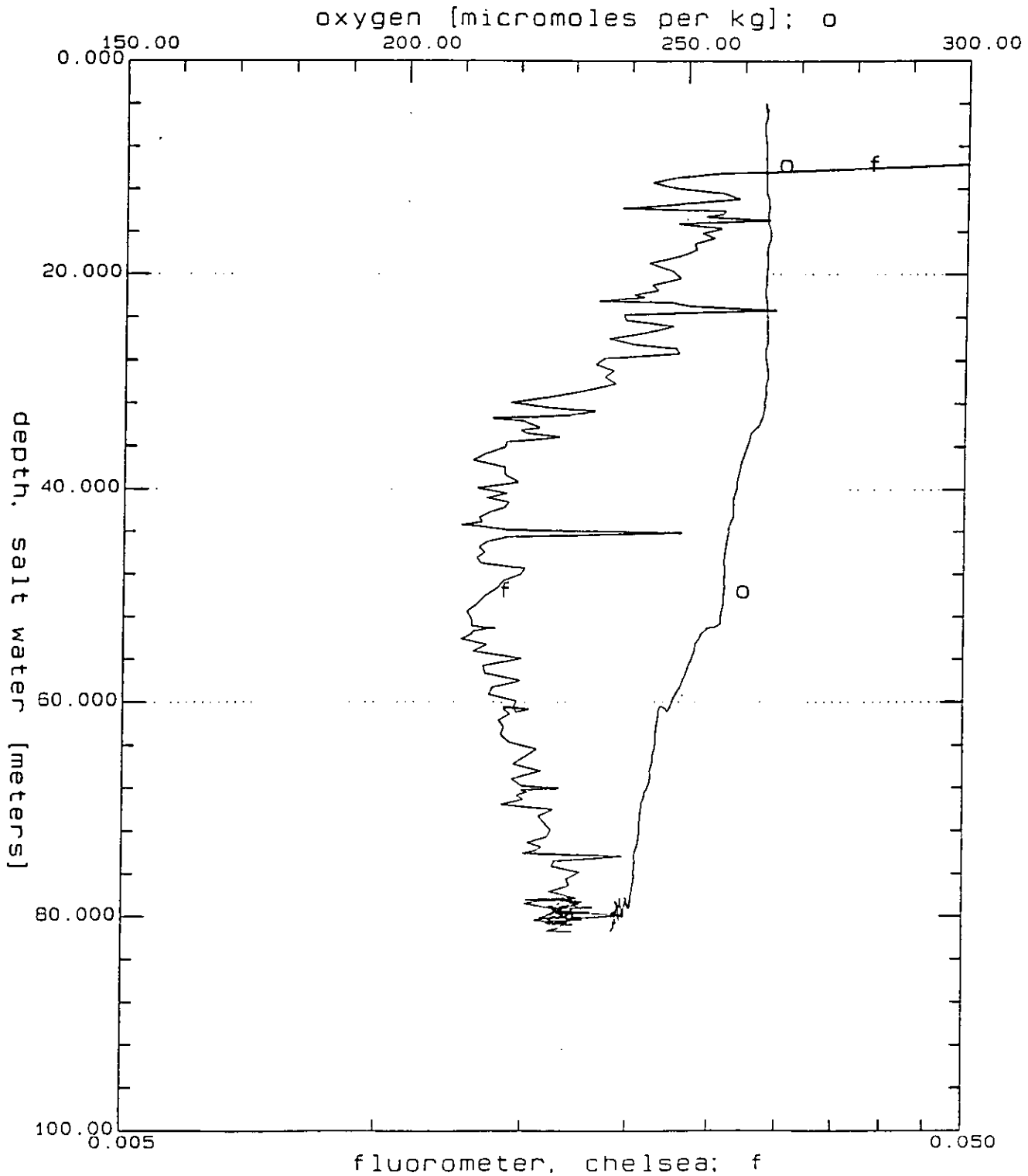
OMX9409.CNV: OMEX 94/12 Station 9 24.04.94 at 11h34.

Figure 41



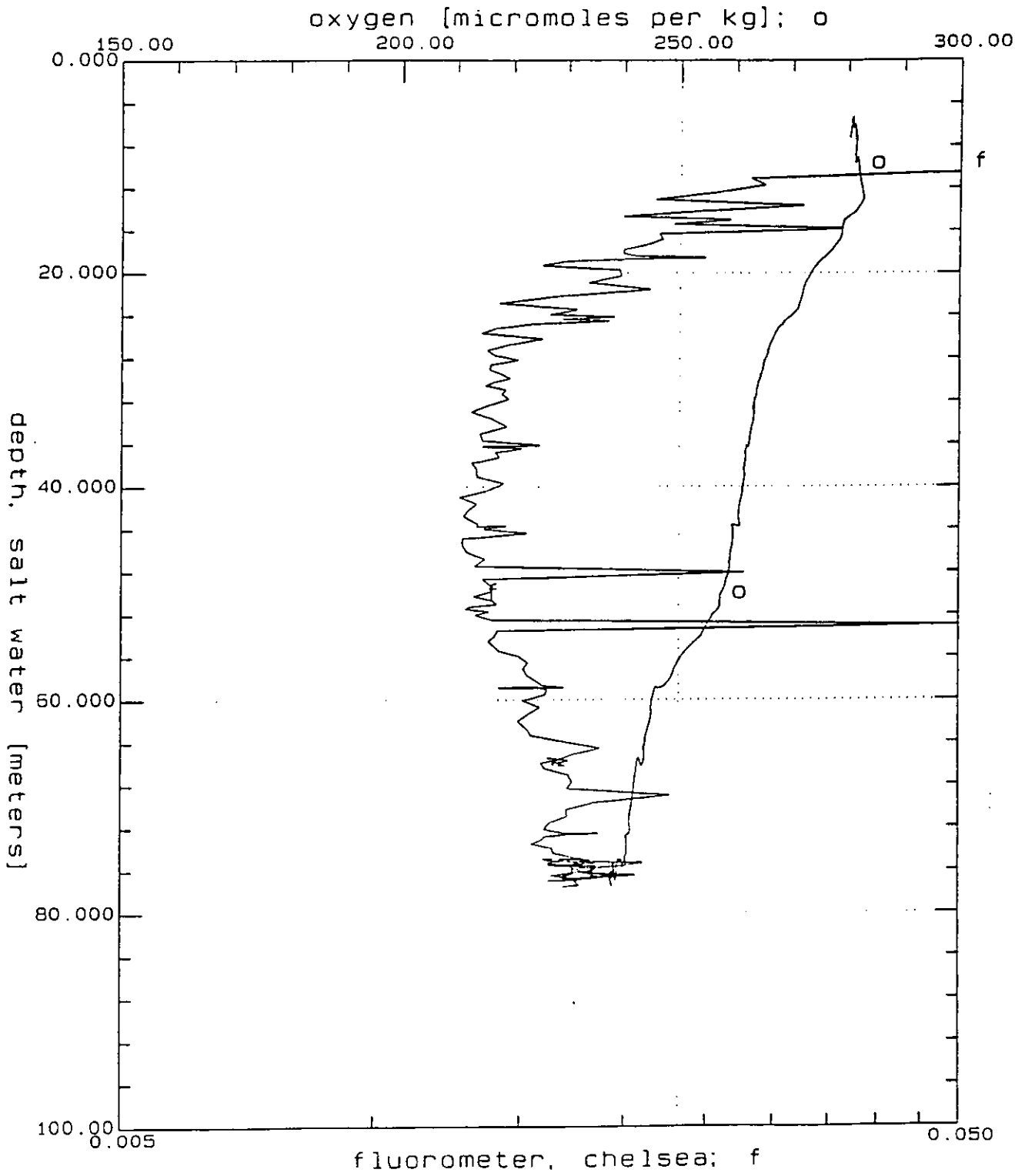
OMX94HO.CNV: OMEX 94/12 Station HO 26.04.94 at 05h16.

Figure 42



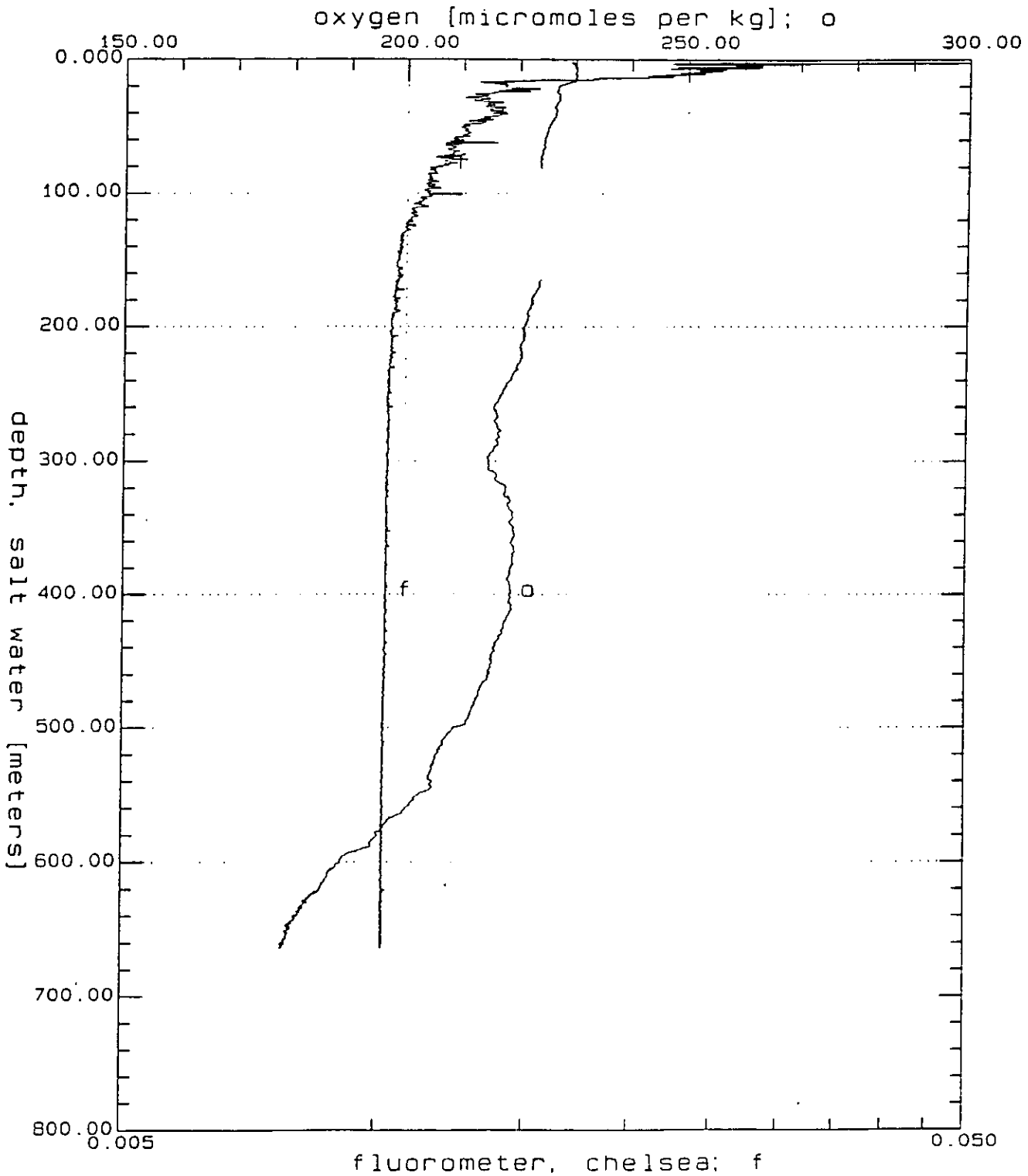
OMX94CS.CNV: OMEX 94/12 Station CS 27.04.94 at 07h38.

Figure 43



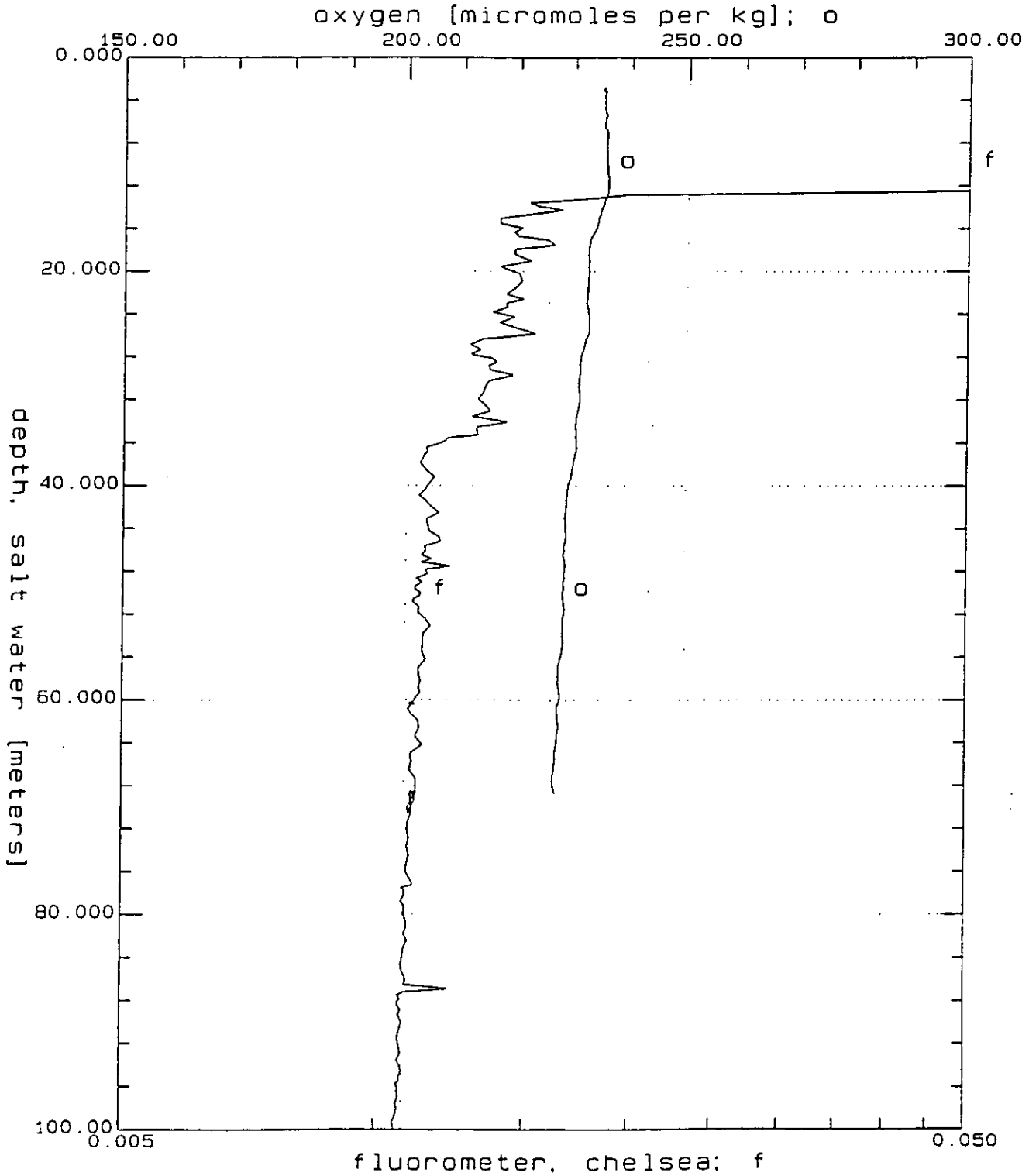
OMX94CSA.CNV: OMEX 94/12 Station CSA 27.04.94 at 11h26.

Figure 44



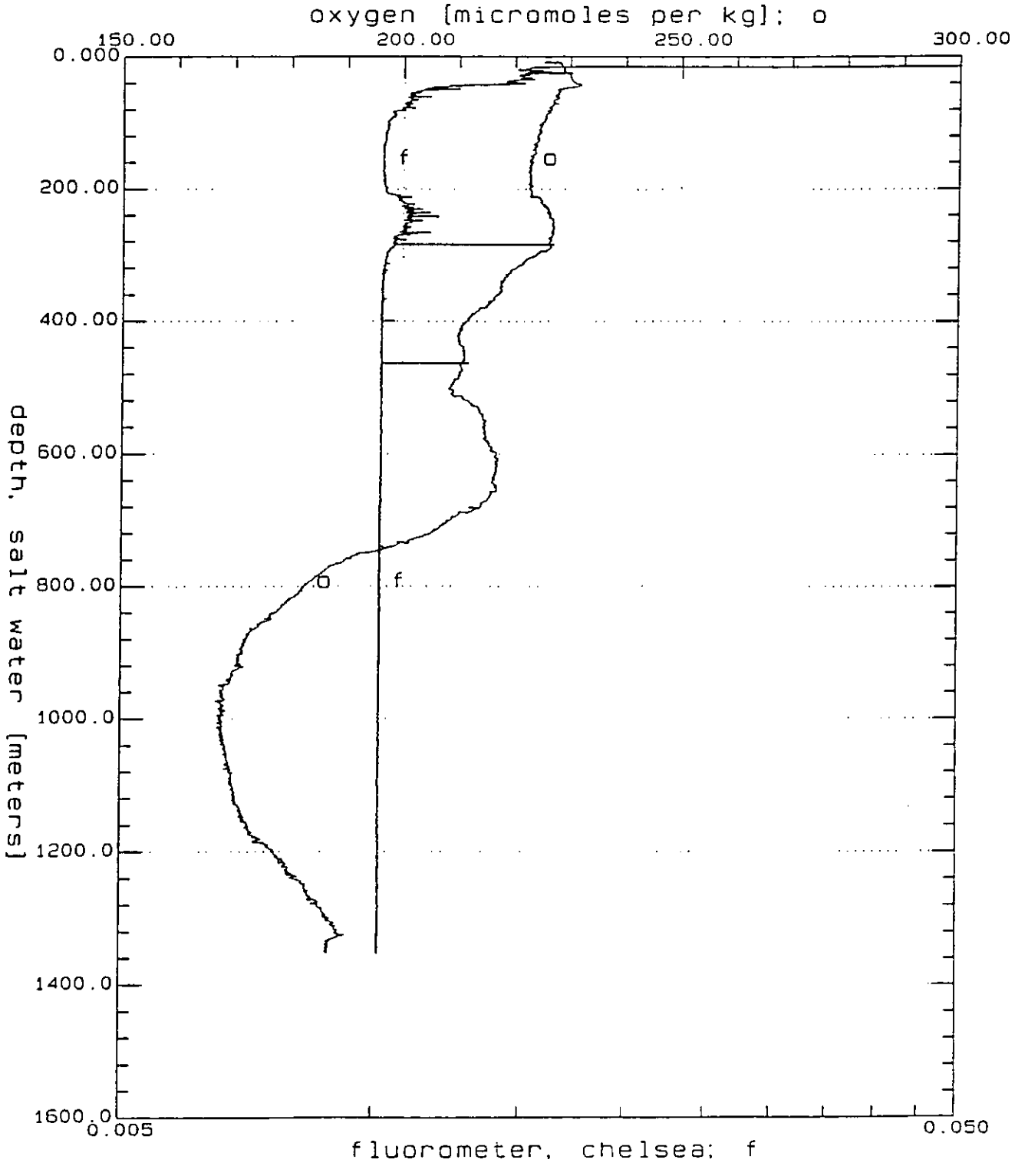
OMX9415.CNV: OMEX 94/12 Station 15 02.05.94 at 04h20.

Figure 45



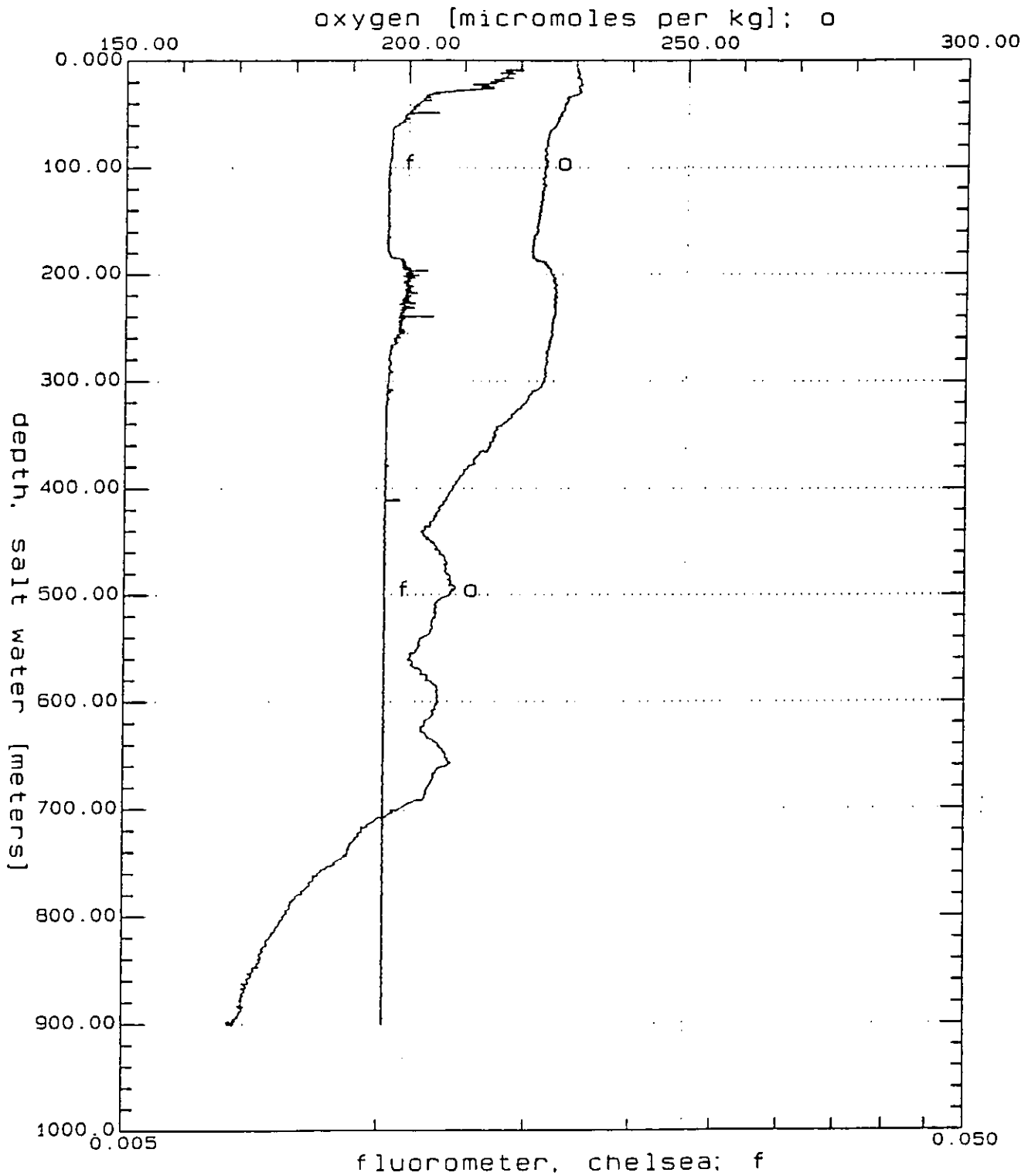
OMX9415A.CNV: OMEX 94/12 Station 15A 02.05.94 at 06h12.

Figure 46



OMX9417.CNV: OMEX 94/12 Station 17 02.05.94 at 18h55.

Figure 47



OMX9417A.CNV: OMEX 94/12 Station 17A 02.05.94 at 22h26.

Figure 48

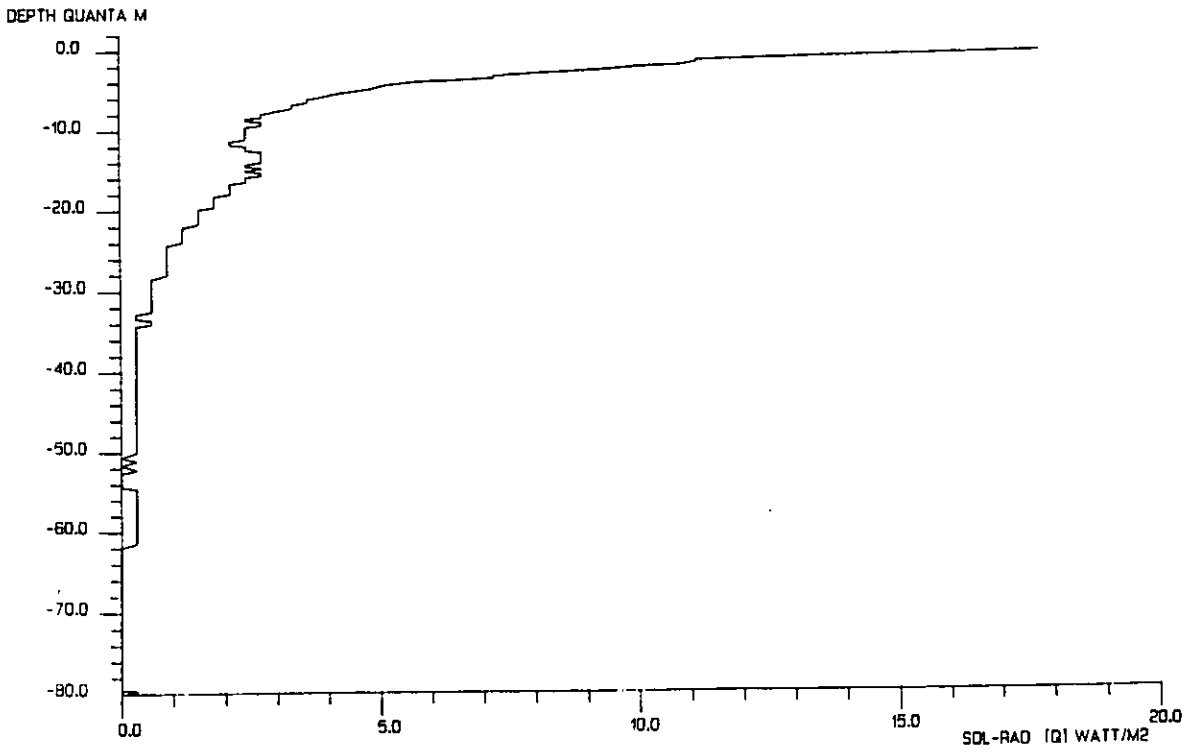
Appendix 6.

Vertical profiles of incident light (quantameter).

Figures 49 & 50

Campaign RV BELGICA 94/12.

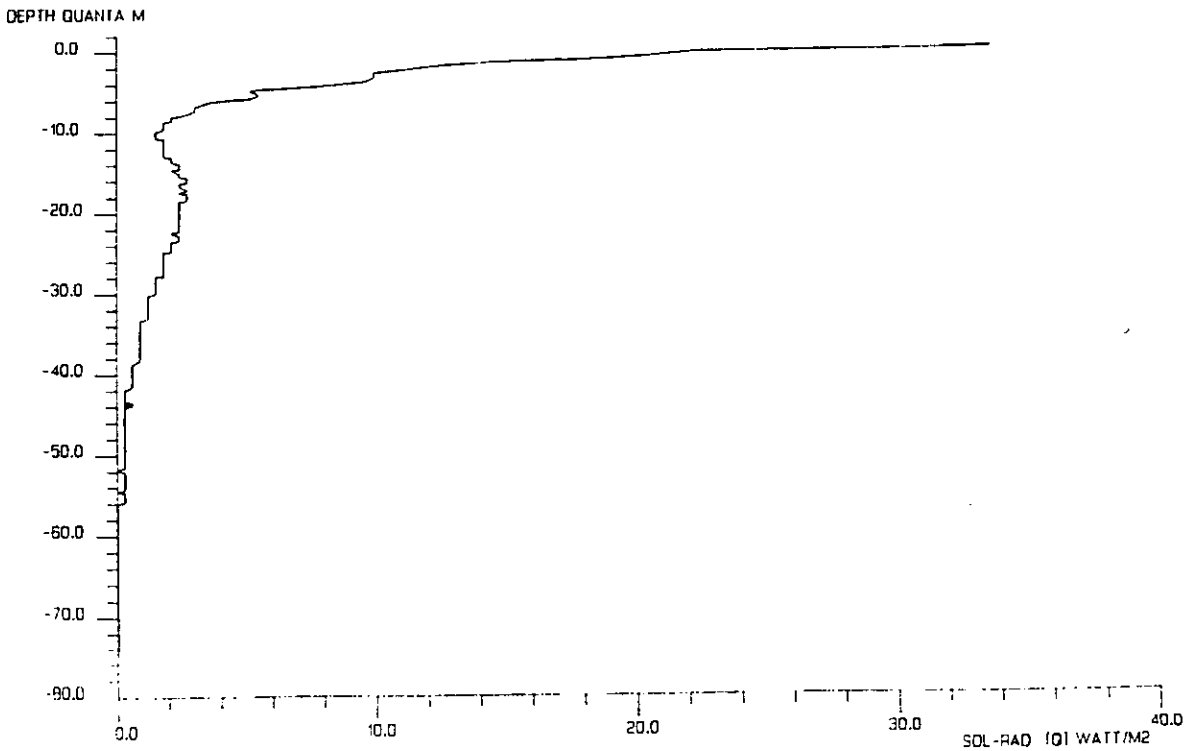
Light profile Station 02 21.04.94 09h37 GMT.



MUMM Meetdienst Oostende.

Campaign RV BELGICA 94/12.

Light profile Station 06 22.04.94 13h23 GMT.

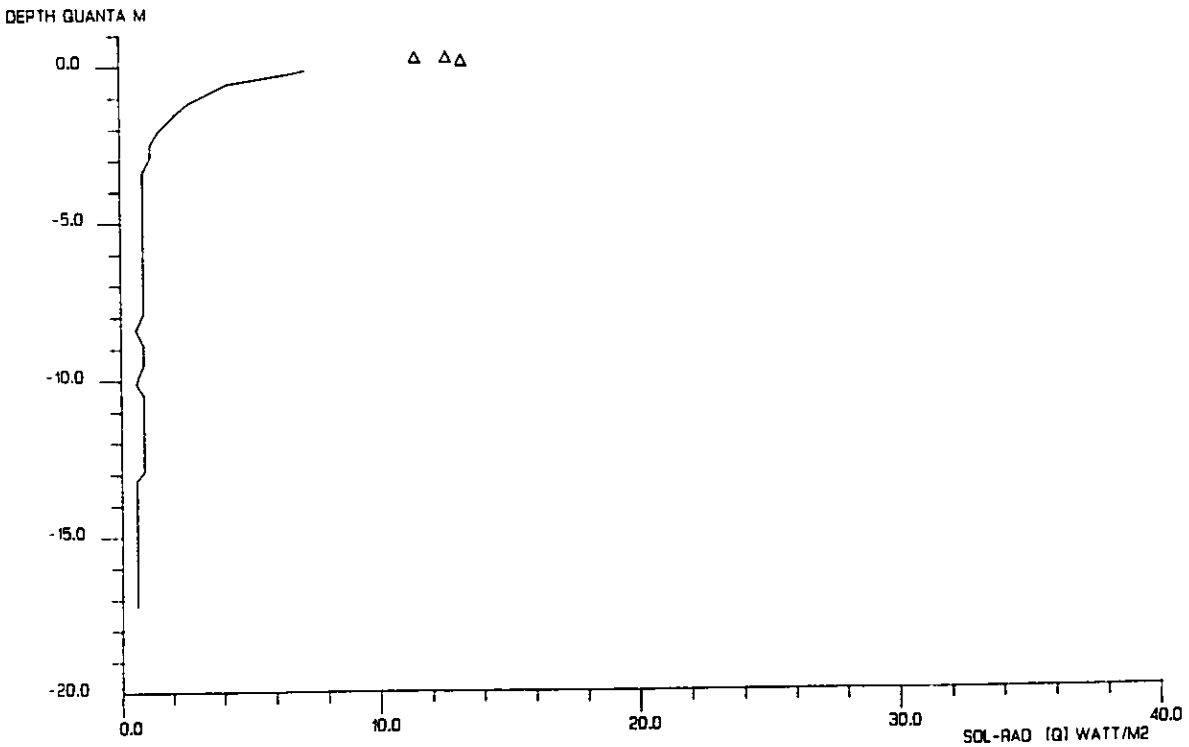


MUMM Meetdienst Oostende.

Figures 51 & 52

Campaign RV BELGICA 94/12.

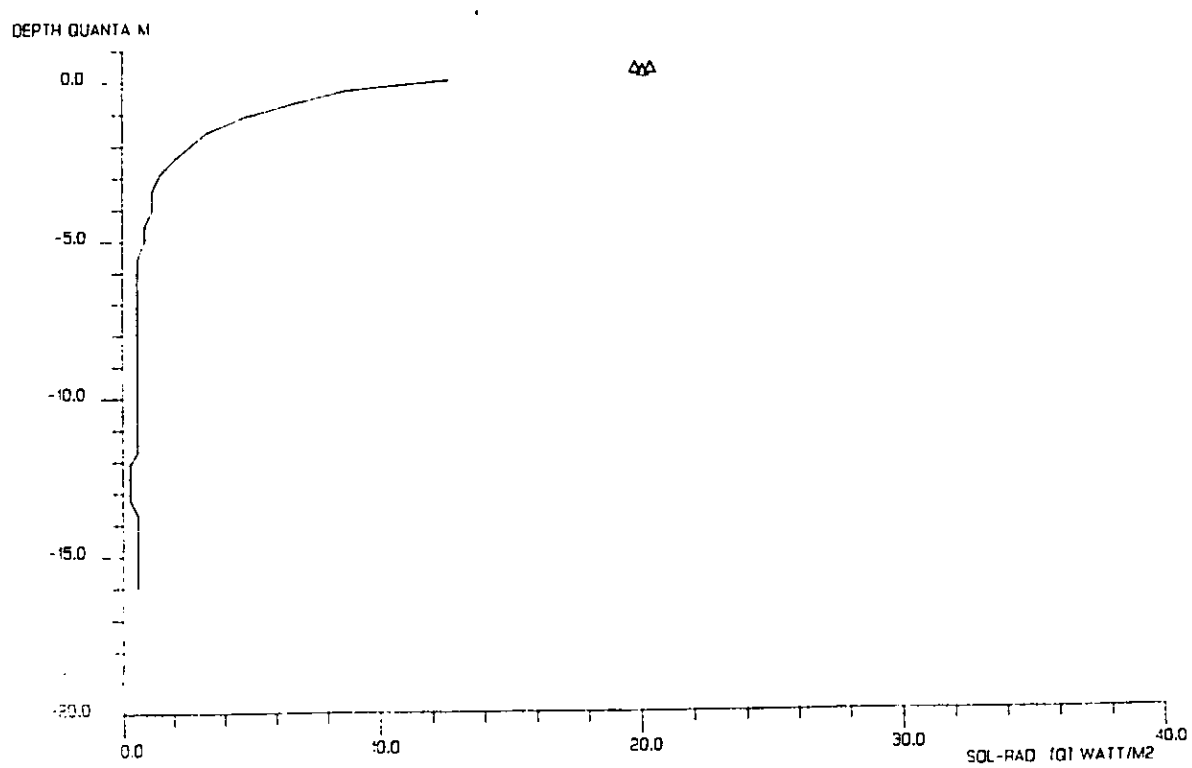
Light profile Station Holeopen Bay East 26.04.94 06h17 GMT.



MUMM Meetdienst Oostende.

Campaign RV BELGICA 94/12.

Light profile Station Holeopen Bay East 26.04.94 08h26 GMT.

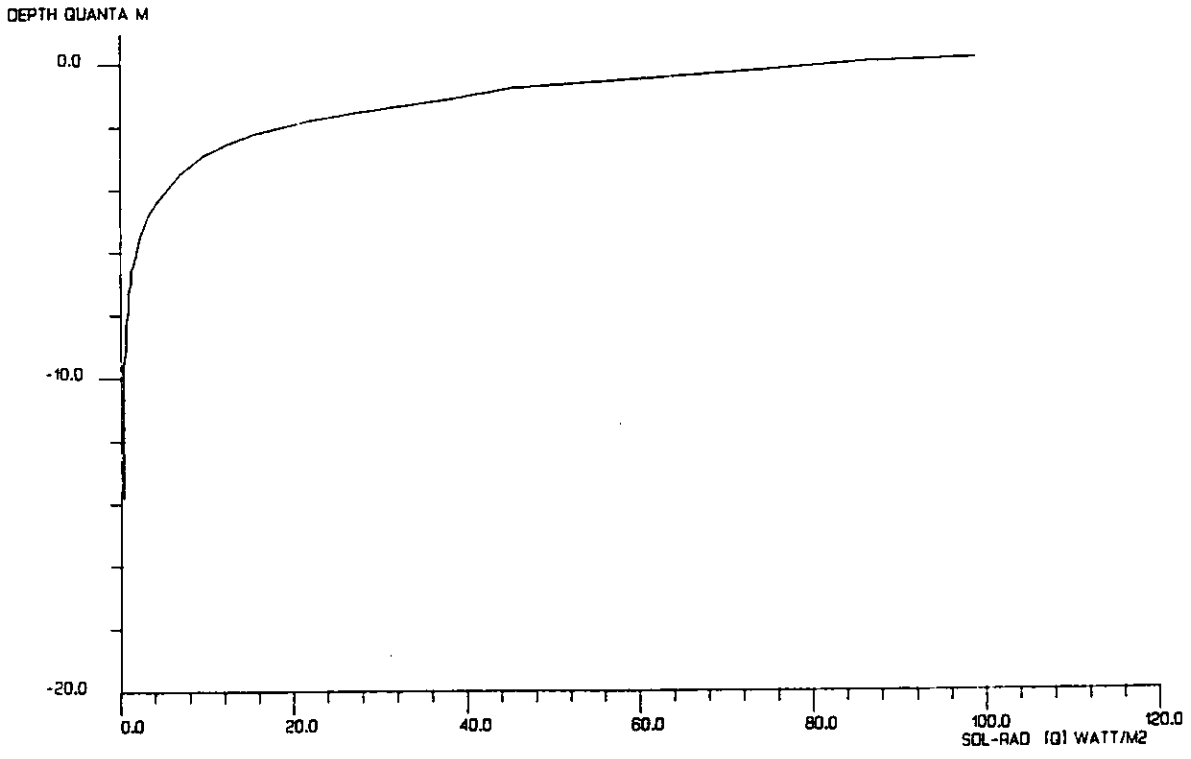


MUMM Meetdienst Oostende.

Figures 53 & 54

Campaign RV BELGICA 94/12.

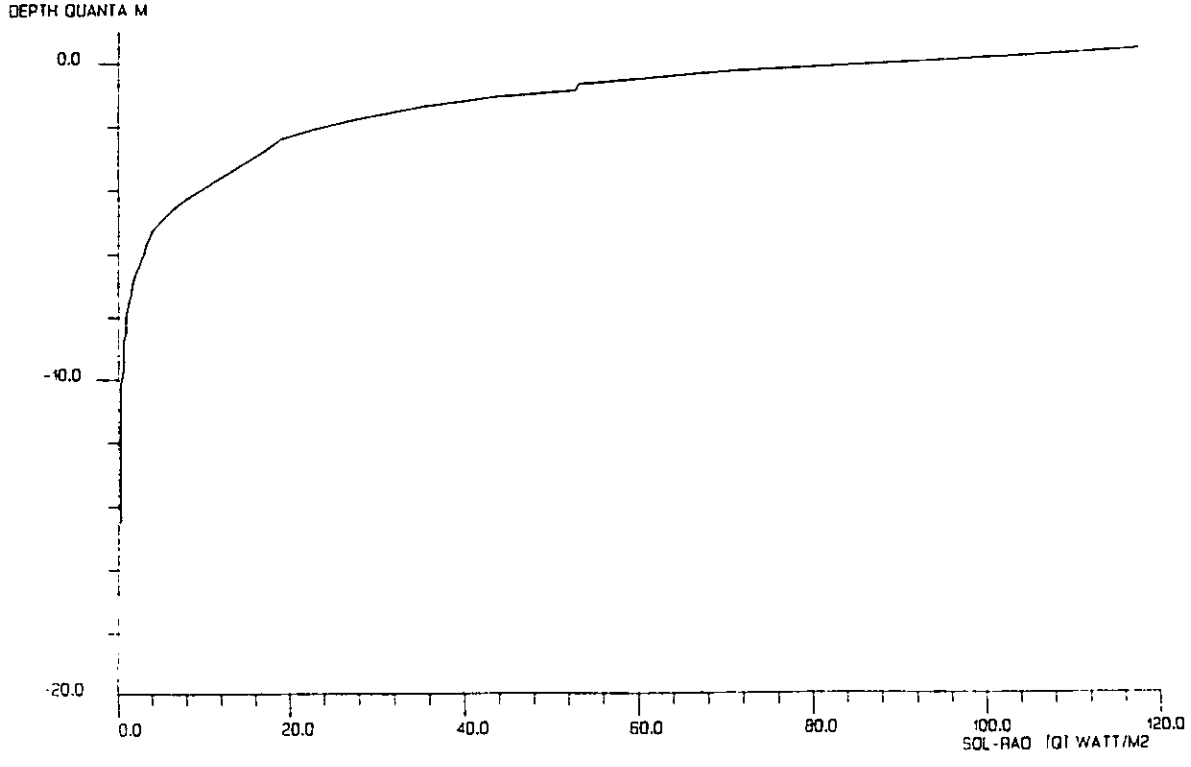
Light profile Station Holeopen Bay East 26.04.94 11h15 GMT.



MUMM Meetdienst Oostende.

Campaign RV BELGICA 94/12.

Light profile Station Holeopen Bay East 26.04.94 13h20 GMT.

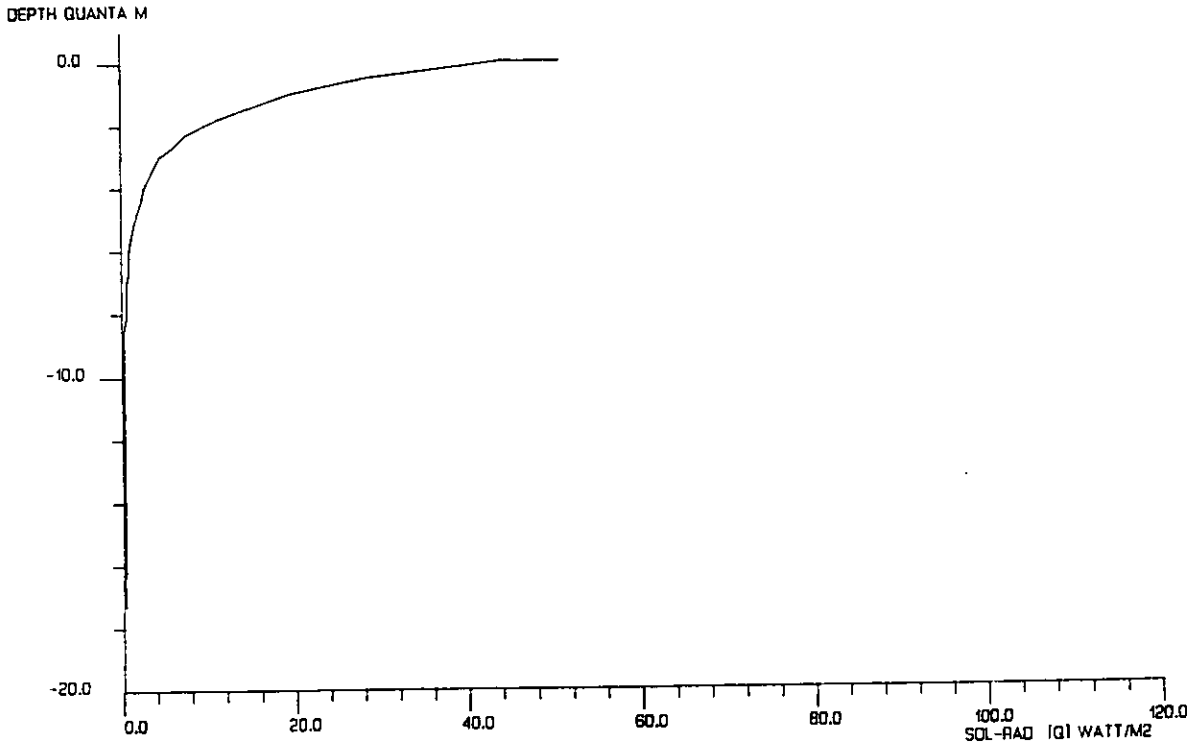


MUMM Meetdienst Oostende.

Figures 55 & 56

Campaign RV BELGICA 94/12.

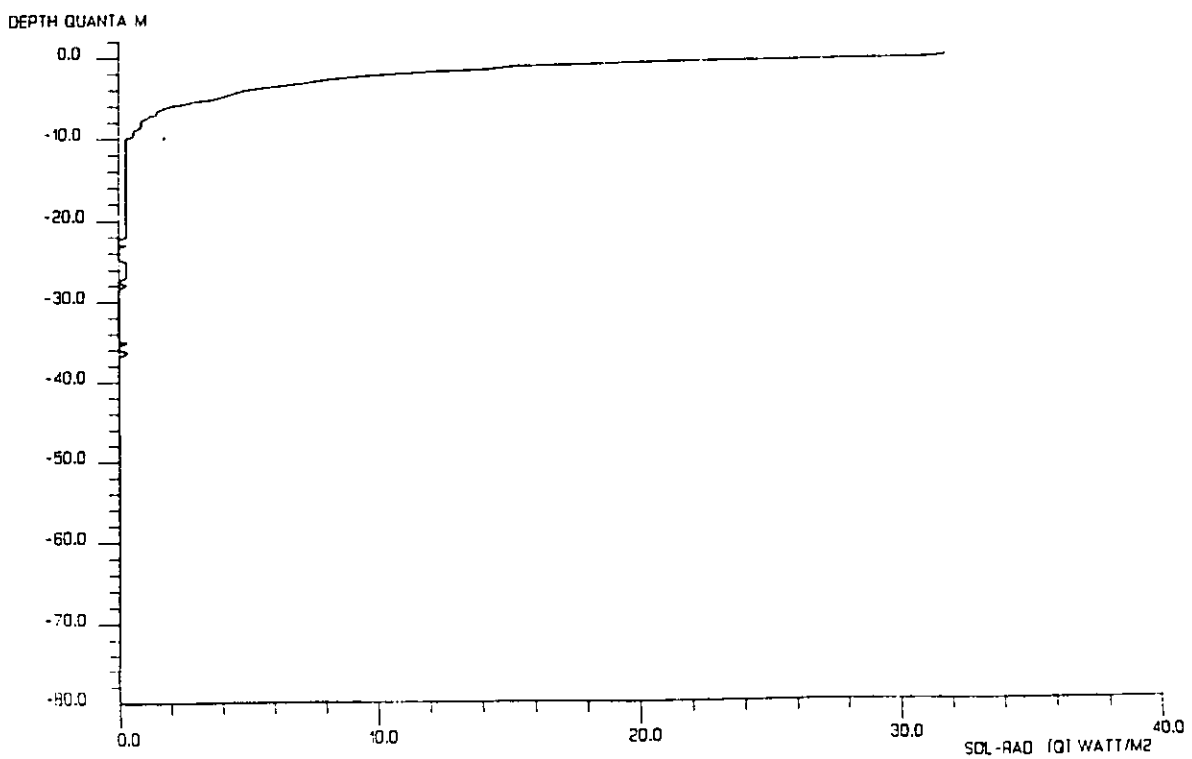
Light profile Station Holeopen Bay East 26.04.94 15h49 GMT.



MUMM Meetdienst Oostende.

Campaign RV BELGICA 94/12.

Light profile Station Celtic Sea 27.04.94 11h45 GMT.

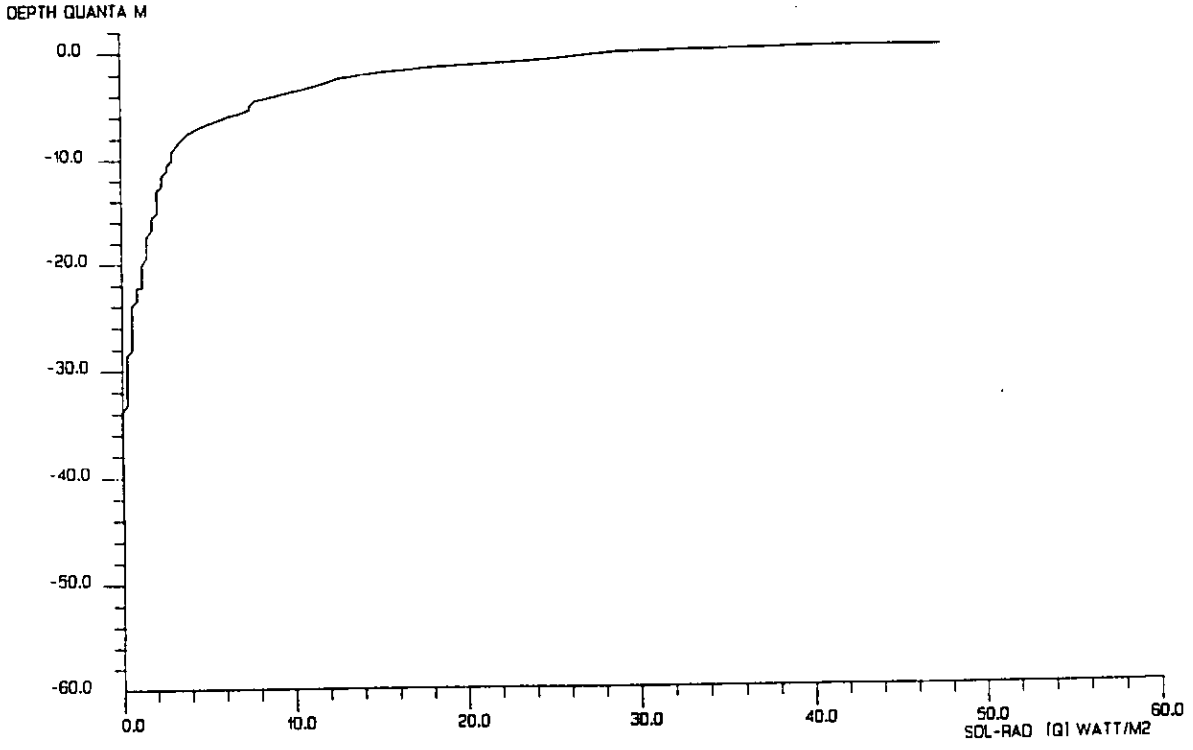


MUMM Meetdienst Oostende.

Figures 57 & 58

Campaign RV BELGICA 94/12.

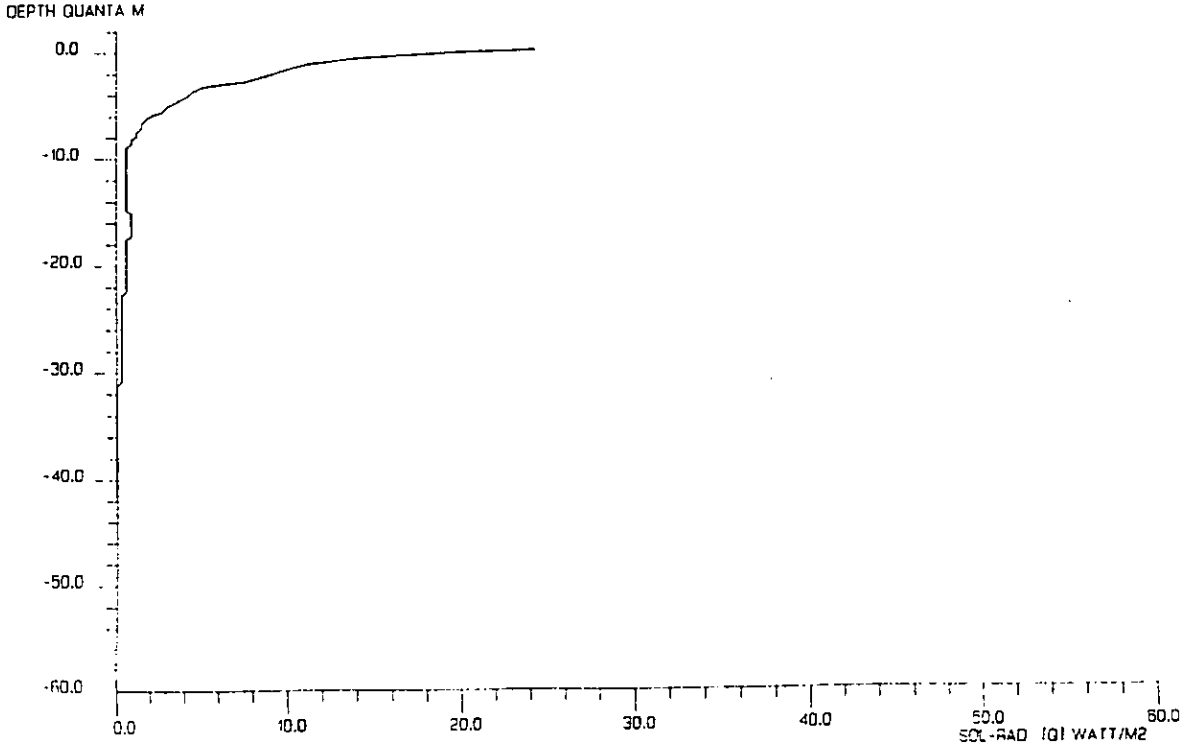
Light profile Station 15 02.05.94 08h37 GMT.



MUMM Meetdienst Oostende.

Campaign RV BELGICA 94/12.

Light profile Station 17 02.05.94 14h35 GMT.



MUMM Meetdienst Oostende.

Appendix 7.

Satellite images of the surface watertemperature.

Appendix 7. Satellite images of the surface watertemperature

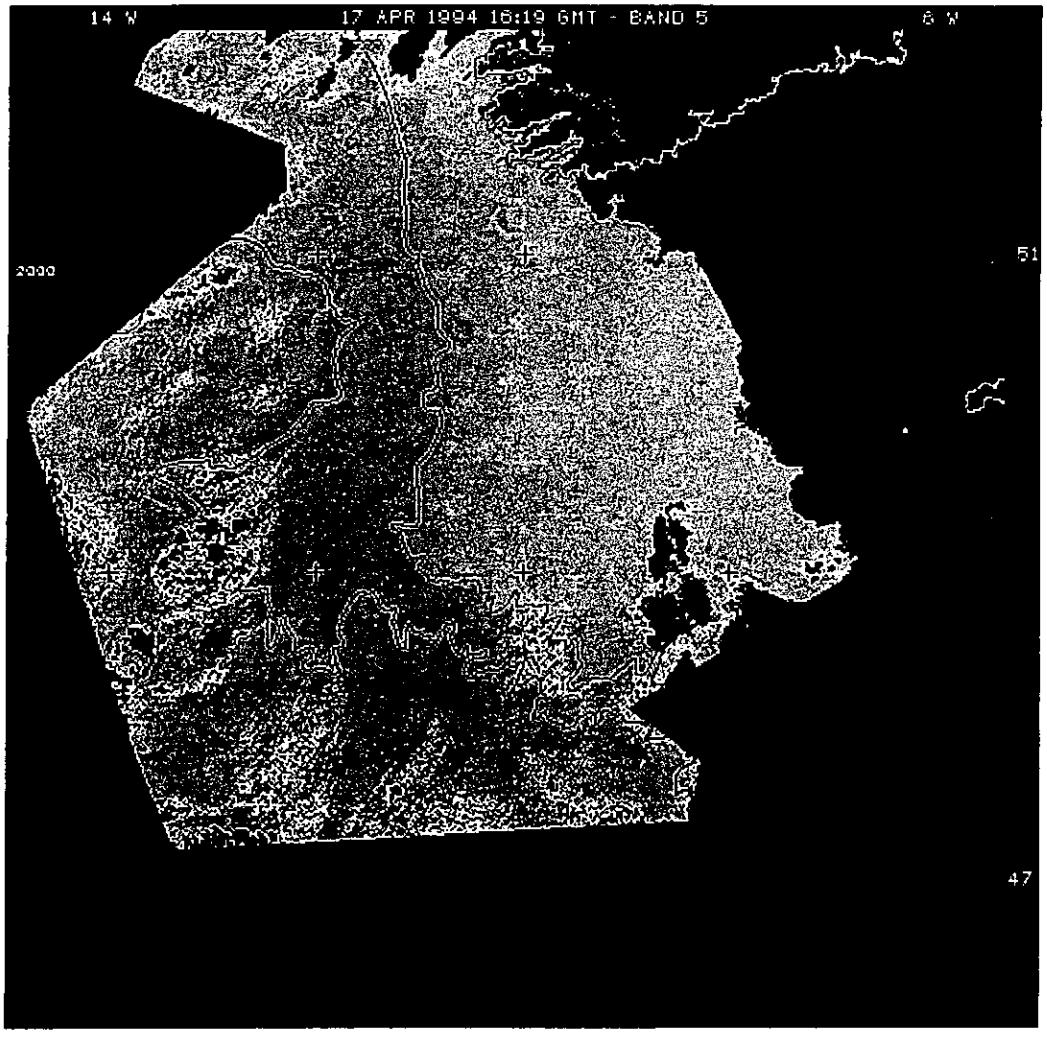


Image 1: Celtic Sea
17-04-94 at 16:19 GMT

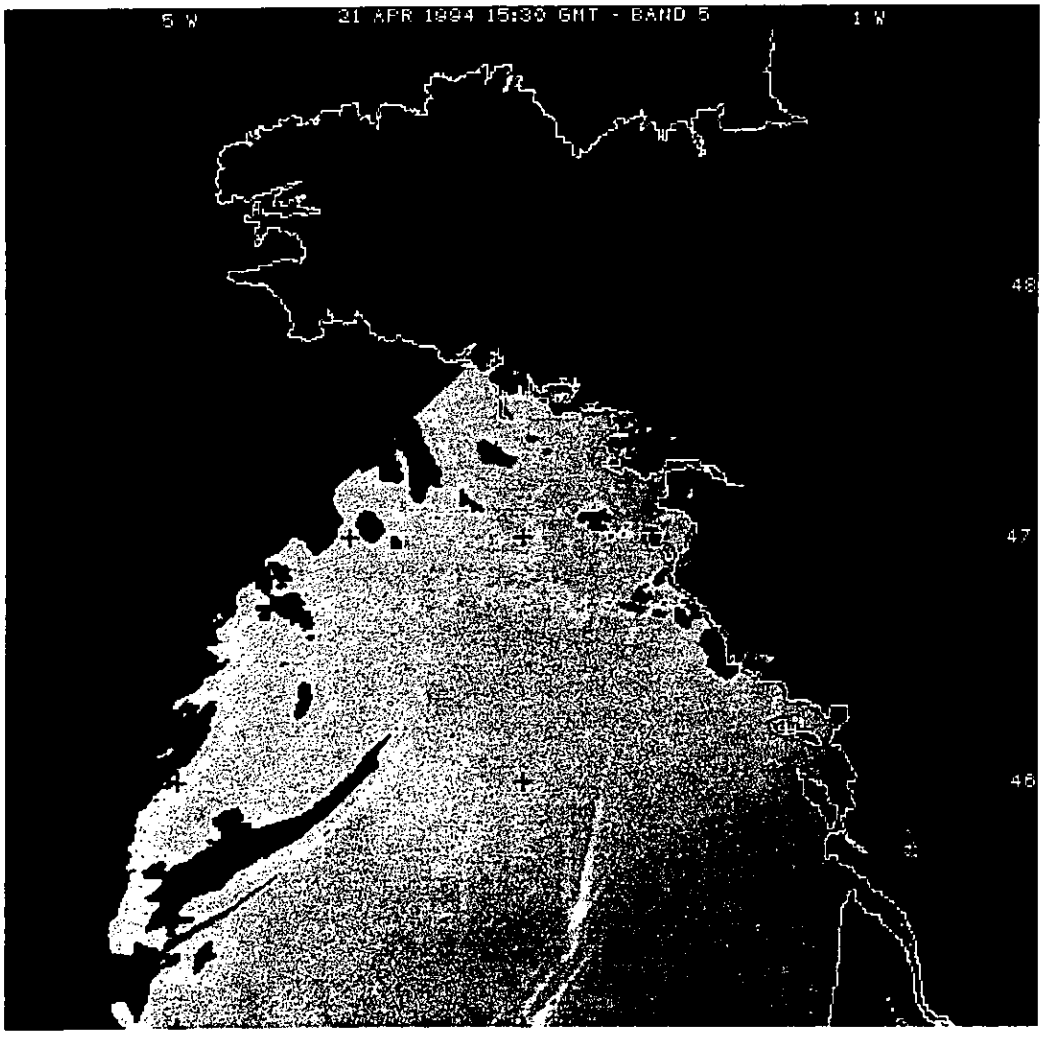


Image 2: Gulf of Biscay
21-04-94 at 15:30 GMT